

# NFPA® 1981

## Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services

### 2013 Edition



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## NFPA® 1981

### Standard on

## Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services

### 2013 Edition

This edition of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, was prepared by the Technical Committee on Respiratory Protection Equipment and released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on November 27, 2012, with an effective date of December 17, 2012, and supersedes all previous editions.

This edition of NFPA 1981 was approved as an American National Standard on December 17, 2012.

### Origin and Development of NFPA 1981

The first NFPA document to address fire fighter respiratory protection was NFPA 19B, *Standard on Respiratory Protective Equipment for Fire Fighters*. NFPA 19B was adopted on May 17, 1971, at the Association's Annual Meeting in San Francisco, California. It was developed by the Sectional Committee on Protective Equipment for Fire Fighters of the Technical Committee on Fire Department Equipment. After 1975, the Sectional Committee was removed from the Technical Committee on Fire Department Equipment and made its own technical committee. The main thrust of NFPA 19B was to prohibit filter-type canister masks for fire fighters and permit only self-contained breathing apparatus. NFPA 19B was officially withdrawn by the Association on May 19, 1981, at the Annual Meeting in Dallas, Texas.

NFPA 1981, *Standard on Self-Contained Breathing Apparatus for Fire Fighters*, was adopted at the same meeting to replace NFPA 19B. That first edition of NFPA 1981 essentially specified NIOSH/MSHA-approved SCBA with a minimum rated service life of 30 minutes. Open-circuit SCBA was required to be positive pressure.

The Technical Committee on Protective Equipment for Fire Fighters undertook a complete revision of NFPA 1981 to state performance requirements and appropriate testing procedures designed to simulate various environmental conditions to which fire fighters' SCBA can be exposed during use and storage. These requirements are in addition to the basic NIOSH/MSHA certification requirements, and now NFPA 1981 applies to open-circuit SCBA.

The second edition of NFPA 1981 was completed in March 1986 and adopted by the Association at the 1987 Annual Meeting in Cincinnati, Ohio.

After the second edition, the name of the Technical Committee was changed to Fire Service Protective Clothing and Equipment, and a standing Subcommittee on Self-Contained Breathing Apparatus was established.

The third edition, in 1992, incorporated new requirements for third-party certification and quality control, as well as a new total heat and flame test for the entire apparatus. Other test methods covering facepiece lens abrasion and communications were revised.

The third edition was completed in December 1991 and presented to the Association at the 1992 Annual Meeting in New Orleans, Louisiana.

In January 1995, the Standards Council reorganized the entire project for fire service protective clothing and equipment. The new project was given a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on Self-Contained Breathing Apparatus was changed to the new Technical Committee on Respiratory Protection and Personal Alarm Equipment.

The fourth edition, presented to the Association membership at the 1997 Annual Meeting in Los Angeles, California, incorporated new requirements for surrogate cylinders to replace

the actual breathing gas cylinders during the vibration testing to ensure a higher level of safety during this rigorous test. A new requirement for redundant end-of-service-time indicators (EOSTI) was added to provide a better level of safety in case of failure of one end-of-service-time indicator.

The fifth edition of NFPA 1981 was presented to the NFPA membership at the 2002 Annual Meeting in Minneapolis, Minnesota, on May 19, 2002. That edition incorporated new requirements for heads-up displays (HUD) that provide visual information and warnings to SCBA wearers of the status of the SCBA's air supply and, where the HUD is powered by a power source, the power source status. Those new requirements were in response to fire service requests for the provision of user-friendly information for SCBA wearers so they can better understand their environment and limitations.

Also in response to strong fire service input to the Committee, new requirements were specified for a single universal air connection located in a specific position on all new SCBA certified as compliant with the 2002 edition of NFPA 1981, and existing SCBA that could be upgraded and certified as compliant with the 2002 edition of NFPA 1981. The RIC UAC [RIC stands for *rapid intervention company* or *crew* (sometimes called RIT for *rapid intervention team*, or FAST company or crew); UAC stands for *universal air connection*] permits the breathing air cylinder of an SCBA user to be replenished from an independent rescue breathing air supply source when the SCBA user is trapped or unable to be removed from a hazardous atmosphere. The RIC UAC does not take breathing air from an SCBA being worn by a member of the rescue operation but replenishes the victim's breathing air cylinder from a source of "rescue breathing air," such as a rescue breathing air cylinder or a high-pressure breathing air supply line. The RIC UAC is not a "buddy breathing" device — it does not permit the sharing of a single SCBA breathing air source between two persons. NIOSH does not permit or certify any buddy breathing system that allows two users to share a single breathing air source. Because NFPA 1981 requires NIOSH certification as a prerequisite to become certified as compliant with NFPA 1981, NFPA cannot permit buddy breathing systems, which would be in violation of NIOSH regulations.

The Committee continued to review and revise text for improved clarity and specificity, improved accuracy in testing and test result reporting, and added additional criteria to better evaluate and test the EOSTI.

In 2002, NFPA revised the format for its codes and standards, resulting in chapter, section, and paragraph numbers not matching or corresponding to those of previous editions.

The 2007 edition of NFPA 1981, the sixth edition, represented a complete revision and retitling of the standard as NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*.

While the Committee made several significant changes to the standard, a major change in the 2007 edition was the mandatory requirement for all emergency services SCBA to also be NIOSH certified as CBRN SCBA in accordance with the NIOSH *Statement of Standard for NIOSH CBRN SCBA Testing*. This requirement provided respiratory protection from CBRN terrorism agents (specified chemicals, biological agents, and radiological particulates) that could be released as a result of a terrorism attack.

Although major metropolitan areas are more likely targets of a terrorist event, emergency responders from smaller communities could be called upon to respond to urban areas where the emergency services have become overwhelmed by a terrorist incident. Terrorists themselves might be residing in smaller communities while they await the opportunity to strike, and if they have chemical, biological, or nuclear material in their possession, the possibility of exposure is even greater for those small, rural areas. Terrorist attacks aside, CBRN-certified SCBA offer greater protection for emergency services personnel at minimal cost.

CBRN certification offers verification of enhanced protection for emergency responders that is not otherwise available. Without CBRN protection evaluation, SCBA components are not tested for permeation, penetration, corrosion resistance, or other detrimental effects from exposure to toxic industrial chemicals during hazardous materials incidents and hazardous chemical warfare atmospheres. NIOSH benchmark testing of non-CBRN-hardened SCBA against CBRN agents demonstrated that chemical warfare agents (CWA) could cause catastrophic failures within minutes of exposure.

NIOSH's selection of the test challenge agents for CBRN protection was based on a comprehensive review of available technical data and consultations with other government agencies [e.g., Department of Defense (DoD), Department of Justice (DoJ), and Department of Energy (DoE)]. Various chemical data lists were analyzed, including lists from the Environmental Protection Agency (EPA); the Agency for Toxic Substances and Disease Registry (ATSDR); NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*; the U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM) Technical Guide 244; and other, classified sources. That analysis identified a total of 151 toxic industrial chemicals (TICs) and CWA as potential candidates for challenge agents. The candidate agents were evaluated for permeation (molecularly diffusing through material) and penetration (seeping through interfacing components) characteristics as part of a review of their physical properties. This evaluation concluded that Sarin (GB) and sulfur mustard (HD) could be selected as the two representative agents for the penetration/permeation test for the complete listing of 151 CWA and TICs due to their physical properties and molecular structure. NIOSH is unaware of any data that indicate that CBRN-certified SCBA provide less protection against TICs than their industrial counterparts.

The evaluation for CBRN protection provides verification and assurance that the component and material combinations in the approved SCBA configurations provided high resistance to permeation and penetration of hazardous atmospheres of TICs and materials into the breathing air. This is of importance to all responders subject to extreme exposures to any hazardous industrial chemicals and materials.

In addition to the new CBRN requirement, the following significant requirements were added to increase the safety to the users of emergency services SCBA and to better assure the proper functioning of the SCBA:

- (1) New breathing air cylinder retention requirement within the mounted position
- (2) Mechanical voice diaphragm performance requirement increased to 80 percent minimum score at 1.5 m (4.9 ft) distance
- (3) New voice communications system with at least an 85 percent score at 3 m (10 ft) distance
- (4) New independent pressure gauge that would not be affected by failure of the heads-up display (HUD)
- (5) New water immersion requirements for electronic devices that are part of the SCBA that must function properly and remain watertight after six exposures to 177°C (350°F) for 15 minutes and water submersion to 1.5 m (4.9 ft)
- (6) New low power capacity requirements for electronic devices to assure that such devices will continue to function properly for at least 2 hours following activation of the low power source signal

The 2013 edition of NFPA 1981, the seventh edition, represents a complete revision of the standard. Among the many changes included in this edition is a new section on Emergency Breathing Safety Systems (EBSS), in response to correspondence that the Technical Committee on Respiratory Protection Equipment received from the National Institute for Occupational Safety and Health (NIOSH) that indicated NIOSH's intention to modify its existing policy on buddy breathers. For the complete text of this letter, please see the NFPA 1981 F12 *Report on Comments* (ROC), 1981–1, LOG #21.

Also in this edition are new definitions for terms related to speech intelligibility, including speech transmission index (STI), sound pressure level (SPL), mouth reference point (MRP), and microphone measurement point (MMP).

The technical committee has also modified the performance requirements for the nonelectronic communications performance test and the supplementary voice communications system performance test. Several additional new tests have been added, including an emergency breathing safety system cold temperature performance test, a lens radiant heat test, and a lens convective heat and flame resistance test.

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**Committee Scope:** This Committee shall have primary responsibility for documents on the design, performance, testing, and certification of protective clothing and protective equipment manufactured for fire and emergency services organizations and personnel, to protect against exposures encountered during emergency incident operations. This Committee shall also have the primary responsibility for documents on the selection, care, and maintenance of such protective clothing and protective equipment by fire and emergency services organizations and personnel.





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**Committee Scope:** This Committee shall have primary responsibility for documents on respiratory equipment, including breathing air, for fire and emergency services personnel during incidents involving hazardous or oxygen deficient atmospheres. This Committee shall also have primary responsibility for documents on the selection, care, and maintenance of respiratory protection equipment and systems by fire and emergency services organizations and personnel.



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## NFPA 1981

## Standard on

## Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services

## 2013 Edition

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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

## Chapter 1 Administration

## 1.1 Scope.

**1.1.1\*** This standard shall specify the minimum requirements for the design, performance, testing, and certification of new compressed breathing air open-circuit self-contained breathing apparatus (SCBA) and compressed breathing air combination open-circuit self-contained breathing apparatus and supplied air respirators (SCBA/SARs) and for the replacement parts, components, and accessories for these respirators.

**1.1.2** This standard shall also specify the minimum requirements for the design, performance, testing, and certification of replacement parts, components, and add-on accessories for SCBA and combination SCBA/SARs certified as compliant to specific earlier editions of this standard.

**1.1.3** This standard shall not specify requirements for other types of SCBA.

**1.1.4\*** This standard shall not specify requirements for any accessories that could be attached to the certified product that are not certified by the National Institute for Occupational Safety and Health (NIOSH).

**1.1.5** This standard shall not establish criteria for SCBA for water or underwater operations.

**1.1.6** This standard shall not establish criteria for protection from ionizing radiation.

**1.1.7** This standard shall not be construed as addressing all of the safety concerns associated with the use of compliant SCBA and combination SCBA/SARs. It shall be the responsibility of the persons and organizations that use compliant SCBA and combination SCBA/SARs to establish safety and health prac-

tices and to determine the applicability of regulatory limitations prior to use.

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

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

## 1.2 Purpose.

**1.2.1** The purpose of this standard shall be to establish minimum levels of protection for emergency services personnel from atmospheres that are categorized as immediately dangerous to life and health (IDLH) atmospheres.

**1.2.2\*** Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all respiratory protective situations and IDLH atmospheres to which personnel can be exposed.

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

## 1.3 Application.

**1.3.1** This standard shall apply to all open-circuit SCBA and combination SCBA/SARs used by emergency services organizations for respiratory protection of its personnel during fire-fighting, rescue, hazardous materials, terrorist incident, and similar operations where products of combustion, oxygen deficiency, particulates, toxic products, or other IDLH atmospheres exist or could exist at the incident scene.

**1.3.1.1\*** If the SCBA is equipped with an EBSS, the EBSS performance requirements set forth in this standard shall apply only to open-circuit SCBA and combination SCBA/SARs used by the fire service for respiratory protection of its personnel during the applications listed in 1.3.1.

**1.3.2** This standard shall apply to the design, manufacturing, and certification of new open-circuit SCBA and combination SCBA/SARs and shall apply to replacement parts, components, and add-on accessories for such respirators certified as compliant to specific earlier editions of this standard.

**1.3.3** This standard shall apply to accessories attached to the SCBA that are certified by NIOSH for use with that specific SCBA or combination SCBA/SARs.

**1.3.4** This standard shall not apply to open-circuit SCBA and combination SCBA/SARs manufactured according to previous editions of this standard; however, organizations shall be permitted to have open-circuit SCBA and combination SCBA/SARs that are certified as compliant with previous editions of this standard and modified to become compliant with this edition of NFPA 1981.

**1.3.5** This standard shall not apply to closed-circuit SCBA.

**1.3.6** This standard shall not apply to accessories that can be attached to an open-circuit SCBA and combination SCBA/



SARs but are not certified by NIOSH for use with that specific SCBA or combination SCBA/SARs.

**1.3.7** This standard shall not apply to the use of SCBA and combination SCBA/SARs; those requirements are specified in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*.

#### 1.4 Units.

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

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

## Chapter 2 Referenced Publications

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

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

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2013 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2013 edition.

NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*, 2013 edition.

#### 2.3 Other Publications.

**2.3.1 AATCC Publications.** American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

AATCC 135, *Dimensional Changes of Fabrics After Home Laundering*, 2004.

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

ANSI B46.1, *Surface Texture*, 1978.

ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems*, 1989.

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

ANSI Y14.SM, *Dimensioning and Tolerancing*, 1982.

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

ASTM B 16, *Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines*, 2000.

ASTM B 117, *Standard Test Method for Salt Spray (Fog) Testing*, 2003.

ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, 2000.

ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, 1999.

ASTM E 162, *Standard Test Method for Surface Flammability of Materials Using Radiant Heat Energy Source*, 2012.

**2.3.4 EBU Publications.** EBU (European Broadcasting Union) Department of Technology & Innovation, L'Ancienne-Route 17A, CH-1218 Grand-Saconnex, Geneva, Switzerland.

EBU Technical Recommendation R68, *Alignment level in digital audio production equipment and in digital audio recorders*, 2000.

**2.3.5 EN Publications (CEN).** European Committee for Standardization Central Secretariat, rue de Stassart 36, B 1050 Brussels, Belgium.

EN 136, *Respiratory protective devices — Full face masks — Requirements, testing, marking*, 1998.

**2.3.6 IEC Publications.** International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 60268, *Sound System Equipment — Part 16: Objective Rating of Speech Intelligibility by Speech Transmission Index*, 2003.

**2.3.7 ISO Publications.** International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH-1211 Genève 20, Switzerland.

ISO 9001, *Quality management systems — Requirements*, 2000.

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

ISO 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*, 2006.

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

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

ISO/IEC Guide 62, *General requirements for bodies operating assessment and certification/registration of quality systems*, 1996.

ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*, 1996.

**2.3.8 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

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

**2.3.9 U.S. Government Publications.** U.S. Government Printing Office, Washington, DC 20402.

*Statement of Standard for NIOSH CBRN SCBA Testing*, 2002.

Title 42, Code of Federal Regulations, Part 84, "Respiratory Protective Devices, Tests for Permissibility," 8 June 1995.

#### 2.3.10 Other Publications.

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

#### 2.4 References for Extracts in Mandatory Sections. (Reserved)

## Chapter 3 Definitions

**3.1 General.** The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within



the context in which they are used. *Meriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

### 3.2 NFPA Official Definitions.

**3.2.1\* Approved.** Acceptable to the authority having jurisdiction.

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

**3.2.3 Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

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

**3.2.5 Shall.** Indicates a mandatory requirement.

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

**3.2.7 Standard.** A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents*.

### 3.3 General Definitions.

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

**3.3.2 Atmosphere-Supplying Respirator.** A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere and includes self-contained breathing apparatus (SCBA) and supplied air respirators (SAR). [See also 3.3.10, *Combination SCBA/SAR*; 3.3.46, *Self-Contained Breathing Apparatus (SCBA)*; and 3.3.51, *Supplied Air Respirator (SAR)*.]

**3.3.3 Breathing Air.** See 3.3.13, *Compressed Breathing Air*.

**3.3.4 Breathing Air Cylinder.** The pressure vessel or vessels that are an integral part of the SCBA and that contain the breathing gas supply; can be configured as a single cylinder or other pressure vessel, or as multiple cylinders or pressure vessels.

**3.3.5 Breathing Air/Gas Container.** See 3.3.4, *Breathing Air Cylinder*.

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

**3.3.7 Certification/Certified.** A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to use a label on listed products that comply with the requirements of this standard, and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine continued compliance of labeled and listed products with the requirements of this standard. (See also 3.3.33, *NIOSH Certified*.)

**3.3.8 Char.** The formation of a brittle residue when material is exposed to thermal energy.

**3.3.9 Closed-Circuit SCBA.** A recirculation-type SCBA in which the exhaled gas is rebreathed by the wearer after the carbon dioxide has been removed from the exhalation gas and the oxygen content within the system has been restored from sources such as compressed breathing air, chemical oxygen, liquid oxygen, or compressed gaseous oxygen.

**3.3.10\* Combination SCBA/SAR.** An atmosphere-supplying respirator that supplies a respirable atmosphere to the user from a combination of two breathing air sources that both are independent of the ambient environment. [See also 3.3.2, *Atmosphere-Supplying Respirator*; 3.3.46, *Self-Contained Breathing Apparatus (SCBA)*; and 3.3.51, *Supplied Air Respirator (SAR)*.]

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

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

**3.3.13\* Compressed Breathing Air.** A respirable gas mixture derived from either normal atmospheric air or from manufactured synthetic air, stored in a compressed state in storage cylinders and respirator breathing air cylinders, and supplied to the user in a gaseous form.

**3.3.14 Cylinder.** See 3.3.4, *Breathing Air Cylinder*.

**3.3.15 Demand SCBA.** See 3.3.32, *Negative Pressure SCBA*.

**3.3.16 Drip.** To run or fall in drops or blobs.

**3.3.17 EBSS.** Abbreviation for emergency breathing safety system.

**3.3.18 Emergency Breathing Safety System (EBSS).** A device on an SCBA that allows users to share their available air supply in an emergency situation.

**3.3.19 End-of-Service-Time Indicator (EOSTI).** A warning device on an SCBA that alerts the user that the reserve air supply is being utilized.

**3.3.20 Fabric Component.** Any single or combination of natural or synthetic material(s) that are pliable and that are made by weaving, felting, forming, or knitting.

**3.3.21 Facepiece.** The component of an SCBA that covers the wearer's nose, mouth, and eyes.

**3.3.22 Follow-up Program.** The sampling, inspections, tests, or other measures conducted by the certification organization on a periodic basis to determine the continued compliance of



labeled and listed products that are being produced by the manufacturer to the requirements of this standard.

**3.3.23 Gas.** Matter in a gaseous state at standard temperature and pressure.

**3.3.24 Haze.** Light that is scattered as a result of passing through a transparent object.

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

**3.3.26 Heads-Up Display (HUD).** Visual display of information and system condition status visible to the wearer.

**3.3.27 Identical SCBA.** SCBA that are produced to the same engineering and manufacturing specifications.

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

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

**3.3.30 Microphone Measurement Point (MMP).** A point 1.5 m in front of and on the axis of the lip position of typical human mouth (or artificial mouth) and 1.5 m above the floor.

**3.3.31 Mouth Reference Point (MRP).** A point 50 mm in front of and on the axis of the lip position of a typical human mouth (or artificial mouth).

**3.3.32 Negative Pressure SCBA.** An SCBA in which the pressure inside the facepiece, in relation to the pressure surrounding the outside of the facepiece, is negative during any part of the inhalation or exhalation cycle when tested by NIOSH in accordance with 42 CFR 84.

**3.3.33\* NIOSH Certified.** Tested and certified by the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Department of Health and Human Services in accordance with the requirements of 42 CFR 84, Subpart H.

**3.3.34 Open-Circuit SCBA.** An SCBA in which exhalation is vented to the atmosphere and not rebreathed.

**3.3.35 Pink Noise.** Noise that contains constant energy per octave band.

**3.3.36 Positive Pressure SCBA.** An SCBA in which the pressure inside the facepiece, in relation to the pressure surrounding the outside of the facepiece, is positive during both inhalation and exhalation when tested by NIOSH in accordance with 42 CFR 84, Subpart H.

**3.3.37 Pressure Demand SCBA.** See 3.3.36, Positive Pressure SCBA.

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

**3.3.39 Rapid Intervention Crew/Company Universal Air Connection (RIC UAC).** A system that allows emergency replenishment of breathing air to the SCBA of disabled or entrapped fire or emergency services personnel.

**3.3.40 Rated Service Time.** The period of time, stated on the SCBA's NIOSH certification label, that the SCBA supplied air to the breathing machine when tested to 42 CFR 84, Subpart H.

**3.3.41 Reserve Air Supply.** The period of time available for emergency egress, self-rescue, or assisted rescue.

**3.3.42 RIC.** Abbreviation for rapid intervention crew/company.

**3.3.43 SAR.** Abbreviation for supplied air respirator. [See 3.3.51, *Supplied Air Respirator (SAR)*.]

**3.3.44 SCBA.** Abbreviation for self-contained breathing apparatus. [See 3.3.46, *Self-Contained Breathing Apparatus (SCBA)*.]

**3.3.45 SCBA/SAR.** Abbreviation for combination open-circuit SCBA and supplied air respirator. [See 3.3.10, *Combination SCBA/SAR*; 3.3.46, *Self-Contained Breathing Apparatus (SCBA)*; and 3.3.51, *Supplied Air Respirator (SAR)*.]

**3.3.46\* Self-Contained Breathing Apparatus (SCBA).** An atmosphere-supplying respirator that supplies a respirable air atmosphere to the user from a breathing air source that is independent of the ambient environment and designed to be carried by the user.

**3.3.47 Service Life.** The period for which compliant product may be useful before retirement.

**3.3.48 Service Time.** See 3.3.40, Rated Service Time.

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

**3.3.50 Speech Transmission Index (STI).** A measure of intelligibility of speech quality on a scale of intelligibility, whose values vary from 0 (completely unintelligible) to 1 (perfect intelligibility).

**3.3.51\* Supplied Air Respirator (SAR).** An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user; also known as an *airline respirator*. [See also 3.3.2, *Atmosphere-Supplying Respirator*; 3.3.10, *Combination SCBA/SAR*; and 3.3.46, *Self-Contained Breathing Apparatus (SCBA)*.]

**3.3.52 Synthetic Breathing Air.** A manufactured breathing air that is produced by blending nitrogen and oxygen. (See also 3.3.13, *Compressed Breathing Air*.)

**3.3.53 UAC.** Abbreviation for universal air connection.

**3.3.54 Universal Air Connection (UAC).** The male fitting, affixed to the SCBA, and the female fitting, affixed to the filling hose, to provide emergency replenishment of breathing air to an SCBA breathing air cylinder. Also known as Rapid Intervention Crew/Company Universal Air Connection.

## Chapter 4 Certification

### 4.1 General.

**4.1.1** The process for certification of SCBA as being compliant with NFPA 1981 shall meet the requirements of Section 4.1, General; Section 4.2, Certification Program; Section 4.3 Inspections and Testing; Section 4.4, Recertification; Section 4.5, Manufacturers' Quality Assurance Program; Section 4.6, Hazards Involving Compliant Product; Section 4.7, Manufacturers' Investigation of Complaints and Returns; and Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.



**4.1.2** Prior to certification of SCBA to the requirements of this standard, SCBA shall be NIOSH certified.

**4.1.2.1** SCBA shall have NIOSH certification as positive pressure.

**4.1.2.2\*** SCBA shall have a NIOSH-certified rated service time of at least 30 minutes.

**4.1.2.3** SCBA that are NIOSH certified as positive pressure but capable of supplying air to the user in a negative pressure demand-type mode shall NOT be certified to this standard.

**4.1.3** SCBA and accessories that are certified as compliant with NFPA 1981 shall also be certified by NIOSH as compliant with the *Statement of Standard for NIOSH CBRN SCBA Testing*.

**4.1.4** All SCBA that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified. This certification shall be in addition to, and shall not be construed to be the same as, the NIOSH certification as specifically defined in 3.3.33.

**4.1.5** All certification shall be performed by a certification organization that meets at least the requirements specified in Section 4.2, Certification Program, and that is accredited for personal protective equipment in accordance with ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*.

**4.1.6** Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard, NFPA 1981, in any statements about their respective product(s) unless the product(s) is certified as compliant to this standard.

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

**4.1.8** All compliant SCBA shall also have a product label that meets the requirements specified in Chapter 5.

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

**4.1.10** The certification organization shall not issue any new certifications for any SCBA to the 2007 edition of this standard on or after the NFPA effective date for the 2013 edition, which is 17 December 2012.

**4.1.11** The certification organization shall not permit any manufacturer to label any SCBA as compliant with the 2007 edition of this standard on or after 31 August 2013, except when replacement labels or replacement components that bear the certification organization's label are required.

**4.1.12** The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2007 edition of this standard from all SCBA that are under the control of the manufacturer on 31 August 2013. The certification organization shall verify that this action is taken.

## **4.2 Certification Program.**

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

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

**4.2.3** The certification organization shall be accredited for personal protective equipment in accordance with ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*. The accreditation shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

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

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

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

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

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

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

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

**4.2.7** The certification organization shall require the manufacturer to establish and maintain a quality assurance program that meets the requirements of Section 4.5, Manufacturers' Quality Assurance Program.

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

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

**4.2.8** The certification organization and the manufacturer shall evaluate any changes affecting the form, fit, or function of the compliant product to determine its continued certification to the 2013 edition of NFPA 1981.

**4.2.8.1** The certification organization and the manufacturer shall evaluate replacement parts, components, and add-on accessories to determine any changes affecting the form, fit, or function for SCBA certified to the 2002 edition or the 2007 edition of NFPA 1981 to permit revisions to the original certification.



**4.2.8.2** Replacement parts, components, and add-on accessories for SCBAs certified to the 2002 edition or the 2007 edition of NFPA 1981 shall be approved by NIOSH in accordance with 42 CFR 84, “Respiratory Protective Devices, Tests for Permissibility.”

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

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

**4.2.9.2** Sample product shall be evaluated by the certification organization to verify the product’s continued compliance in order to ensure that the materials, components, and manufacturing quality assurance systems are consistent with the materials, components, and manufacturing quality assurance that were inspected and tested by the certification organization during initial certification and recertification.

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

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

**4.2.10** The certification organization shall have in place a series of procedures, as specified in Section 4.6, Hazards Involving Compliant Product, that address report(s) of situation(s) in which a compliant product is subsequently found to be hazardous.

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

**4.2.12** The certification organization shall be in a position to use legal means to protect the integrity of its name and label. The name and label shall be registered and legally defended.

### **4.3\* Inspections and Testing.**

**4.3.1** For both certification and recertification of SCBA, the certification organization shall conduct both the inspection and the testing specified in this section.

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

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

**4.3.2.2** The accreditation of a certification organization’s testing laboratory shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *Conformity assess-*

*ment — General requirements for accreditation bodies accrediting conformity assessment bodies.*

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

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

**4.3.3.2** The manufacturer’s testing laboratory’s scope of accreditation to ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of personal protective equipment.

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

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

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

**4.3.4** Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to ensure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified to this standard are compliant, unless such sampling levels are specified herein.

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

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

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

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

**4.3.9** SCBA and SCBA components shall be subjected to the tests specified in Table 4.3.9 for each series.

**4.3.10** SCBA shall be initially tested for certification and shall meet the performance requirements of three separate test series of Categories A, B, C, D, E, and F, as specified in Table 4.3.9. All tests within Categories A, B, C, D, E, and F shall be conducted in the order specified and are designed as cumulative damage tests.

Table 4.3.9 Test Series

Test Order	Category A (SCBA #1)	Category B (SCBA #2)	Category C (SCBA #3)	Category D (SCBA #4)	Category E (SCBA #5)	Category F (SCBA #6)	Category G (Component Tests)	Category H (Additional SCBA as required)
1	Airflow (Section 8.1)	Airflow (Section 8.1)	Airflow (Section 8.1)	Airflow (Section 8.1)	HUD visibility performance (Sections 8.17 through 8.19)	Low power capacity test (Section 8.26)	Fabric flame tests (Section 8.4)	EOSTI independent activation (Section 8.13)
2	Facepiece carbon dioxide content (Section 8.12)	Breathing air cylinder and valve assembly retention test (Section 8.22)	Vibration resistance (Section 8.3)	Heat and flame resistance (Section 8.11)	HUD low power source visual alert signal test (Section 8.16)	Heat and immersion leakage tests (Section 8.24)	Fabric heat tests (Section 8.5)	EOSTI recognition performance (Section 8.14)
3	Nonelectronic communications test (Section 8.10)	Cylinder connections and accessibility test (Section 8.23)	—	—	Wiring connection strength (Section 8.15)	—	Thread heat test (Section 8.6)	Elevated temperature heat and flame resistance test (Section 8.29)
4	Supplementary voice communications system performance test (Section 8.25)	RIC UAC cylinder refill breathing performance (Section 8.20)	—	—	Lens radiant heat (Section 8.28)	—	Facepiece lens abrasion resistance (Section 8.9)	—
5	Environmental temperature (Section 8.2)	RIC UAC system fill rate performance (Section 8.21)	—	—	—	—	—	—
6	EBSS cold temp. performance test* (Section 8.27)	EBSS cold temp. performance test* (Section 8.27)	—	—	—	—	—	—
7	Particulate test (Section 8.8)	Accelerated corrosion test (Section 8.7)	—	—	—	—	—	—

\*To be tested together.

**4.3.11** SCBA fabric, thread, and lens components shall be initially tested for certification and shall meet the performance requirements of one test series of Category G, as specified in Table 4.3.9. SCBA component testing in Category G shall be conducted on test specimens as specified in each respective test method.

**4.3.12** SCBA shall be initially tested for certification and shall meet the performance requirements of one test series for Category H, as specified in Table 4.3.9 for each EOSTI identified by the product manufacturer. Additional SCBA shall be permitted to be used, where necessary, to conduct all of the Category H tests.

**4.3.13** After certification, compliant SCBA and components of compliant SCBA shall be tested annually within 12 months of previous tests and shall meet the performance requirements of one test series of Categories A, B, C, D, E, F, G, and H, as specified in Table 4.3.9.

**4.3.14** A minimum of seven identical SCBA that are to be certified to this standard shall be selected from the manufacturer's production.

**4.3.15** The first SCBA shall be subjected to the tests listed in Category A, the second SCBA shall be subjected to the tests listed in Category B, the third SCBA shall be subjected to the tests in



Category C, the fourth SCBA shall be subjected to the tests in Category D, the fifth SCBA shall be subjected to the tests in Category E, the sixth SCBA shall be subjected to the tests in Category F, and the seventh SCBA, at a minimum, shall be subjected to the tests in Category H, as shown in Table 4.3.9. Additional SCBA shall be permitted to be used, where necessary, to conduct all of the Category H tests.

**4.3.16** Components from SCBA that are to be certified to this standard shall be subjected to the tests specified in Category G of Table 4.3.9. SCBA component testing in Category F shall be conducted on test specimens as specified in each respective test method.

**4.3.17** The requirement specified in 4.3.13 shall be waived every fifth year when the testing required by 4.3.18 is conducted.

**4.3.18** Compliant SCBA shall be tested and shall meet the performance requirements of three separate test series of Categories A, B, C, D, E, and F, as specified in Table 4.3.9, every fifth year from the date of the initial certification testing specified in 4.3.10.

**4.3.19** SCBA fabric, thread, and lens components shall be tested and shall meet the performance requirements of one test series of Category G, as specified in Table 4.3.9, every fifth year from the date of the initial certification testing specified in 4.3.11. SCBA component testing in Category G shall be conducted on test specimens as specified in each respective test method.

**4.3.20** Compliant SCBA shall be tested and shall meet the performance requirements of one test series for Category H, as specified in Table 4.3.9, for each EOSTI identified by the product manufacturer, every fifth year from the date of the initial certification testing specified in 4.3.12. Additional SCBA shall be permitted to be used, where necessary, to conduct all of the Category H tests.

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

**4.3.21.1** The certification organization shall accept from the manufacturer for evaluation and testing for certification only product or product components that are the same in every respect to the actual final product or product component.

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

**4.3.22** No adjustment, repair, or replacement of parts shall be permitted to any SCBA being tested in accordance with this standard; however, breathing air cylinders shall be permitted to be filled as required.

**4.3.23** Where SCBA are provided with an accessory or accessories that are certified by NIOSH in accordance with 42 CFR 84 for that specific SCBA, the SCBA with accessories installed shall be tested to all of the performance requirements specified in Chapter 7, and the accessories shall not cause degradation of the performance of the SCBA. The accessories themselves shall not be required to pass the performance testing unless specifically specified herein.

**4.3.24** After completion of these tests for a specific model SCBA or its variant, only those tests on other similar SCBA

models or variants shall be required where, in the determination of the certification organization, the SCBA's test results can be affected by any components or NIOSH-certified accessories that are different from those on the original SCBA tested.

**4.3.25** Any modifications made to an SCBA or to any NIOSH-certified accessories provided for an SCBA by the SCBA manufacturer after certification shall require the retesting and meeting of the performance requirements of all those individual tests that the certification organization determines could be affected by such changes. This retesting shall be conducted before the modified SCBA is certified as being compliant with this standard.

**4.3.26** The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the certification of the manufacturer's compliant product. The manufacturer shall provide such data, upon request, to the purchaser or authority having jurisdiction.

#### **4.4 Recertification.**

**4.4.1** All SCBA models that are labeled as being compliant with this standard shall undergo recertification on an annual basis.

**4.4.2** Recertification shall include inspection and evaluation to all design requirements and testing to all performance requirements as required by 4.3.8 and 4.3.13 on all manufacturer models and components.

**4.4.3** The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the recertification of manufacturer models and components and shall provide such data, upon request, to the purchaser or authority having jurisdiction.

#### **4.5 Manufacturers' Quality Assurance Program.**

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

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

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

**4.5.3.1** Registration to the requirements of ISO 9001, *Quality management systems — Requirements*, shall be conducted by a registrar that is accredited for personal protective equipment.

**4.5.3.2** Where the registrar specified in 4.5.3.1 is currently accredited for personal protective equipment in accordance with ISO/IEC Guide 62, *General requirements for bodies operating assessment and certification/registration of quality systems*, that accreditation shall be permitted until 14 September 2008.

**4.5.3.3** Not later than 14 September 2008, registrars specified in 4.5.3.1 shall be accredited for personal protective equipment in accordance with ISO/IEC 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*.

**4.5.3.4** Any new accreditations for registrars specified in 4.5.3.1 for personal protective equipment shall only be in accordance with ISO/IEC 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*.



**4.5.4\*** Any entity that meets the definition of *manufacturer* specified in Section 3.3, General Definitions, and therefore is considered to be the “manufacturer” but that does not manufacture or assemble the compliant product shall meet the requirements specified in Section 4.5.

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

#### **4.6 Hazards Involving Compliant Product.**

**4.6.1\*** The certification organization shall establish procedures to be followed where situation(s) are reported in which a compliant product is subsequently found to be hazardous. These procedures shall comply with the provisions of ISO Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*, and as modified herein.

**4.6.2\*** Where a report of a hazard involved with a compliant product is received by the certification organization, the certification organization shall contact NIOSH National Personal Protective Technology Laboratory (NPPTL), and the validity of the report shall be investigated following the procedures established by NIOSH/NPPTL.

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

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

**4.6.5** Where it is established that a hazard is involved with a compliant product, the certification organization, in coordination with NIOSH/NPPTL, shall determine the scope of the hazard, including products, model numbers, serial numbers, factory production facilities, production runs, and quantities involved.

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

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

**4.6.8** The certification organization, in coordination with NIOSH/NPPTL, shall require the manufacturer of the compliant product or the manufacturer of the compliant product component, if applicable, to assist the certification organization and NIOSH/NPPTL in the investigation and to conduct its own investigation as specified in Section 4.7, Manufacturers’ Investigation of Complaints and Returns.

**4.6.9** Where the facts indicating a need for corrective action are conclusive and the manufacturer has exhausted all appeal rights, the certification organization, in coordination with NIOSH/NPPTL, shall initiate corrective action immediately, provided there is a manufacturer to be held responsible for such action.

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

**4.6.11\*** Where the facts are conclusive and corrective action is indicated, the certification organization, in coordination with NIOSH/NPPTL, shall take one or more of the following corrective actions:

- (1) Parties authorized and responsible for issuing a safety alert shall be notified when, in the opinion of the certification organization and NIOSH/NPPTL, such a safety alert is necessary to inform the users.
- (2) Parties authorized and responsible for issuing a product recall shall be notified when, in the opinion of the certification organization and NIOSH/NPPTL, such a recall is necessary to protect the users.
- (3) The mark of certification shall be removed from the product.
- (4) Where a hazardous condition exists and it is not practical to implement 4.6.11(1), (2), or (3), or the responsible parties refuse to take corrective action, the certification organization, in coordination with NIOSH/NPPTL, shall notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard.

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

**4.6.13\*** Where a change to an NFPA standard(s) is felt necessary, the certification organization, in coordination with NIOSH/NPPTL, shall also provide a copy of the report and indicated corrective actions to the NFPA and shall also submit either a Public Proposal for a proposed change to the next revision of the applicable standard or a proposed Temporary Interim Amendment (TIA) to the current edition of the applicable standard.

#### **4.7 Manufacturers’ Investigation of Complaints and Returns.**

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

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

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



#### 4.8 Manufacturers' Safety Alert and Product Recall Systems.

**4.8.1** Manufacturers shall establish a written safety alert system and a written product recall system that describes the procedures to be used in the event that it decides or is directed by the certification organization or NIOSH/NPPTL to either issue a safety alert or conduct a product recall.

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

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

### Chapter 5 Labeling and Information

#### 5.1 Product Label Requirements.

**5.1.1** In addition to the NIOSH certification label, each SCBA shall have an SCBA product label, which shall be permanently and conspicuously attached to the SCBA.

**5.1.2** Multiple label pieces shall be permitted in order to carry all statements and information required to be on the SCBA product label; however, all label pieces of the product label shall be located adjacent to each other.

**5.1.3** The certification organization's label, symbol, or identifying mark shall be attached to both the NIOSH certification label and the SCBA product label or be part of the product labels and shall be placed in a conspicuous location. All letters shall be at least 2.5 mm ( $\frac{3}{32}$  in.) in height, and the label, symbol, or identifying mark shall be at least 6 mm ( $1\frac{3}{4}$  in.) in height.

**5.1.4** All worded portions of both required product labels shall be at least in English.

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

**5.1.6** The SCBA product label shall bear the following compliance statement legibly printed, and all letters and numbers shall be at least 2 mm in height:

**THIS SCBA MEETS THE REQUIREMENTS OF  
NFPA 1981, STANDARD ON OPEN-CIRCUIT  
SELF-CONTAINED BREATHING APPARATUS  
(SCBA) FOR EMERGENCY SERVICES,  
2013 EDITION.**

**DO NOT REMOVE THIS LABEL**

**5.1.7** SCBA components, as listed on the NIOSH certification labels, shall be marked directly on the component with the lot number, the serial number, or the year and month of manufacture.

#### 5.2 User Information.

**5.2.1** The SCBA manufacturer shall provide with each SCBA at least the training material and user instructions specified within this section.

**5.2.2** Upon request at the time of purchase, the SCBA manufacturer shall provide to the purchaser an information sheet with each SCBA that documents at least the following:

- (1) Manufacturing performance tests conducted at time of manufacture and the results
- (2) Date of manufacture
- (3) Model number
- (4) Serial number
- (5) Lot number, if applicable
- (6) Hydrostatic test dates and results, if applicable

**5.2.3** Information or training materials regarding pre-use shall be provided at least on the following areas:

- (1) Safety considerations
- (2) Limitations of use
- (3) Charging breathing air cylinders
- (4) Breathing air quality in accordance with NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*
- (5) Marking recommendations and restrictions
- (6) Warranty information
- (7) Recommended storage practices
- (8) Mounting on/in vehicles or fire apparatus

**5.2.4** Information or training materials regarding periodic inspections shall be provided at least on inspection frequency and details.

**5.2.5** Information or training materials regarding donning and doffing shall be provided at least on the following areas:

- (1) Donning and doffing procedures
- (2) Adjustment procedures
- (3) Interface issues

**5.2.6** Information or training materials regarding use shall be provided at least on the following areas:

- (1) Pre-use checks
- (2) For fire departments or fire department-based emergency services, proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*
- (3) Recharging breathing air cylinders
- (4) Emergency procedures to be followed in the event of damage, malfunction, or failure of the breathing apparatus
- (5) Emergency procedures to be followed in the event of an out-of-air situation

**5.2.7\*** Information or training materials regarding periodic maintenance and cleaning shall be provided at least on the following areas:

- (1) Cleaning instructions and precautions
- (2) Disinfecting procedures
- (3) Maintenance frequency and details
- (4) Methods of repair, where applicable



- (5) Low power source signals and power source replacement, where applicable
- (6) Complete instructions for reporting to the manufacturer, certification authority, and NIOSH/NPPTL all returned equipment or complaints of damage, malfunction, or failure of the breathing apparatus that may present a hazard to the user

**5.2.8** Information or training materials regarding retirement shall be provided at least on replacement/retirement considerations.

**5.2.9** The SCBA manufacturer shall provide the manufacturer's specified component service life for composite breathing air cylinders and for all elastomeric components of the SCBA. This information shall be included at least in the maintenance information provided to the users.

## Chapter 6 Design Requirements

### 6.1 General Design Requirements.

**6.1.1** SCBA shall have at least the applicable design requirements specified in this chapter where inspected and evaluated by the certification organization as specified in Section 4.3, Inspections and Testing.

**6.1.2** Prior to certification of SCBA to the requirements of this standard, SCBA shall be NIOSH certified in accordance with 42 CFR 84.

**6.1.2.1** SCBA shall have NIOSH certification as positive pressure.

**6.1.2.2** SCBA shall have a NIOSH-certified rated service time of at least 30 minutes.

**6.1.2.3** SCBA that are NIOSH certified as positive pressure but capable of supplying air to the user in a negative pressure demand-type mode shall NOT be certified to this standard.

**6.1.3** SCBA that are certified as compliant with NFPA 1981 shall also be certified by NIOSH as compliant with the *Statement of Standard for NIOSH CBRN SCBA Testing*.

**6.1.4** SCBA shall consist of all the components necessary for NIOSH certification in accordance with 42 CFR 84, at least two independent end-of-service-time indicators (EOSTI), heads-up display (HUD), voice communications system, and a rapid intervention crew/company universal air connection (RIC UAC).

**6.1.5** In addition to the HUD and cylinder-mounted breathing air pressure gauge, all SCBA shall have another independently operating breathing air pressure gauge that shall be capable of being viewed by the wearer when the SCBA is worn in accordance with the SCBA manufacturer's instructions.

**6.1.5.1** The design of this independently operating breathing air pressure gauge shall be such that the failure of one breathing air pressure gauge shall not affect the activation and operation of other breathing air pressure gauge.

**6.1.5.2** A failure mode and effects analysis shall be provided to the certification organization for each independently operating breathing air pressure gauge.

**6.1.5.3** The failure mode and effects analysis shall identify each potential failure mode for each component necessary for

the independently operating breathing air pressure gauge to function.

**6.1.5.4** The failure mode and effects analysis shall demonstrate that the activation and operation of the independently operating breathing air pressure gauge specified in 6.1.5 is not affected by any of the potential failure modes, as identified in accordance with 6.1.5.3, of all other breathing air pressure gauges.

**6.1.6** The pressure gauge provided as part of the SCBA manufacturer's breathing air cylinder and valve assembly shall be readable by a person other than the wearer of the SCBA when the SCBA is worn in accordance with the SCBA manufacturer's instructions and with the breathing air cylinder securely retained in the SCBA backframe.

**6.1.7** All SCBA shall be equipped with a full facepiece that covers, as a minimum, the wearer's eyes, nose, and mouth.

**6.1.8** All electric circuits integral to an SCBA or to any SCBA accessories shall be certified to the requirements for Class I, Groups C and D; Class II, Groups E, F, and G, Division 1 hazardous locations specified in ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations*.

**6.1.9** All hardware, brackets, and snaps or other fasteners of SCBA or any NIOSH-certified accessories shall be free of rough spots, burrs, and sharp edges.

**6.1.10** All SCBA shall have a voice communications system that, at a minimum, shall consist of a mechanical speaking diaphragm.

**6.1.10.1** The voice communications system shall be designed to project sound without other persons needing a receiver to hear the voice communications.

**6.1.10.2** If the SCBA incorporates an optional electronic Supplementary Voice Communications System, the Supplementary Voice Communications System design shall incorporate an indicator that the system is "on." This indicator shall be permitted to be positioned outside the user's field of vision with the SCBA facepiece properly donned.

**6.1.10.3** The optional Supplementary Voice Communications System's power source shall display a visual alert signal indicating low power capacity.

**6.1.10.4** The optional Supplementary Voice Communications System shall be designed to be switched off and on manually without the performance of the SCBA being affected.

**6.1.10.5** Where the optional Supplementary Voice Communications System is automatically activated, the operation of the on/off control shall override the auto activation of the Supplementary Voice Communications System without affecting the performance of the SCBA.

**6.1.10.6** The optional Supplementary Voice Communications System shall be permitted to be equipped with an adjustable volume (gain) control.

### 6.2 End-of-Service-Time Indicator (EOSTI) Design Requirements.

**6.2.1** All SCBA shall be equipped with a minimum of two independent EOSTI.

**6.2.2** Each EOSTI shall be activated with no additional procedures than those required to activate the SCBA breathing system.



**6.2.3** Each EOSTI shall meet the activation requirements of NIOSH certification as specified in 42 CFR 84.

**6.2.4** Each EOSTI shall consist of at least the following:

- (1) A sensing mechanism
- (2) A signaling device

**6.2.4.1** At least one of the two required EOSTI shall be independent of any other EOSTI.

**6.2.4.2** The EOSTI sensing mechanism shall activate the signaling device(s).

**6.2.4.3** The EOSTI signaling devices shall provide notification to the SCBA user of the activation of the EOSTI by stimulating one or more human senses.

**6.2.4.4** Each EOSTI shall be permitted to have more than one signaling device, and each signaling device shall be permitted to stimulate more than one human sense.

**6.2.4.5** Where one EOSTI signaling device stimulates only one human sense, the other EOSTI shall stimulate at least one different human sense.

**6.2.5** The design of EOSTI shall be such that the failure of one EOSTI shall not affect the activation and operation of other EOSTI.

**6.2.5.1** A failure mode and effects analysis shall be provided to the certification organization for each EOSTI.

**6.2.5.2** The failure mode and effects analysis shall identify each potential failure mode for each component necessary for the EOSTI to function.

**6.2.5.3** The failure mode and effects analysis shall demonstrate that the activation and operation of both EOSTI specified in 6.2.1 are not affected by any of the potential failure modes, as identified in accordance with 6.2.5.2, of all other EOSTI.

**6.2.5.4** For purposes of the failure mode and effects analysis, power sources other than the air from the SCBA breathing air cylinder shall be considered as part of the EOSTI.

**6.2.6** The EOSTI alarm shall activate at 33 percent, +5/–0 percent of full cylinder pressure.

### **6.3 Heads-Up Display (HUD) Design Requirements.**

**6.3.1** All SCBA shall be equipped with at least one heads-up display.

**6.3.2** The HUD shall be activated with no additional procedures than those required to activate the SCBA breathing system.

**6.3.3** Each time the SCBA breathing system is activated with the breathing air cylinder pressure of 20 bar (290 psi) or greater, the HUD shall provide a visual indication of activation for a minimum of 20 consecutive seconds.

**6.3.4** Where HUD is provided with an external wiring disconnect, the wiring disconnect shall be designed to prevent accidental disconnection and shall not be capable of being connected in such a manner as to prevent the pneumatic system and the HUD from operating simultaneously.

**6.3.5** HUD shall provide at least visual displays of alert signals and information.

**6.3.6** All HUD visual displays shall be visible to the SCBA wearer with the SCBA and facepiece properly donned and regardless of the wearer's head movement.

**6.3.7** HUD shall not use color as the only means of differentiating between alert signal displays and informational displays.

#### **6.3.8 Visual Alert Signals.**

**6.3.8.1** HUD shall display visual alert signals for breathing air cylinder content specified in 6.3.8.5, and for power source condition specified in 6.3.8.6.

**6.3.8.2** In addition to the mandatory visual alert signals specified in 6.3.8.5 and 6.3.8.6, additional visual alert signals to indicate when other status or conditions have occurred shall be permitted.

**6.3.8.3** All visual alert signals shall be visible for a minimum of 20 consecutive seconds.

**6.3.8.4** Each visual alert signal shall be identifiable, by the SCBA wearer, from any other visual alert signals or other informational displays provided on HUD or on the SCBA.

**6.3.8.5** HUD shall display a visual alert signal for breathing air cylinder content when the breathing air in the SCBA cylinder has been reduced to 50 percent of rated service content. This visual alert signal shall visibly flash at a frequency of not less than one per second.

**6.3.8.6** Where a power source is used for HUD to comply with the requirements of this standard, HUD shall display a visual alert signal for low power source capacity when the remaining power source life will provide a minimum of 2 hours of operation of the HUD at maximum electrical draw.

**6.3.8.6.1** The low power source visual alert signal shall be independent from and physically distinguishable from the breathing air cylinder content visual alert signal display.

**6.3.8.6.2** The low power source visual alert signal shall be displayed at all times when the power source condition is below the level specified in 6.3.8.6 while the HUD is activated.

#### **6.3.9 Visual Informational Displays.**

**6.3.9.1** HUD shall display visual informational signals for at least breathing air cylinder content as specified in 6.3.9.5.1.

**6.3.9.2** In addition to the mandatory visual informational signal specified in 6.3.9.5.1, additional visual informational signals to indicate when other status or conditions have occurred shall be permitted.

**6.3.9.3** All visual displays of information shall be permitted to flash at a frequency of not less than one per second for a minimum of 10 consecutive seconds every 60 seconds.

**6.3.9.4** Where the visual display is not constantly visible or is not visible for at least 10 consecutive seconds every 60 seconds, the HUD shall be provided with a manual activation of the display. The manual activation shall cause the display to be visible for at least 5 consecutive seconds for each activation.

**6.3.9.5** HUD shall display a visual informational signal for breathing air cylinder content in at least four increments of the cylinder's total rated service content from full to 33 percent.

**6.3.9.5.1** HUD visual information signals for breathing air cylinder content shall display at 100 percent, 75 percent, 50 percent, and 33 percent.

**6.3.9.5.2** Where an analog visual display is used, the gauge shall visually indicate the reserve air zone with a red background.

**6.3.9.5.3** Where an electronic visual display is used, the gauge shall visually indicate that reserve air is being utilized with a flash at a frequency of not less than one per second for the remaining duration of the cylinder.

**6.3.9.6** A display only in units of pressure shall not be permitted.

**6.4\* Rapid Intervention Crew/Company Universal Air Connection (RIC UAC) Design Requirements.**

**6.4.1** Each SCBA shall be equipped with an RIC UAC male fitting to allow replenishment of breathing air to the SCBA breathing air cylinder.

**6.4.2** The RIC UAC male fitting shall meet the requirements specified in 6.4.5, and shall be located on each SCBA in a permanently fixed position.

**6.4.3** The distance between the leading edge of the CGA fitting at the outlet of the SCBA cylinder valve and the leading edge of the RIC UAC male fitting shall be a maximum of 100 mm (4 in.).

**6.4.4** A separate self-resetting relief valve shall be installed on the SCBA to protect the SCBA against overpressurization.

**6.4.5 RIC UAC Male Fitting.**

**6.4.5.1** The RIC UAC male fitting shall be designed as specified in Figure 6.4.5.1.

**6.4.5.2** The RIC UAC male fitting shall be capable of connecting to any RIC UAC female fitting.

**6.4.5.3** The RIC UAC male fitting shall not interfere with any other operation of the SCBA.

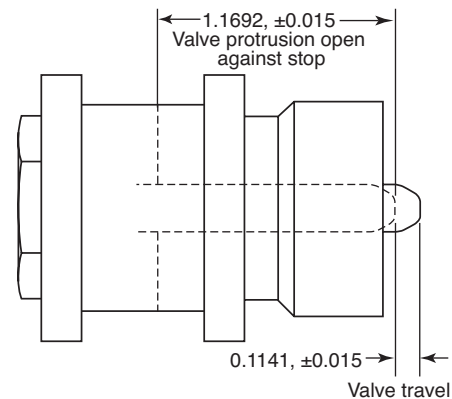
**6.4.5.4** RIC UAC male fittings shall be equipped with a dust cap or sealing plug to prevent dust, dirt, and debris from entering the fitting and to serve as a leakproof seal.

**6.4.6 RIC UAC Female Fitting.**

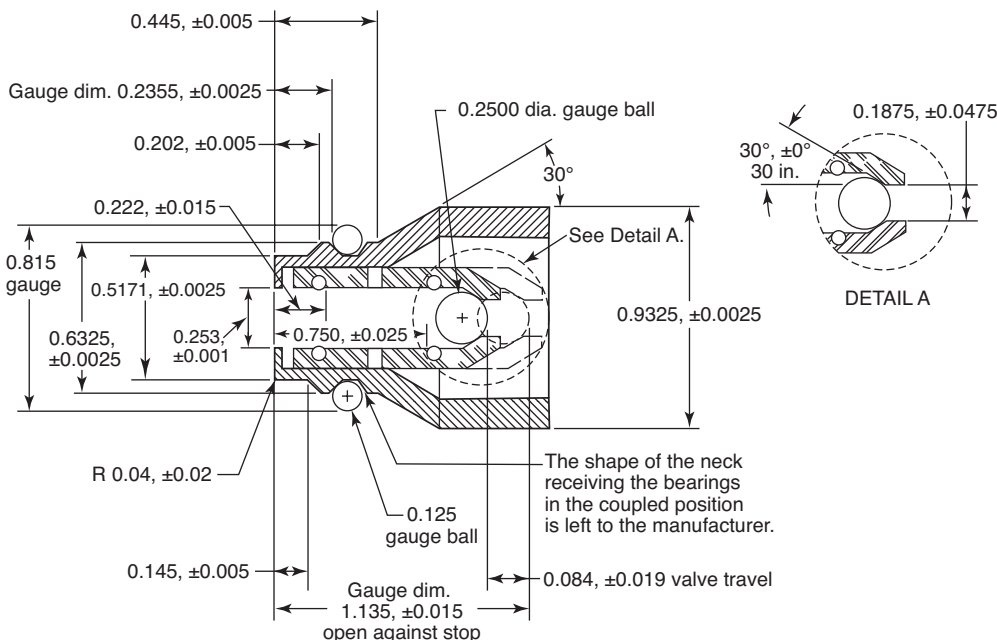
**6.4.6.1** The RIC UAC female fitting shall be designed as specified in Figure 6.4.6.1.

**6.4.6.2** The RIC UAC female fitting shall be capable of connecting to all RIC UAC male fittings.

**6.4.6.3** RIC UAC female fittings shall be equipped with a dust cap or sealing plug to prevent dust, dirt, and debris from entering the fitting and to serve as a leakproof seal.



**FIGURE 6.4.6.1 RIC UAC Female Fitting (all measurements in inches).**



**FIGURE 6.4.5.1 RIC UAC Male Fitting (all measurements in inches).**

**6.4.7 RIC UAC Filling Hose Assembly.**

**6.4.7.1** Each SCBA manufacturer shall make available an RIC UAC filling hose assembly that consists of a filling hose and a RIC UAC female fitting.

**6.4.7.2** The RIC UAC filling hose assembly shall be a high-pressure, 310 bar (4500 psi) assembly designed to replenish breathing air to an SCBA breathing air cylinder.

**6.4.7.3** The filling hose shall have an RIC UAC female fitting that meets the requirements specified in 6.4.6, attached to the delivery end.

**6.4.8 RIC UAC Coupling.**

**6.4.8.1** The complete RIC UAC male and female fittings shall constitute the RIC UAC coupling.

**6.4.8.2** The RIC UAC coupling shall be capable of connection and disconnection with one hand while subjected to maximum operation pressure.

**6.4.8.3** The RIC UAC coupling shall have an operating pressure of at least 310 bar (4500 psi).

**6.5 Power Source Design Requirements.**

**6.5.1** The power source for electronics that are part of the SCBA shall be either a single dedicated source for one device, or shall be a common power source for multiple devices.

**6.5.2** Where all electronic devices that are part of the SCBA share a common power source, a single low power source visual alert signal shall be provided and shall be part of the HUD display.

**6.5.3** Where multiple but not all electronic devices that are part of the SCBA share a common power source, a low power source visual alert signal shall be located on each of those electronic devices supplied by the common power source, and positioned on each of those electronic devices where it will be seen with the electronic device mounted in its permanent position on the SCBA.

**6.5.4** Where an electronic device uses a single, dedicated power source, the low power source visual alert signal shall be located on the electronic device and positioned where it will be seen with the electronic device mounted in its permanent position on the SCBA.

**6.5.5** With the exception of HUD displays of low power source visual alert signals specified in 6.5.2, the low power source visual alert signals shall be permitted to be positioned outside of the user's field of vision with the SCBA facepiece properly donned.

**6.6 Emergency Breathing Safety System (EBSS) Design Requirements.**

**6.6.1** If an SCBA is equipped with an EBSS, it shall meet the performance requirements of Sections 7.20 and 8.27.

**6.6.2** Each EBSS shall operate off the pressure after the first stage pressure reducer of the SCBA.

**6.6.3** The EBSS shall have an operating pressure of at least 5.5 bar (80 psi).

**6.6.4** The EBSS shall have a male and female connection with a check valve feature to prevent inward contaminants.

**6.6.5** The EBSS pressure hose assembly shall be a minimum of 20 in. long.

**6.6.6** The EBSS shall be accessible by the wearer.

**6.6.7** The EBSS shall require only one action for connection of the donor's fitting to the receiving SCBA's fitting.

**6.6.8** The EBSS shall require two distinctive actions to disconnect the fitting between the donor SCBA and receiving SCBA.

**6.6.9** The EBSS fitting(s) shall be equipped with a dust cap or sealing plug to prevent dust, dirt, and debris from entering the fitting(s).

**6.6.10** The connection of two EBSS shall be independent of the facepieces.

**6.7 Accessories Design Requirements.**

**6.7.1** Items attached to or integrated with SCBA that are not required for the SCBA to meet the requirements of this standard shall be considered as accessories.

**6.7.2** All accessories attached to or integrated with SCBA shall be certified by NIOSH in accordance with 42 CFR 84 for use with that specific SCBA.

**6.7.3** Any accessories attached to SCBA shall not interfere with the function of the SCBA or with the function of any of the SCBA's component parts.

**6.7.4** Where SCBA are provided with an accessory or accessories that are attached to or integrated with the SCBA, the SCBA, with accessories installed, shall meet all of the design and performance requirements of this standard.

**6.7.5** In all cases, such accessories shall not degrade the performance of the SCBA.

## Chapter 7 Performance Requirements

**7.1\* Airflow Performance.**

**7.1.1** SCBA shall be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.1.2** SCBA shall be tested for activation of EOSTI during the airflow performance testing specified in Section 8.1, Airflow Performance Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.1.3** The SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the airflow performance testing specified in Section 8.1, Airflow Performance Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.2 Environmental Temperature Performance.**

**7.2.1** SCBA shall be tested for environmental temperature performance as specified in Section 8.2, Environmental Temperature Tests.

**7.2.1.1** SCBA shall be tested for cold environment as specified in 8.2.5.5, Test 1, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not



be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.2.1.2** SCBA shall be tested for hot environment as specified in 8.2.5.6, Test 2, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.2.1.3** SCBA shall be tested for hot-to-cold environment as specified in 8.2.5.7, Test 3, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.2.1.4** SCBA shall be tested for cold-to-hot environment as specified in 8.2.5.8, Test 4, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.2.2** SCBA shall be tested for activation of EOSTI during the environmental temperature performance as specified in Section 8.2, Environmental Temperature Tests.

**7.2.2.1** SCBA shall be tested for cold environment as specified in 8.2.5.5, Test 1, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.2.2.2** SCBA shall be tested for hot environment as specified in 8.2.5.6, Test 2, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.2.2.3** SCBA shall be tested for hot-to-cold environment as specified in 8.2.5.7, Test 3, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.2.2.4** SCBA shall be tested for cold-to-hot environment as specified in 8.2.5.8, Test 4, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.2.3** SCBA shall be tested for the proper functioning of the HUD breathing air cylinder content informational display and the visual alert signal during the environmental temperature performance as specified in Section 8.2, Environmental Temperature Tests.

**7.2.3.1** SCBA shall be tested for cold environment as specified in 8.2.5.5, Test 1, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.2.3.2** SCBA shall be tested for hot environment as specified in 8.2.5.6, Test 2, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.2.3.3** SCBA shall be tested for hot-to-cold environment as specified in 8.2.5.7, Test 3, and the HUD shall display the visual information for the breathing air cylinder content as

specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.2.3.4** SCBA shall be tested for cold-to-hot environment as specified in 8.2.5.8, Test 4, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signals as specified in 6.3.8.5.

### **7.3 Vibration Resistance Performance.**

**7.3.1** SCBA shall be tested for vibration resistance as specified in Section 8.3, Vibration Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded, and shall not have movement of the CGA fittings causing a break of any width in the line.

**7.3.2** SCBA shall be tested for activation of EOSTI during the vibration testing specified in Section 8.3, Vibration Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.3.3** The SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the vibration testing specified in Section 8.3, Vibration Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.4 Fabric Flame Resistance Performance.** All fabric components of SCBA that are used to secure the SCBA to the wearer shall be tested for flame resistance as specified in Section 8.4, Fabric Flame Tests, and shall have an average char length of not more than 100 mm (4 in.), shall have an average after-flame of not more than 2.0 seconds, and shall not melt or drip.

**7.5 Fabric Heat Resistance Performance.** All fabric components of SCBA that are used to secure the SCBA to the wearer shall be tested for heat resistance as specified in Section 8.5, Fabric Heat Tests, and shall not melt or ignite.

**7.6 Thread Heat Resistance Performance.** All thread used in SCBA components shall be tested for heat resistance as specified in Section 8.6, Thread Heat Test, and shall not melt or ignite.

### **7.7 Corrosion Resistance Performance.**

**7.7.1** SCBA shall be tested for corrosion resistance as specified in Section 8.7, Accelerated Corrosion Test, and any corrosion shall not prohibit the proper use and function, as specified in the manufacturer's instructions, of any control or operating feature of the SCBA.

**7.7.2** SCBA shall be tested for corrosion resistance as specified in Section 8.7, Accelerated Corrosion Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.7.3** SCBA shall be tested for activation of EOSTI during the corrosion resistance testing specified in Section 8.7, Accelerated Corrosion Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.



**7.7.4** The SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the corrosion resistance testing specified in Section 8.7, Accelerated Corrosion Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

#### **7.8 Particulate Resistance Performance.**

**7.8.1** SCBA shall be tested for particulate resistance as specified in Section 8.8, Particulate Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.8.2** SCBA shall be tested for activation of EOSTI during the particulate resistance testing specified in Section 8.8, Particulate Test, and the EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.8.3** SCBA shall be tested for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the particulate resistance testing specified in Section 8.8, Particulate Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.9\* Facepiece Lens Abrasion Resistance Performance.** SCBA facepiece lenses shall be tested for abrasion resistance as specified in Section 8.9, Facepiece Lens Abrasion Test, and the average value of the tested specimens shall not exhibit a delta haze greater than 14 percent.

**7.10\* Nonelectronic Communications Performance Requirements.** The SCBA voice communications system shall be tested for communications performance as specified in Section 8.10, Nonelectronic Communications Test, and shall have a Speech Transmission Index (STI) average value of not less than 0.55.

#### **7.11 Heat and Flame Resistance Performance.**

**7.11.1** SCBA shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.11.2** SCBA and SCBA accessories shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and no components of the SCBA and no accessories shall have an afterflame of more than 2.2 seconds.

**7.11.3** SCBA shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and no component of the SCBA shall separate or fail in such a manner that would cause the SCBA to be worn and used in a position not specified by the manufacturer's instructions.

**7.11.4** The SCBA facepiece shall be tested for heat and flame resistance as specified in Section 8.11, Heat and Flame Test, and the facepiece lens shall not obscure vision below the 20/100 vision criterion.

**7.11.5** SCBA shall be tested for activation of EOSTI during the heat and flame resistance testing specified in Section 8.11, Heat and Flame Test, and each EOSTI shall activate as speci-

fied in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.11.6** SCBA shall be tested for functioning of the HUD breathing air cylinder content informational display and visual alert signals during the heat and flame resistance testing specified in Section 8.11, Heat and Flame Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.12 Carbon Dioxide (CO<sub>2</sub>) Content Performance.** SCBA facepieces shall be tested for CO<sub>2</sub> content as specified in Section 8.12, Facepiece Carbon Dioxide Content Test, and the CO<sub>2</sub> content in the inhalation air shall not be greater than 1.0 percent by volume.

#### **7.13 Additional SCBA EOSTI Performance.**

##### **7.13.1 EOSTI Independent Activation.**

**7.13.1.1** Each EOSTI shall be tested for independent activation as specified in Section 8.13, EOSTI Independent Activation Test, and the activation of the alarm of each EOSTI shall be independent of any other EOSTI.

**7.13.1.2** After activation of the unblocked EOSTI, the alarm signal shall remain active at least until the cylinder pressure drops below 20 bar (290 psi).

**7.13.2 EOSTI Alarm Recognition.** Each EOSTI shall be tested for alarm recognition as specified in Section 8.14, EOSTI Recognition Test, and the EOSTI alarm signal shall be recognized in 10 seconds or less.

#### **7.14 Additional SCBA HUD Performance.**

**7.14.1** Where HUD incorporates exposed wiring, the wire's entry into any associated components shall be tested for connection strength as specified in Section 8.15, HUD Wiring Connection Strength Test, and the HUD shall remain functional.

**7.14.2** Where a power source is used for HUD to comply with the requirements of this standard, HUD shall be tested for proper functioning of visual alert signals and visual information displays as specified in Section 8.16, HUD Low Power Source Visual Alert Signal Test, and HUD shall continue to function at maximum current draw for a minimum of 2 hours following the activation of the low power source visual alert signal and shall display the visual alert signals specified in 6.3.8.5 and 6.3.8.6 and shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5.

**7.14.3** HUD shall be tested for wearer visibility as specified in Section 8.17, HUD Visibility Test, and each informational display and visual alert signal shall be observable, distinct, and identifiable in both darkness and bright light.

**7.14.4** Where the HUD displays are external to the facepiece and the gap between the HUD display and the facepiece lens is greater than 1 mm (1/32 in.), HUD displays shall be tested for wearer visibility while obscured as specified in Section 8.18, HUD Obscuration Test, and each informational display and visual alert signal shall be observable, distinct, and identifiable.

**7.14.5** HUD shall be tested for disabling glare as specified in Section 8.19, HUD Disabling Glare Test, and the test subject shall be able to read at least 9 out of 10 selected letters when each visual alert signal is activated.



### 7.15 RIC UAC Performance Requirements.

**7.15.1** SCBA shall be tested for cylinder refill breathing performance as specified in Section 8.20, Cylinder Refill Breathing Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.15.2** SCBA shall be tested for RIC UAC system fill rate performance as specified in Section 8.21, RIC UAC System Fill Rate Test, and the maximum allowable fill time shall be 3.0 minutes.

**7.15.3** The RIC UAC system connection shall be tested for accessibility as specified in Section 8.23, Cylinder Connections and Accessibility Test, and the RIC UAC shall be connected in a maximum of 15 seconds and shall disconnect in a maximum of 15 seconds.

### 7.16 Breathing Air Cylinder Performance Requirements.

**7.16.1** The SCBA backframe and cylinder retention device shall be tested for breathing air cylinder and valve assembly retention security as specified in Section 8.22, Breathing Air Cylinder and Valve Assembly Retention Test, and the cylinder and valve assembly shall not change position by more than 25 mm (1 in.).

**7.16.2** The SCBA cylinder valve connection shall be tested for accessibility, attachment, and detachment as specified in Section 8.23, Cylinder Connections and Accessibility Test, and the cylinder and valve assembly shall fully attach to the SCBA in less than 30 seconds, and the cylinder and valve assembly shall fully detach from the SCBA in less than 30 seconds.

**7.16.3** The SCBA RIC UAC connections shall be tested for accessibility, attachment, and detachment as specified in Section 8.23, Cylinder Connections and Accessibility Test, and the breathing air fill hose shall fully attach to the RIC UAC connection in less than 15 seconds, and the breathing air fill hose shall fully detach from the RIC UAC connection in less than 15 seconds.

**7.17 Supplementary Voice Communications System Performance Requirements.** The SCBA voice communications system, as identified by the SCBA manufacturer, shall be tested for communication performance as specified in Section 8.25, Supplementary Voice Communications System Performance Test, and shall have a Speech Transmission Index (STI) average value of not less than 0.60.

**7.18 Heat and Immersion Leakage Performance Requirements.** SCBA electronics shall be tested for resistance to heat and water ingress as specified in Section 8.24, Heat and Immersion Leakage Test, and the electronics shall function properly in accordance with the SCBA manufacturer's instructions for normal use, and all power source compartments or enclosures shall remain dry.

**7.19 Low Power Capacity.** Where power sources are used to comply with the requirements of this standard, electronic devices shall be tested for proper functioning during low power capacity as specified in Section 8.26, Low Power Capacity Test, and shall continue to properly function at maximum power consumption for a minimum of 2 hours following the activation of the low power source visual alert signal.

### 7.20 Emergency Breathing Safety System Cold Temperature Performance Requirements.

**7.20.1** The donor and receiving SCBA shall be tested independently for airflow performance as specified in Section 8.27, Emer-

gency Breathing Safety System Cold Temperature Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.20.2** Each SCBA shall be tested independently for activation of EOSTI during the airflow performance testing specified in Section 8.1, Airflow Performance Test, and each EOSTI shall activate as specified in 6.2.2 and shall continue to operate throughout the remainder of the airflow performance test.

**7.20.3** Each SCBA shall be tested independently for proper functioning of the HUD breathing air cylinder content informational display and visual alert signals during the airflow performance testing specified in Section 8.1, Airflow Performance Test, and the HUD shall display the visual information for the breathing air cylinder content as specified in 6.3.9.5 and shall display the visual alert signal as specified in 6.3.8.5.

**7.20.4** The SCBA classified as the donor shall start at full cylinder pressure, and the SCBA classified as the receiving SCBA shall have a pressure of 7 bar, +0.6 bar/-0 bar (100 psi, +10 psi/-0).

**7.20.5** Both SCBA shall be connected through the EBSS and shall be tested for cold environment as specified in Section 8.27, Emergency Breathing Safety System Cold Temperature Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.20.6** The donor SCBA shall be tested for activation of EOSTI during the environmental temperature performance as specified in Section 8.27, Emergency Breathing System Cold Temperature Performance Test.

**7.20.7** The donor SCBA shall be tested for the proper functioning of the HUD breathing air cylinder content informational display and the visual alert signal during the environmental temperature performance as specified in Section 8.27, Emergency Breathing System Cold Temperature Performance Test.

### 7.21 Lens Radiant Heat Resistance Performance.

**7.21.1** SCBA shall be tested for lens radiant heat resistance as specified in Section 8.28, Lens Radiant Heat Test. SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.21.2** The duration of the test as specified in Section 8.28, Lens Radiant Heat Test, shall be 24 minutes, +2/-0 minutes.

### 7.22 Elevated Temperature Heat and Flame Resistance Performance.

**7.22.1** SCBA shall be tested for lens heat and flame resistance as specified in Section 8.29, Elevated Temperature Heat and Flame Resistance Test. SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) water column above ambient pressure from the time the test begins until the time the test is concluded.

**7.22.2** The duration of the test as specified in Section 8.29, Elevated Temperature Heat and Flame Resistance Test, shall be 24 minutes, +2/-0 minutes.



## Chapter 8 Test Methods

### 8.1 Airflow Performance Test.

**8.1.1 Application.** This test method shall apply to complete SCBA.

**8.1.2 Samples.** Each sample shall be tested as specified in 4.3.9.

#### 8.1.3 Specimen Preparation.

**8.1.3.1** Specimens for conditioning shall be complete SCBA.

**8.1.3.2** Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), and relative humidity (RH) of 50 percent, ±25 percent.

**8.1.3.3\*** The air used in the SCBA breathing air cylinders shall comply with the air quality requirements of NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*.

#### 8.1.4 Apparatus.

**8.1.4.1** A test headform as specified in Figure 8.1.4.1, or equivalent, shall be used.

**8.1.4.2** A pressure probe shall be attached to the test headform to monitor facepiece pressure.

**8.1.4.2.1** The pressure probe shall be a 6.5 mm (¼ in.) O.D. with a 1.5 mm (⅛ in.) wall thickness metal tube having one open end and one closed end.

**8.1.4.2.2** The closed end of the pressure probe shall have four equally spaced holes, each 1.5 mm, ±0.1 mm (⅛ in., ±0.0 in.), and each shall be positioned 6.5 mm, ±0.4 mm (¼ in., ±0.0 in.) from the end of the pressure probe.

**8.1.4.2.3** The closed end of the pressure probe shall extend through the test headform, exiting out the center of the left eye.

**8.1.4.2.4** The pressure probe shall extend 13 mm, +1.5 mm/-0 mm (½ in., +⅛ in./-0 in.) outward from the surface of the center of the left eye.

**8.1.4.3** A length of tubing, including connections, of a 1.5 m (5 ft) length with a nominal 5 mm (⅜ in.) I.D. flexible smooth-bore tubing with a nominal 1.5 mm (⅛ in.) wall thickness shall be permitted to be connected to the open end of the pressure probe and to the inlet of the pressure transducer.

**8.1.4.4** A differential pressure transducer having the following characteristics shall be used:

- (1) Range: 225 mm (8.9 in.) of water differential
- (2) Linearity: ±0.5 percent full scale (FS) best straight line
- (3) Line pressure effect: less than 1 percent FS zero shift/1000 psig
- (4) Output: ±2.5 Vdc for +FS
- (5) Output ripple: 10 mV peak to peak
- (6) Regulation: FS output shall not change more than ±0.1 percent for input voltage change from 22 to 35 Vdc
- (7) Temperature, operating: -54°C to 121°C (-65°F to 250°F)
- (8) Temperature, compensated: -18°C to 71°C (0°F to 160°F)
- (9) Temperature effects: within 2 percent FS/55.6°C (100°F) error band

**8.1.4.5** The differential pressure transducer shall be connected to a strip chart recorder having the following characteristics:

- (1) Chart width of 250 mm
- (2) Pen speed of at least 750 mm/sec
- (3) Accuracy of ±0.25 percent FS
- (4) Input voltage range of 1 V FS
- (5) Span set at 25 mm (1 in.) of chart per 25.4 mm (1 in.) water column

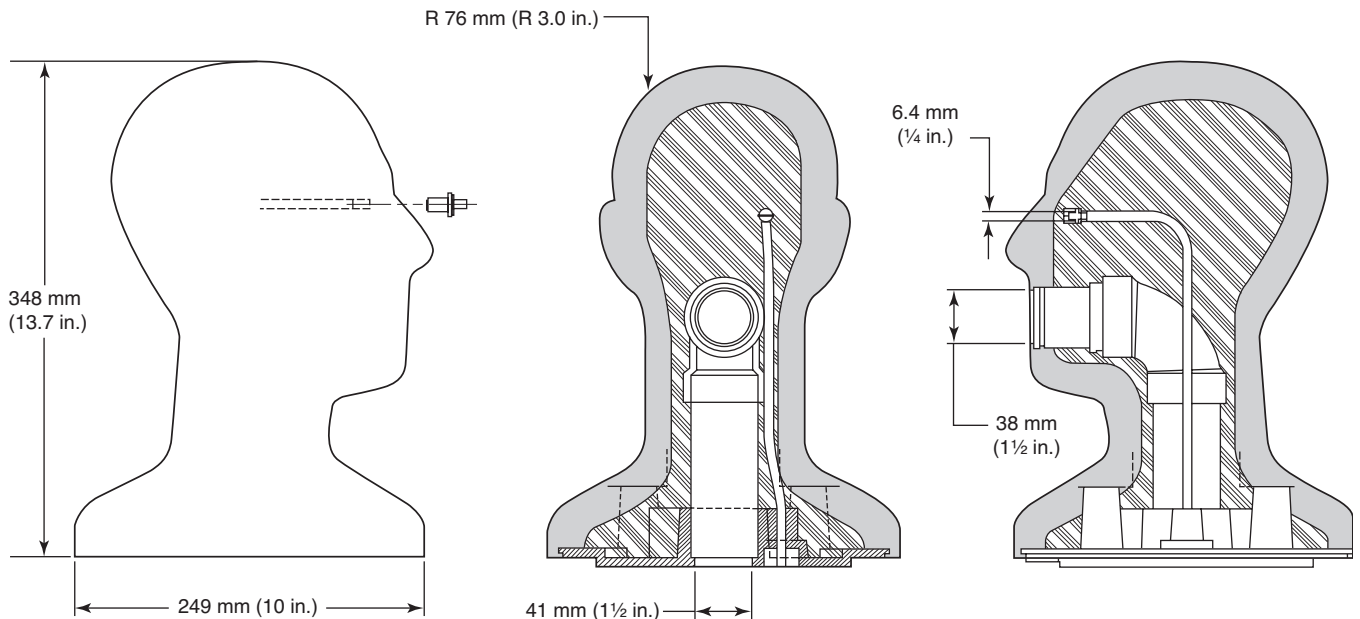


FIGURE 8.1.4.1 Test Headform.

**8.1.4.6** The test headform shall be equipped with a breathing passage.

**8.1.4.6.1** The breathing passage shall lead from the mouth of the test head to the lung.

**8.1.4.6.2** The sum of the volumes of the lung, when fully extended to a 3.4 L tidal volume position, and the breathing passage shall not exceed 4.0 L.

**8.1.4.6.3** The breathing passage shall be located on the centerline of the mouth and shall be flush with the test headform.

**8.1.4.7** The breathing passage shall extend a minimum of 200 mm (8 in.) and a maximum of 450 mm (18 in.).

**8.1.4.8** Where flexible smooth-bore tubing is used from the metal breathing tube to the inlet connection of the breathing machine, it shall have a maximum length of 1.2 m (4 ft) and a 19 mm ( $\frac{3}{4}$  in.) I.D. with a nominal 3 mm ( $\frac{1}{8}$  in.) wall thickness.

**8.1.4.8.1** When 8.2.5.5.2 of the environmental temperature test and 8.27.5.5 of the emergency breathing safety system cold temperature performance test are performed, air exhaled through the headform shall be conditioned to an average temperature of 27°C,  $\pm 6^\circ\text{C}$  (80°F,  $\pm 10^\circ\text{F}$ ) when measured at the breathing passage outlet at the mouth of the test headform. See Figure 8.1.4.8.1.

**8.1.4.9** The breathing machine shown in Figure 8.1.4.9 or equivalent shall be used.

**8.1.4.9.1** The breathing machine shall consist of a flexible bellows material attached at one end to a fixed plate and at the other end by a free plate constrained to two degrees of freedom.

**8.1.4.9.2** The free plate shall be connected to a rotating shaft by means of a connecting rod, vibration damper, and bellows crank mechanism.

**8.1.4.9.3** The bellows crank mechanism shall have a center-to-center distance of 57 mm,  $\pm 0.005$  mm ( $2\frac{1}{4}$  in.,  $\pm 0.01$  in.).

**8.1.4.9.4** The connecting rod shall have a center-to-center free plate distance of 133 mm,  $\pm 0.005$  mm ( $5\frac{1}{4}$  in.,  $\pm 0.01$  in.).

**8.1.4.9.5** The vibration damper shall be a rubber-to-metal bonded antivibration mounting with a mounting flange hole spacing of 50 mm,  $\pm 5$  mm (2 in.,  $\pm \frac{3}{16}$  in.) and an overall height of 20 mm,  $\pm 2$  mm ( $\frac{3}{16}$  in.,  $\pm \frac{5}{64}$  in.) and have a static force/displacement curve with a slope of 11.5 N/mm,  $\pm 0.5$  N/mm.

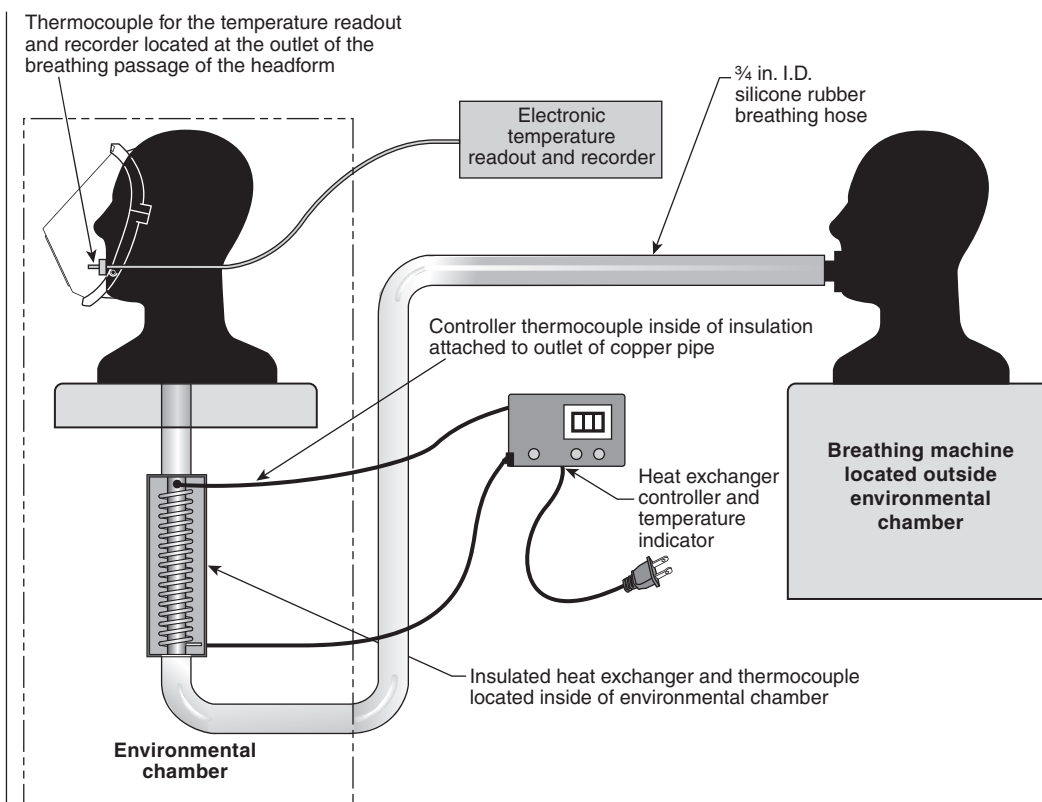
**8.1.4.10** The bellows material shall consist of neoprene-impregnated nylon fabric convoluted tubing.

**8.1.4.10.1** The tubing shall have an I.D. of 200 mm,  $\pm 5$  mm (8 in.,  $\pm \frac{3}{16}$  in.) and an O.D. of 250 mm,  $\pm 5$  mm (10 in.,  $\pm \frac{3}{16}$  in.).

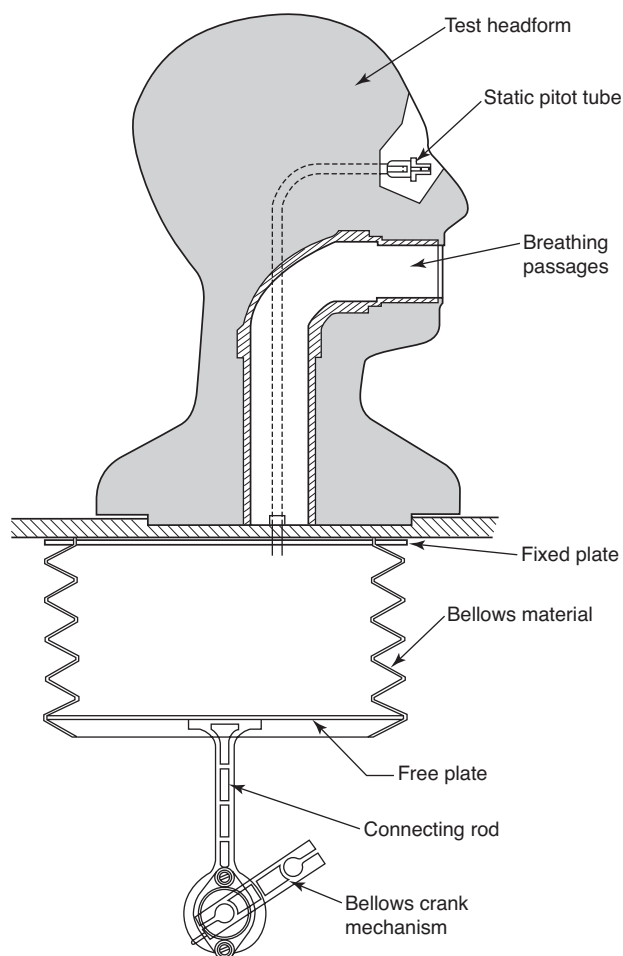
**8.1.4.10.2** The nominal wall thickness of the tubing shall be 1.4 mm ( $\frac{1}{32}$  in.).

**8.1.4.10.3** The breathing machine shall have the capability to conduct breathing resistance testing at 40 L/min,  $\pm 1.0$  L/min and 103 L/min,  $\pm 3.0$  L/min.

**8.1.4.10.4** The tidal volume of the lung shall determine the volume of air moved during each inhalation/exhalation cycle.



**FIGURE 8.1.4.8.1 Cold Temperature Performance Test.**



**FIGURE 8.1.4.9 Breathing Machine.**

**8.1.4.10.5** The airflow shall be determined by three factors:

- (1) Number of inhalation/exhalation cycles per minute
- (2) Tidal volume of the lung
- (3) Breathing waveform

**8.1.4.10.6** The breathing waveform shall be produced by reciprocal action of the shaft.

**8.1.4.10.7** Inspired and expired volumes as a function of time shall be incorporated in accordance with the values given in Table 8.1.4.10.7(a) and Table 8.1.4.10.7(b), which list the linear displacement of the bellows free plate as a function of time for 103 L/min volume and 40 L/min volume work rates.

**8.1.4.10.8** Switching between the two work rates shall be performed within 10 seconds.

**8.1.4.10.9** The construction of the breathing machine shall be such that the respiration rate, tidal volume, peak flow, and facepiece pressure measurement system accuracy are unaffected by temperature changes caused by the environmental airflow performance tests as specified in Section 8.2, Environmental Temperature Tests.

**Table 8.1.4.10.7(a) Lung Breathing Waveforms for 103 L/min Volume Work Rate**

Step No.	Time (sec)	Inspire/Expire	Volume (L, $\pm 0.1$ L)	Volume Change (L, $\pm 5\%$ )
0	0.00	—	-1.7	-0.012
1	0.02	Inspire	-1.688	0.012
2	0.04	Inspire	-1.662	0.025
3	0.06	Inspire	-1.626	0.036
4	0.08	Inspire	-1.581	0.045
5	0.10	Inspire	-1.529	0.052
6	0.12	Inspire	-1.471	0.058
7	0.14	Inspire	-1.409	0.062
8	0.16	Inspire	-1.345	0.064
9	0.18	Inspire	-1.277	0.068
10	0.20	Inspire	-1.207	0.07
11	0.22	Inspire	-1.134	0.073
12	0.24	Inspire	-1.059	0.075
13	0.26	Inspire	-0.984	0.076
14	0.28	Inspire	-0.906	0.077
15	0.30	Inspire	-0.828	0.079
16	0.32	Inspire	-0.748	0.08
17	0.34	Inspire	-0.667	0.081
18	0.36	Inspire	-0.586	0.081
19	0.38	Inspire	-0.504	0.082
20	0.40	Inspire	-0.421	0.083
21	0.42	Inspire	-0.337	0.084
22	0.44	Inspire	-0.254	0.084
23	0.46	Inspire	-0.169	0.085
24	0.48	Inspire	-0.085	0.085
25	0.50	Inspire	0	0.085
26	0.52	Inspire	0.085	0.085
27	0.54	Inspire	0.169	0.085
28	0.56	Inspire	0.254	0.085
29	0.58	Inspire	0.337	0.084
30	0.60	Inspire	0.421	0.084
31	0.62	Inspire	0.504	0.083
32	0.64	Inspire	0.586	0.082
33	0.66	Inspire	0.667	0.081
34	0.68	Inspire	0.748	0.081
35	0.70	Inspire	0.828	0.08
36	0.72	Inspire	0.906	0.079
37	0.74	Inspire	0.984	0.077
38	0.76	Inspire	1.059	0.076
39	0.78	Inspire	1.134	0.075
40	0.80	Inspire	1.207	0.073
41	0.82	Inspire	1.277	0.07
42	0.84	Inspire	1.345	0.068
43	0.86	Inspire	1.409	0.064
44	0.88	Inspire	1.471	0.062
45	0.90	Inspire	1.529	0.058
46	0.92	Inspire	1.581	0.052
47	0.94	Inspire	1.626	0.045
48	0.96	Inspire	1.662	0.036
49	0.98	Inspire	1.688	0.025
50	1.00	—	1.7	0.012

(continues)

Table 8.1.4.10.7(a) *Continued*

Step No.	Time (sec)	Inspire/Expire	Volume (L, $\pm 0.1$ L)	Volume Change (L, $\pm 5\%$ )
51	1.02	Expire	1.688	−0.012
52	1.04	Expire	1.662	−0.025
53	1.06	Expire	1.626	−0.036
54	1.08	Expire	1.581	−0.045
55	1.10	Expire	1.529	−0.052
56	1.12	Expire	1.471	−0.058
57	1.14	Expire	1.409	−0.062
58	1.16	Expire	1.345	−0.064
59	1.18	Expire	1.277	−0.068
60	1.20	Expire	1.207	−0.07
61	1.22	Expire	1.134	−0.073
62	1.24	Expire	1.059	−0.075
63	1.26	Expire	0.984	−0.076
64	1.28	Expire	0.906	−0.077
65	1.30	Expire	0.828	−0.079
66	1.32	Expire	0.748	−0.08
67	1.34	Expire	0.667	−0.081
68	1.36	Expire	0.586	−0.081
69	1.38	Expire	0.504	−0.082
70	1.40	Expire	0.421	−0.083
71	1.42	Expire	0.337	−0.084
72	1.44	Expire	0.254	−0.084
73	1.46	Expire	0.169	−0.085
74	1.48	Expire	0.085	−0.085
75	1.50	Expire	0	−0.085
76	1.52	Expire	−0.085	−0.085
77	1.54	Expire	−0.169	−0.085
78	1.56	Expire	−0.254	−0.085
79	1.58	Expire	−0.337	−0.084
80	1.60	Expire	−0.421	−0.084
81	1.62	Expire	−0.504	−0.083
82	1.64	Expire	−0.586	−0.082
83	1.66	Expire	−0.667	−0.081
84	1.68	Expire	−0.748	−0.081
85	1.70	Expire	−0.828	−0.08
86	1.72	Expire	−0.906	−0.079
87	1.74	Expire	−0.984	−0.077
88	1.76	Expire	−1.059	−0.076
89	1.78	Expire	−1.134	−0.075
90	1.80	Expire	−1.207	−0.073
91	1.82	Expire	−1.277	−0.07
92	1.84	Expire	−1.345	−0.068
93	1.86	Expire	−1.409	−0.064
94	1.88	Expire	−1.471	−0.062
95	1.90	Expire	−1.529	−0.058
96	1.92	Expire	−1.581	−0.052
97	1.94	Expire	−1.626	−0.045
98	1.96	Expire	−1.662	−0.036
99	1.98	Expire	−1.688	−0.025

Table 8.1.4.10.7(b) Lung Breathing Waveforms for 40 L/min Volume Work Rate

Step No.	Time (sec)	Inspire/Expire	Volume (L, $\pm 0.1$ L)	Volume Change (L, $\pm 5\%$ )
0	0	—	−0.833	0.001
1	0.025	Inspire	−0.831	0.002
2	0.050	Inspire	−0.825	0.005
3	0.075	Inspire	−0.816	0.009
4	0.100	Inspire	−0.803	0.013
5	0.125	Inspire	−0.787	0.016
6	0.150	Inspire	−0.768	0.019
7	0.175	Inspire	−0.745	0.022
8	0.200	Inspire	−0.720	0.025
9	0.225	Inspire	−0.692	0.028
10	0.250	Inspire	−0.661	0.031
11	0.275	Inspire	−0.628	0.033
12	0.300	Inspire	−0.592	0.035
13	0.325	Inspire	−0.555	0.038
14	0.350	Inspire	−0.515	0.039
15	0.375	Inspire	−0.474	0.041
16	0.400	Inspire	−0.431	0.043
17	0.425	Inspire	−0.387	0.044
18	0.450	Inspire	−0.341	0.046
19	0.475	Inspire	−0.295	0.047
20	0.500	Inspire	−0.247	0.048
21	0.525	Inspire	−0.198	0.049
22	0.550	Inspire	−0.149	0.049
23	0.575	Inspire	−0.100	0.050
24	0.600	Inspire	−0.050	0.050
25	0.625	Inspire	0.000	0.050
26	0.650	Inspire	0.051	0.050
27	0.675	Inspire	0.100	0.050
28	0.700	Inspire	0.150	0.050
29	0.725	Inspire	0.199	0.049
30	0.750	Inspire	0.248	0.048
31	0.775	Inspire	0.295	0.048
32	0.800	Inspire	0.342	0.047
33	0.825	Inspire	0.388	0.046
34	0.850	Inspire	0.432	0.044
35	0.875	Inspire	0.475	0.043
36	0.900	Inspire	0.516	0.041
37	0.925	Inspire	0.555	0.039
38	0.950	Inspire	0.592	0.037
39	0.975	Inspire	0.628	0.035
40	1.000	Inspire	0.661	0.033
41	1.025	Inspire	0.691	0.031
42	1.050	Inspire	0.719	0.028
43	1.075	Inspire	0.744	0.025
44	1.100	Inspire	0.767	0.022
45	1.125	Inspire	0.786	0.019
46	1.150	Inspire	0.802	0.016
47	1.175	Inspire	0.814	0.013
48	1.200	Inspire	0.823	0.009
49	1.225	Inspire	0.829	0.005
50	1.250	—	0.833	0.004



Table 8.1.4.10.7(b) *Continued*

Step No.	Time (sec)	Inspire/Expire	Volume (L, $\pm 0.1$ L)	Volume Change (L, $\pm 5\%$ )
51	1.275	Expire	0.831	-0.002
52	1.300	Expire	0.825	-0.005
53	1.325	Expire	0.816	-0.009
54	1.350	Expire	0.803	-0.013
55	1.375	Expire	0.787	-0.016
56	1.400	Expire	0.768	-0.019
57	1.425	Expire	0.745	-0.022
58	1.450	Expire	0.720	-0.025
59	1.475	Expire	0.692	-0.028
60	1.500	Expire	0.661	-0.031
61	1.525	Expire	0.628	-0.033
62	1.550	Expire	0.592	-0.035
63	1.575	Expire	0.555	-0.038
64	1.600	Expire	0.515	-0.039
65	1.625	Expire	0.474	-0.041
66	1.650	Expire	0.431	-0.043
67	1.675	Expire	0.387	-0.044
68	1.700	Expire	0.341	-0.046
69	1.725	Expire	0.295	-0.047
70	1.750	Expire	0.247	-0.048
71	1.775	Expire	0.198	-0.049
72	1.800	Expire	0.149	-0.049
73	1.825	Expire	0.100	-0.050
74	1.850	Expire	0.050	-0.050
75	1.875	Expire	0.000	-0.050
76	1.900	Expire	-0.051	-0.050
77	1.925	Expire	-0.100	-0.050
78	1.950	Expire	-0.150	-0.050
79	1.975	Expire	-0.199	-0.049
80	2.000	Expire	-0.248	-0.048
81	2.025	Expire	-0.295	-0.048
82	2.050	Expire	-0.342	-0.047
83	2.075	Expire	-0.388	-0.046
84	2.100	Expire	-0.432	-0.044
85	2.125	Expire	-0.475	-0.043
86	2.150	Expire	-0.516	-0.041
87	2.175	Expire	-0.555	-0.039
88	2.200	Expire	-0.592	-0.037
89	2.225	Expire	-0.628	-0.035
90	2.250	Expire	-0.661	-0.033
91	2.275	Expire	-0.691	-0.031
92	2.300	Expire	-0.719	-0.028
93	2.325	Expire	-0.744	-0.025
94	2.350	Expire	-0.767	-0.022
95	2.375	Expire	-0.786	-0.019
96	2.400	Expire	-0.802	-0.016
97	2.425	Expire	-0.814	-0.013
98	2.450	Expire	-0.823	-0.009
99	2.475	Expire	-0.829	-0.005

**8.1.5 Procedure.**

**8.1.5.1\*** The test setup for conducting the airflow performance test shall be calibrated at least once each day before

tests are conducted and shall be verified at least once each day after testing.

**8.1.5.1.1** The calibration procedure utilized for the differential pressure transducer shall consist of confirmation of at least three different pressures between 0 mm and 125 mm (0 in. and 5 in.) water column.

**8.1.5.1.2** The pressure shall be measured using an incline manometer or equivalent with a scale measuring in increments of  $\pm 0.5$  mm ( $\pm 0.02$  in.) water column or less.

**8.1.5.2** The SCBA being tested shall utilize a fully charged breathing air cylinder.

**8.1.5.3** The facepiece of the SCBA being tested shall be secured to the test headform. The facepiece seal to the headform shall ensure that an initial pressure of 25 mm,  $\pm 2.5$  mm (1 in.,  $\pm 0.1$  in.) water column below ambient shall not decay by more than 5 mm (0.2 in.) water column in 5 seconds.

**8.1.5.4** The remaining components of the SCBA shall be mounted to simulate the proper wearing position as specified by the manufacturer's instructions.

**8.1.5.5** SCBA shall be tested at an ambient temperature of  $22^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ,  $\pm 5^{\circ}\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.1.5.6** The airflow performance test shall begin after five cycles of the breathing machine and shall continue to operate through at least 20 bar (290 psi) of cylinder inlet pressure.

**8.1.5.7** The breathing machine shall be set at a rate of 103 L/min,  $\pm 3$  L/min with a respiratory frequency of 30 breaths/min,  $\pm 1$  breath/min.

**8.1.6 Report.**

**8.1.6.1** The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test.

**8.1.6.2** The EOSTI activation and operation or the failure of the EOSTI to activate and operate shall be recorded and reported.

**8.1.6.3** The activation and identification of HUD visual alert signals shall be recorded and reported.

**8.1.7 Interpretation.**

**8.1.7.1** The peak inhalation pressure and peak exhalation pressure shall be used to determine pass or fail performance.

**8.1.7.2** One or more specimens failing this test shall constitute failing performance.

**8.1.7.3** Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

**8.1.7.4** Failure of the HUD to display the breathing air cylinder content or to display the visual alert signal during the test shall constitute failing performance.

**8.2 Environmental Temperature Tests.**

**8.2.1 Application.** This test method shall apply to complete SCBA.

**8.2.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.2.3 Specimen Preparation.**

**8.2.3.1** Specimens for conditioning shall be complete SCBA.



**8.2.3.2** Prior to testing, the SCBA shall be placed in an ambient environment of  $22^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ,  $\pm 5^{\circ}\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent for a minimum 12-hour dwell period.

#### **8.2.4 Apparatus.**

**8.2.4.1** The SCBA shall be placed in an environmental chamber and positioned to simulate the normal wearing position of the SCBA on a person as specified by the manufacturer.

**8.2.4.2** During the environmental exposures in 8.2.5.5, 8.2.5.6, 8.2.5.7, and 8.2.5.8, the SCBA shall be mounted on a Scott Aviation Model No. 803608-01 or 803608-02 test headform or equivalent.

**8.2.4.3** The thermocouple or other temperature-sensing element used shall be mounted within the chamber in a manner in which it will be exposed directly to the chamber atmosphere.

**8.2.4.4** The test headform shall be connected to the breathing machine specified in Section 8.1, Airflow Performance Test.

**8.2.4.5** The breathing machine shall be permitted to be located either inside or outside the environmental chamber.

#### **8.2.5 Procedure.**

**8.2.5.1** The variation in pressure extremes caused by the environmental test configuration shall be determined in the following manner. The airflow performance test as specified in Section 8.1, Airflow Performance Test, shall be carried out using the configuration specified in 8.2.4 at the 103 L/min,  $\pm 3$  L/min ventilation rate. The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 8.2.4 from the values obtained using the configuration specified in Section 8.1, Airflow Performance Test.

**8.2.5.2** The facepiece pressure during each entire test shall be read from the strip chart recorder and corrected by adding the value of the difference in pressure calculated in 8.2.5.1 to determine pass or fail as specified in 7.2.1.1 through 7.2.1.4.

**8.2.5.3** These environmental temperature tests shall be permitted to be conducted in any sequence.

**8.2.5.4** The dwell period between environmental temperature tests shall be used for refilling the breathing air cylinder and visually inspecting the SCBA for any gross damage that could cause unsafe test conditions.

#### **8.2.5.5 Test 1.**

**8.2.5.5.1** The SCBA shall be cold soaked at  $-32^{\circ}\text{C}$ ,  $\pm 1^{\circ}\text{C}$  ( $-25^{\circ}\text{F}$ ,  $\pm 2^{\circ}\text{F}$ ) for a minimum of 12 hours.

**8.2.5.5.2** The SCBA shall then be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, at a chamber air temperature of  $-32^{\circ}\text{C}$ ,  $\pm 5^{\circ}\text{C}$  ( $-25^{\circ}\text{F}$ ,  $\pm 10^{\circ}\text{F}$ ).

#### **8.2.5.6 Test 2.**

**8.2.5.6.1** The SCBA shall be hot soaked at  $71^{\circ}\text{C}$ ,  $\pm 1^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ,  $\pm 2^{\circ}\text{F}$ ) for a minimum of 12 hours.

**8.2.5.6.2** The SCBA shall then be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, at a chamber air temperature of  $71^{\circ}\text{C}$ ,  $\pm 5^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ,  $\pm 10^{\circ}\text{F}$ ).

#### **8.2.5.7 Test 3.**

**8.2.5.7.1** The SCBA shall be hot soaked at  $71^{\circ}\text{C}$ ,  $\pm 1^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ,  $\pm 2^{\circ}\text{F}$ ) for a minimum of 12 hours.

**8.2.5.7.2** Immediately following the 12-hour hot soak, the SCBA shall be transferred to a chamber with an air temperature of  $-32^{\circ}\text{C}$ ,  $\pm 1^{\circ}\text{C}$  ( $-25^{\circ}\text{F}$ ,  $\pm 2^{\circ}\text{F}$ ).

**8.2.5.7.3** The SCBA shall then be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, at a chamber air temperature of  $-32^{\circ}\text{C}$ ,  $\pm 5^{\circ}\text{C}$  ( $-25^{\circ}\text{F}$ ,  $\pm 10^{\circ}\text{F}$ ).

**8.2.5.7.4** The airflow performance test shall commence within 3 minutes after removal of the SCBA from the hot soak.

#### **8.2.5.8 Test 4.**

**8.2.5.8.1** The SCBA shall be cold soaked at  $-32^{\circ}\text{C}$ ,  $\pm 1^{\circ}\text{C}$  ( $-25^{\circ}\text{F}$ ,  $\pm 2^{\circ}\text{F}$ ) for a minimum of 12 hours.

**8.2.5.8.2** Immediately following the 12-hour cold soak, the SCBA shall be transferred to a chamber with an air temperature of  $71^{\circ}\text{C}$ ,  $\pm 1^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ,  $\pm 2^{\circ}\text{F}$ ).

**8.2.5.8.3** The SCBA shall then be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, at a chamber air temperature of  $71^{\circ}\text{C}$ ,  $\pm 5^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ,  $\pm 10^{\circ}\text{F}$ ).

**8.2.5.8.4** The airflow performance test shall commence within 3 minutes after removal of the SCBA from the cold soak.

#### **8.2.6 Report.**

**8.2.6.1** The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test condition.

**8.2.6.2** The activation and operation or the failure to activate and operate of the EOSTI shall be recorded and reported.

**8.2.6.3** The activation and identification of HUD visual alert signals shall be recorded and reported.

#### **8.2.7 Interpretation.**

**8.2.7.1** The peak inhalation and peak exhalation shall be used to determine pass or fail performance for each test procedure.

**8.2.7.2** One or more specimens failing any test procedure shall constitute failing performance.

**8.2.7.3** Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

**8.2.7.4** Failure of the HUD to display the breathing air cylinder content or to display the visual alert signal during the test shall constitute failing performance.

#### **8.3 Vibration Test.**

**8.3.1 Application.** This test method shall apply to complete SCBA.

**8.3.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

#### **8.3.3 Specimen Preparation.**

**8.3.3.1** Specimens for conditioning shall be complete SCBA.

**8.3.3.2** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of  $22^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ,  $\pm 5^{\circ}\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

#### **8.3.4 Apparatus.**

**8.3.4.1** SCBA shall be tested on a typical package tester within the compartments specified in 8.3.4.2 through 8.3.4.4.



**8.3.4.2** Compartments shall be set up as specified in Figure 8.3.4.2(a) and Figure 8.3.4.2(b).

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

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

**8.3.4.2.3** If the SCBA does not fit the compartment as specified in Figure 8.3.4.2(a) and Figure 8.3.4.2(b), the compartment shall be designed to accommodate the size and shape of the SCBA, allowing a clearance of 150 mm, +150/-0 mm (6 in., +6/-0 in.) between the top to bottom length and width of the SCBA.

**8.3.4.3** The large compartments shall encase the complete SCBA.

**8.3.4.3.1** SCBA regulators and hose shall remain attached to the complete SCBA.

**8.3.4.3.2** Regulators shall be allowed to be placed in the regulator holder of the SCBA.

**8.3.4.3.3** The SCBA facepiece and those components that attach directly to the facepiece, excluding regulators, shall not be included in the SCBA compartment.

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

**FIGURE 8.3.4.2(a) Vibration Table Compartments — Top View (Not to Scale).**

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

**FIGURE 8.3.4.2(b) Vibration Table Compartments — Side View (Not to Scale).**

**8.3.4.4** The small compartments shall encase the facepiece and those components that attach directly to the facepiece, excluding the regulator and associated hose.

**8.3.4.5\*** The breathing air cylinder of the SCBA shall be replaced by a surrogate cylinder.

**8.3.4.6** The surrogate cylinder and cylinder valve shall be of identical design and construction as the breathing air cylinder and cylinder valve of the SCBA to be tested.

**8.3.4.7** The mass of the breathing air of a fully pressurized breathing air cylinder shall be replaced in the surrogate cylinder with a substitute mass. The substitute mass shall consist of a brass rod and surrounding foam constructed as shown in Figure 8.3.4.7.

**8.3.4.8** The surrogate cylinder and cylinder valve with the substitute mass shall have the same total mass ±5 percent as the fully pressurized breathing air cylinder and cylinder valve.

**8.3.4.9** The attachment of the cylinder valve shall be tightened to a torque setting of 5 N-m, +0.5/-0.0 5 N-m (45 in. lb, +5/-0 in. lb) prior to the test. An opposing line no wider than 3 mm (⅛ in.) shall be placed on both the male and female CGA fitting prior to the start of the test, to identify the relationship between the male and the female CGA fittings when tightened at the proper torque setting.

### 8.3.5 Procedure.

**8.3.5.1** The test items shall be placed unrestrained in the compartments specified in 8.3.4.2, and all SCBA adjustment straps shall be fully extended.

**8.3.5.2** No tie-downs shall be allowed to be made to the SCBA.

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

**8.3.5.4** The test duration shall be 3 hours.

**8.3.5.5** After being subjected to the vibration test, the male and female CGA fittings shall be observed for movement.

**8.3.5.6** After being subjected to the vibration test, the SCBA shall be reattached to the breathing air cylinder originally provided with the SCBA and shall then be tested as specified in Section 8.1, Airflow Performance Test.

### 8.3.6 Report.

**8.3.6.1** The observation of movement or no movement of the male and female CGA fittings shall be recorded and reported.

**8.3.6.2** The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test condition.

**8.3.6.3** The activation and operation, or failure to activate and operate, of the EOSTI shall be recorded and reported.

**8.3.6.4** The activation and identification of HUD visual alert signals shall be recorded and reported.

### 8.3.7 Interpretation.

**8.3.7.1** The movement of either the male or female CGA fitting causing a break in the line of any width shall constitute a failure.

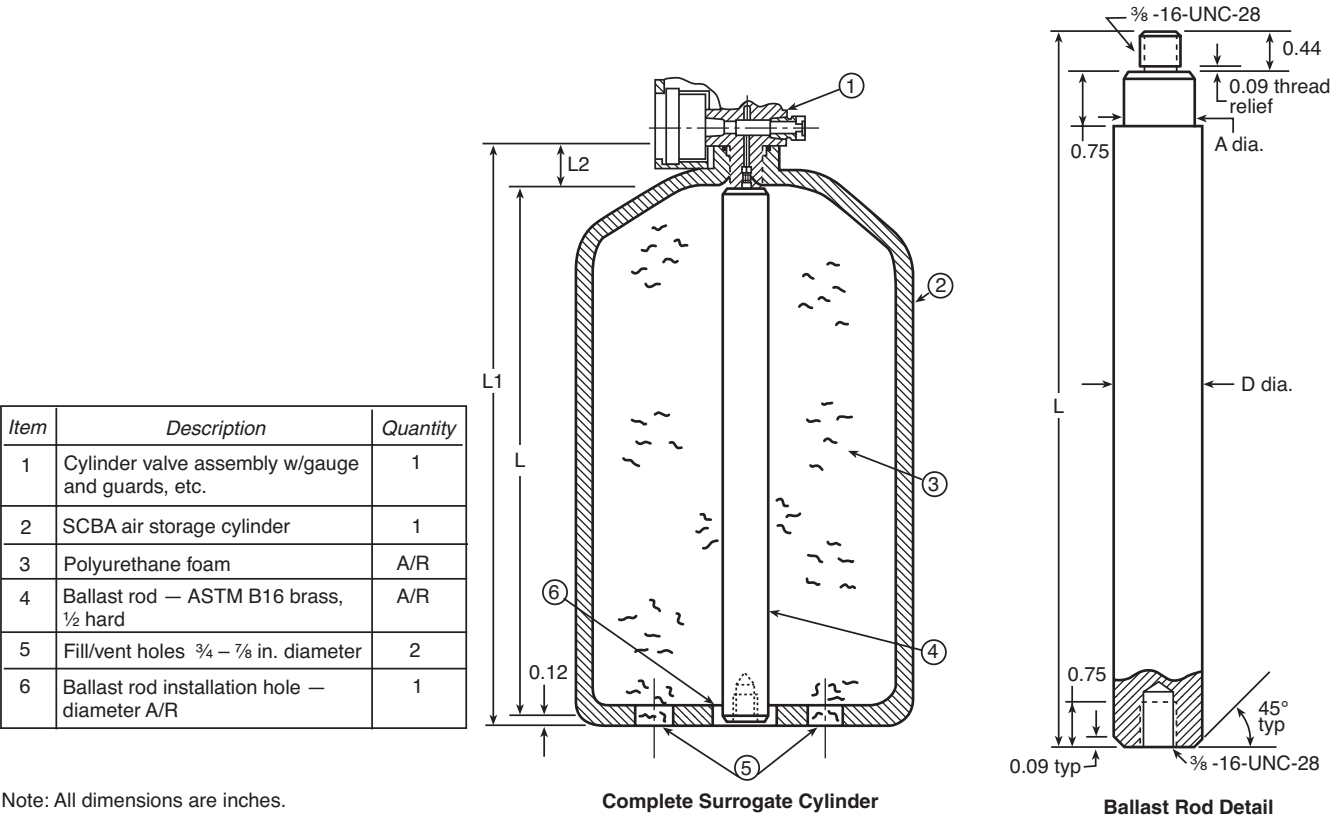


FIGURE 8.3.4.7 Surrogate Cylinder.

- 8.3.7.2 The peak inhalation and peak exhalation shall be used to determine pass or fail performance for each test procedure.
- 8.3.7.3 One or more specimens failing this test shall constitute failing performance.
- 8.3.7.4 Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.
- 8.3.7.5 Failure of the HUD to display the breathing air cylinder content or to display the visual alert signal during the test shall constitute failing performance.

8.4 Fabric Flame Tests.

8.4.1 Application.

- 8.4.1.1 This test method shall apply to each different fabric component of the SCBA.
- 8.4.1.2 Modifications for testing fabrics less than 75 mm (3 in.) wide shall be as specified in 8.4.8.
- 8.4.1.3 Modifications for testing fabrics less than 305 mm (12 in.) long shall be as specified in 8.4.9.

8.4.2 Specimens.

- 8.4.2.1 Specimens shall consist of a 75 mm × 305 mm (3 in. × 12 in.) rectangle.
- 8.4.2.2 A total of 10 test specimens shall be cut from a standard production run of the fabric components used in the SCBA.

8.4.3 Specimen Preparation.

- 8.4.3.1 Five test specimens shall be tested without any conditioning.
- 8.4.3.2 The remaining five test specimens shall be conditioned by five cycles of washing and drying in accordance with the procedures specified in Machine Cycle 1, Wash Temperature V, Drying Procedure Ai, of AATCC 135, *Dimensional Changes of Fabrics After Home Laundering*.

8.4.4 Apparatus. The test apparatus specified in ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, shall be used.

8.4.5 Procedure.

- 8.4.5.1 Specimens shall be tested in accordance with ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*.
- 8.4.5.2 Each specimen shall be examined for evidence of melting or ignition to determine pass or fail.
- 8.4.6 Report.
- 8.4.6.1 Afterflame time and char length shall be recorded and reported for each specimen.
- 8.4.6.2 The average afterflame time and char length for each material tested shall be calculated and reported.
- 8.4.6.3 The afterflame time shall be reported to the nearest 0.2 second and the char length to the nearest 3.2 mm (⅛ in.).

8.4.6.4 Observations of melting or dripping for each specimen shall be reported.

#### 8.4.7 Interpretation.

8.4.7.1 Pass or fail performance shall be based on any observed melting or dripping, the average afterflame time, and the average char length.

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

#### 8.4.8 Specific Requirements for Testing Fabrics Less Than 75 mm (3 in.) Wide.

8.4.8.1 If the fabric components are not available in the width specified in 8.4.2.1, the width of the test specimen shall be the width as used on the SCBA, but shall be a minimum of 305 mm (12 in.) long.

8.4.8.2 The test frame in Figure 8.4.8.2 shall be utilized to hold samples not available in the width specified in 8.4.2.1.

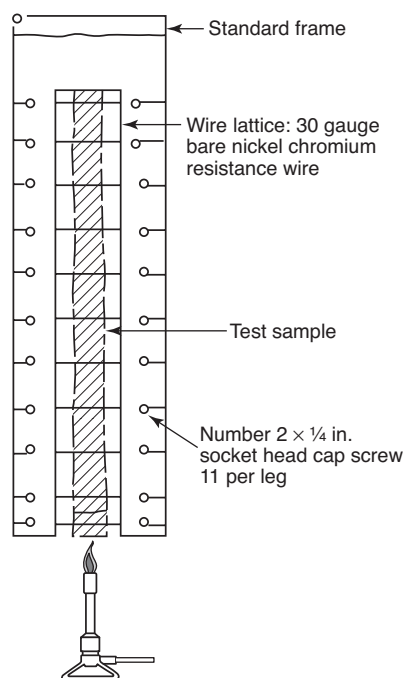


FIGURE 8.4.8.2 Wire Lattice Test Frame.

8.4.8.3 Testing shall be performed as specified in 8.4.5.

#### 8.4.9 Specific Requirements for Testing Fabrics Less Than 305 mm (12 in.) Long.

8.4.9.1 Where the fabric components are not available in the length specified in 8.4.2.1, the length of the test specimen shall be the length as used on the SCBA.

8.4.9.2 Samples that are not available in the length required in 8.4.2.1 shall be positioned such that the bottom edge of the sample is positioned at the bottom of the test frame.

8.4.9.3 Testing shall be performed as specified in 8.4.5.

### 8.5 Fabric Heat Tests.

#### 8.5.1 Application.

8.5.1.1 This test method shall apply to each different fabric component of the SCBA.

8.5.1.2 Modifications for testing fabrics less than 380 mm (15 in.) wide shall be as specified in 8.5.8.

8.5.1.3 Modifications for testing fabrics less than 380 mm (15 in.) long shall be as specified in 8.5.9.

#### 8.5.2 Specimens.

8.5.2.1 Specimens shall consist of a 380 mm x 380 mm (15 in. x 15 in.) square.

8.5.2.2 A total of 10 test specimens shall be cut from a standard production run of the fabric components used in the SCBA.

#### 8.5.3 Specimen Preparation.

8.5.3.1 Five test specimens shall be tested without any conditioning.

8.5.3.2 The remaining five test specimens shall be conditioned by five cycles of washing and drying in accordance with the procedures specified in Machine Cycle 1, Wash Temperature V, Drying Procedure Ai, of AATCC 135, *Dimensional Changes of Fabrics After Home Laundering*.

#### 8.5.4 Apparatus.

8.5.4.1 The test oven shall be a horizontal flow circulating oven with minimum interior dimensions so that the specimens can be suspended and are at least 50 mm (2 in.) from any interior oven surface and other test specimens.

8.5.4.2 The test oven shall have an airflow rate of 38 m/min to 76 m/min (125 ft/min to 250 ft/min) at the standard temperature and pressure of 21°C (70°F) at 1 atmosphere measured at the center point of the oven.

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

8.5.4.3.1 The thermocouple shall be equidistant between the vertical centerline of a mounted specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

8.5.4.3.2 The thermocouple shall be an exposed bead, Type J or Type K, No. 30 AWG thermocouple.

8.5.4.3.3 The test oven shall be heated and the test thermocouple stabilized at 260°C, +6°C/-0°C (500°F, +10°F/-0°F) for a period of not less than 30 minutes.

#### 8.5.5 Procedure.

8.5.5.1 The test specimen shall be suspended by a metal hook(s) at the top and centered in the oven so that the entire test specimen is at least 50 mm (2 in.) from any oven surface and other test specimens.

8.5.5.2 Oven airflow shall be parallel to the plane of the material.

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

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



**8.5.5.3.2** The total oven recovery time after the door is closed shall not exceed 30 seconds.

**8.5.5.4** The specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +0.15 minute/-0 minutes.

**8.5.5.5** The test exposure time shall begin when the test thermocouple recovers to the temperature of 260°C, +6°C/-0°C (500°F, +10°F/-0°F).

**8.5.5.6** Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition or melting.

**8.5.6 Report.** Observations of ignition or melting shall be recorded and reported for each specimen.

**8.5.7 Interpretation.** Any evidence of ignition or melting on any specimen shall constitute failing performance.

#### **8.5.8 Specific Requirements for Testing Fabrics Less Than 380 mm (15 in.) Wide.**

**8.5.8.1** If the fabric components are not available in the width specified in 8.5.2.1, the width of the test specimen shall be the width as used on the SCBA but shall be a minimum of 380 mm (15 in.) long.

**8.5.8.2** Testing shall be performed as specified in 8.5.5.

#### **8.5.9 Specific Requirements for Testing Fabrics Less Than 380 mm (15 in.) Long.**

**8.5.9.1** If the fabric components are not available in the length specified in 8.5.2.1, the length of the test specimen shall be the length as used on the SCBA.

**8.5.9.2** Testing shall be performed as specified in 8.5.5.

### **8.6 Thread Heat Test.**

**8.6.1 Application.** This test shall apply to sewing thread used in construction of the SCBA.

**8.6.2 Specimens.** Three 3 mg to 4 mg specimens shall be tested.

**8.6.3 Specimen Preparation.** Specimens shall be conditioned at 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent for a minimum of 4 hours prior to testing.

#### **8.6.4 Apparatus.**

**8.6.4.1** An electrically heated stage having a circular depression large enough to insert a micro cover glass and a variable transformer controlling the rate of heat input to the stage shall be used.

**8.6.4.2** Two armored stem thermometers shall be used, one with a range of 20°C to 160°C (68°F to 320°F), accurate to 0.5°C (1°F), and one with a range from 150°C to 300°C (302°F to 572°F), accurate to 1°C (2°F).

**8.6.4.3** The following items shall be provided for test equipment:

- (1) Low powered magnifying glass
- (2) Two micro cover glasses
- (3) Spatula, pick needle, or other instrument for applying pressure to the cover glass
- (4) Soxhlet extraction apparatus
- (5) Chloroform, U.S.P. reagent

### **8.6.5 Procedure.**

**8.6.5.1** Specimens shall be extracted with chloroform for a minimum of 20 extractions in a Soxhlet extractor, or equivalent, and dried.

**8.6.5.2** The specimen shall then be cut into lengths of 2 mm (1/16 in.) or less.

**8.6.5.3** The specimen shall be placed in a small mound on a cover glass and covered with another cover glass.

**8.6.5.4** The two cover glasses shall be pressed together gently but firmly and placed in the circular depression on the stage.

**8.6.5.5** The temperature of the stage shall be raised with some rapidity to 245°C (473°F) and thereafter at a rate of 3°C to 4°C (5°F to 8°F) per minute until 260°C (500°F) is reached.

**8.6.5.6** At this rate of temperature rise, a slight pressure shall be applied on the upper glass cover by pressing with a spatula, pick needle, or other instrument, so that the complete fiber is in contact with the cover glass.

**8.6.5.7** The specimen shall be observed with the aid of a magnifying glass at 260°C (500°F).

**8.6.6 Report.** Observations of any melting of the specimens shall be recorded and reported.

**8.6.7 Interpretation.** Any specimen exhibiting melting at 260°C (500°F) shall constitute failure of this test.

### **8.7 Accelerated Corrosion Test.**

**8.7.1 Application.** This test method shall apply to complete SCBA.

**8.7.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

#### **8.7.3 Specimen Preparation.**

**8.7.3.1** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.7.3.2** Specimens for conditioning shall be complete SCBA.

**8.7.4 Apparatus.** A salt fog chamber shall be used for testing and shall meet the requirements of Section 4 of ASTM B 117, *Standard Test Method for Salt Spray (Fog) Testing*.

#### **8.7.5 Procedure.**

**8.7.5.1** The SCBA with a fully charged breathing air cylinder, with the breathing air cylinder valve fully closed, shall be placed in the test chamber attached to a mannequin to simulate its typical wearing position on a fire fighter as specified by the manufacturer.

**8.7.5.2** SCBA shall not contact each other or the sides of the test chamber.

**8.7.5.3** The SCBA shall be placed in the temperature-stabilized chamber for a minimum of 2 hours prior to introduction of the salt solution.

**8.7.5.4** The SCBA shall then be exposed to the salt fog for 48 hours, +15 minutes/-0 minutes.

**8.7.5.5** Specimen SCBA shall be subjected to a 5 percent, ±1 percent salt solution fog.

**8.7.5.5.1** The salt solution shall be prepared by dissolving 5 parts, ±1 part by mass of sodium chloride in 95 parts of water.



**8.7.5.5.2** The salt used shall be sodium chloride substantially free of nickel and copper and containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent of total impurities.

**8.7.5.5.3** The pH of the salt solution shall be in the range of 6.5 to 7.2.

**8.7.5.6** The compressed air supply to the nozzle or nozzles for atomizing the salt solution shall be free of oil and dirt and maintained between 69 kPa/m and 172 kPa/m (10 psi and 25 psi).

**8.7.5.7** The exposure temperature in the chamber shall be maintained at 35°C, ±1°C (95°F, ±2°F) for the duration of the test.

**8.7.5.8** At least two clean fog collectors shall be placed within the exposure zone so that no drops of solution from the test specimens or any other source shall be collected in them.

**8.7.5.8.1** The collectors shall be placed in the proximity of the test specimens, one nearest to any nozzle and the other farthest from all nozzles.

**8.7.5.8.2** The fog shall be such that for each 80 cm<sup>2</sup> (12.4 in.<sup>2</sup>) of horizontal collecting area from 1.0 mL to 2.0 mL of solution per hour will be collected in each collector.

**8.7.5.9** After completion of the salt fog exposure, the SCBA shall be stored in an environment of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±5 percent for a minimum of 48 hours.

**8.7.5.10** The SCBA shall then be tested as specified in Section 8.1, Airflow Performance Test, to determine pass or fail.

**8.7.5.11** All controls or operating features of the SCBA shall operate per the SCBA manufacturer's instructions to determine pass or fail.

### **8.7.6 Report.**

**8.7.6.1** The facepiece pressure peak inhalation and peak exhalation shall be recorded and reported for each test condition.

**8.7.6.2** The activation and operation, or failure to activate and operate, of the EOSTI shall be reported and recorded.

**8.7.6.3** The activation and identification of HUD visual alert signals shall be reported and recorded.

### **8.7.7 Interpretation.**

**8.7.7.1** The peak inhalation and peak exhalation shall be used to determine pass or fail performance.

**8.7.7.2** One or more specimens failing this test shall constitute failing performance.

**8.7.7.3** Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

**8.7.7.4** Failure of the HUD to display the breathing air cylinder content or to display the visual alert signal during the test shall constitute failing performance.

## **8.8 Particulate Test.**

**8.8.1 Application.** This test method shall apply to complete SCBA.

**8.8.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

## **8.8.3 Specimen Preparation.**

**8.8.3.1** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.8.3.2** Specimens for conditioning shall be complete SCBA.

## **8.8.4 Apparatus.**

**8.8.4.1** A Scott Aviation model No. 803608-01 or 803608-02 test headform or equivalent shall be joined to a mannequin to simulate its typical wearing position, as specified by the manufacturer.

**8.8.4.2** The test headform shall be connected, as specified in Section 8.1, Airflow Performance Test, to the breathing machine specified in 8.1.4.9 or other respiration simulator producing a 1-minute volume of 40 L, ±2 L at the ambient conditions specified in 8.1.3.2, with a minimum tidal volume of 1.6 L per breath at a minimum respiration of 10 breaths/min.

**8.8.4.3** A test facility consisting of a chamber and accessories to control dust concentration, velocity, temperature, and humidity of dust-laden air shall be used.

**8.8.4.4** To provide adequate circulation of the dust-laden air, no more than 50 percent of the cross-sectional area and no more than 30 percent of the volume of the test chamber shall be occupied by the test item(s).

**8.8.4.5\*** The chamber shall be provided with a means of maintaining and verifying the dust circulation.

**8.8.4.6** The dust-laden air shall be introduced into the test space in such a manner as to allow the air to become laminar in flow before it strikes the test item.

**8.8.4.7\*** Dust shall be silica flour and shall contain 97 percent to 99 percent by weight silicon dioxide (SiO<sub>2</sub>).

**8.8.4.8** The following size distribution shall apply:

- (1) 100 percent shall pass through a 100 mesh screen.
- (2) 98 percent, ±2 percent shall pass through a 140 mesh screen.
- (3) 90 percent, ±2 percent shall pass through a 200 mesh screen.
- (4) 75 percent, ±2 percent shall pass through a 325 mesh screen.

## **8.8.5 Procedure.**

**8.8.5.1** A fully charged SCBA shall be secured to a test headform and mannequin as specified in 8.8.4.1.

**8.8.5.2** The mannequin, including the test headform, shall be mounted upright and placed inside the test chamber.

**8.8.5.3** The temperature of the test chamber shall be adjusted to 22°C, ±3°C (72°F, ±5°F) and the RH to less than 30 percent.

**8.8.5.4** The air velocity shall be adjusted to 530 m/min, ±15 m/min (1750 ft/min, ±50 ft/min).

**8.8.5.5** The dust concentration for the blowing dust shall be maintained at 10.6 g/m<sup>3</sup>, ±7 g/m<sup>3</sup> (0.3 g/ft<sup>3</sup>, ±0.2 g/ft<sup>3</sup>).

**8.8.5.6** The test duration shall be 1 hour, and the breathing machine shall be operating throughout the entire test.

**8.8.5.6.1** The test shall be permitted to be interrupted to change the SCBA breathing air cylinder.

**8.8.5.6.2** Test item configuration and orientation shall be turned around its vertical axis 180 degrees midway through the test.

**8.8.5.7** After the completion of the test, the SCBA shall be removed from the test compartment.

**8.8.5.8** The SCBA shall be lightly shaken or brushed free of dust and then shall be tested as specified in Section 8.1, Air-flow Performance Test, to determine pass or fail.

#### **8.8.6 Report.**

**8.8.6.1** The facepiece pressure peak inhalation and peak exhalation shall be recorded and reported for each test condition.

**8.8.6.2** The activation and operation, or failure to activate and operate, of both EOSTI shall be recorded and reported.

**8.8.6.3** The activation and identification of HUD visual alert signals shall be recorded and reported.

#### **8.8.7 Interpretation.**

**8.8.7.1** The peak inhalation and peak exhalation shall be used to determine pass or fail performance.

**8.8.7.2** One or more specimens failing this test shall constitute failing performance.

**8.8.7.3** Failure of any EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

**8.8.7.4** Failure of the HUD to display the breathing air cylinder content or display the visual alert signal during the test shall constitute failing performance.

#### **8.9 Facepiece Lens Abrasion Test.**

**8.9.1 Application.** This test method shall apply to facepiece lenses.

**8.9.2 Samples.** A minimum of four faceshield lenses shall be tested.

#### **8.9.3 Specimen Preparation.**

**8.9.3.1** Seven specimens shall be chosen from a minimum of four facepiece lenses.

**8.9.3.1.1** Four specimens shall be taken from the left viewing area, and three samples shall be taken from the right viewing area.

**8.9.3.1.2** One of the four specimens taken from the left viewing area shall be the set-up specimen.

**8.9.3.2** The left test specimens shall conform to all the following criteria:

- (1) The specimen shall be a square measuring 50 mm × 50 mm (2 in. × 2 in.).
- (2) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the specimen.
- (3) At least 38 mm (1½ in.) of the 50 mm × 50 mm (2 in. × 2 in.) square shall be taken from the left side of the center line of the lens.
- (4) The 50 mm × 50 mm (2 in. × 2 in.) square shall be cut at approximately eye level.

**8.9.3.3** The right test specimens shall conform to all the following criteria:

- (1) The specimen shall be a square measuring 50 mm × 50 mm (2 in. × 2 in.).
- (2) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the specimen.
- (3) At least 38 mm (1½ in.) of the 50 mm × 50 mm (2 in. × 2 in.) square shall be taken from the right side of the center line of the lens.
- (4) The 50 mm × 50 mm (2 in. × 2 in.) square shall be cut at approximately eye level.

**8.9.3.4** Each of the specimens shall be cleaned in the following manner:

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

**8.9.4 Apparatus.** The test apparatus shall be constructed in accordance with Figure 8.9.4(a) and Figure 8.9.4(b).

#### **8.9.5 Procedure.**

**8.9.5.1** The haze of the specimen shall be measured using a haze meter in accordance with ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, and recorded with the following additions:

- (1) The haze shall be measured in the middle of the specimen ±1.6 mm (±⅛ in.).
- (2) The specimen shall be repositioned to achieve the maximum haze value within the area defined in 8.9.5.1(1).
- (3) The haze meter shall have a specified aperture of 22.4 mm (⅞ in.).
- (4) The haze meter shall have a visual display showing 0.1 percent resolution.
- (5) The haze meter shall be calibrated before and after each day's use following procedures specified in ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*.

**8.9.5.2** The set-up specimen shall be placed cover side up in the test apparatus specimen holder.

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

**8.9.5.4** The pad holder shall consist of a cylinder 10 mm (⅜ in.) high and 25 mm (1 in.) in diameter with a radius of curvature equal to the radius of curvature of the outside of the lens in the viewing area, ±0.25 diopter. This cylinder shall be rigidly affixed to the stroking arm by a #10-32 UNF threaded rod.

**8.9.5.5** The pad shall be a Blue Streak M306M wool felt polishing pad or equivalent, 24 mm (1⅝ in.) in diameter.

**8.9.5.6** The abrasive disc shall be made from 3M Part Number 7415, Wood Finishing Pad or equivalent.

**8.9.5.6.1** A disc 24 mm (1⅝ in.) in diameter shall be cut from the abrasive sheet.

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



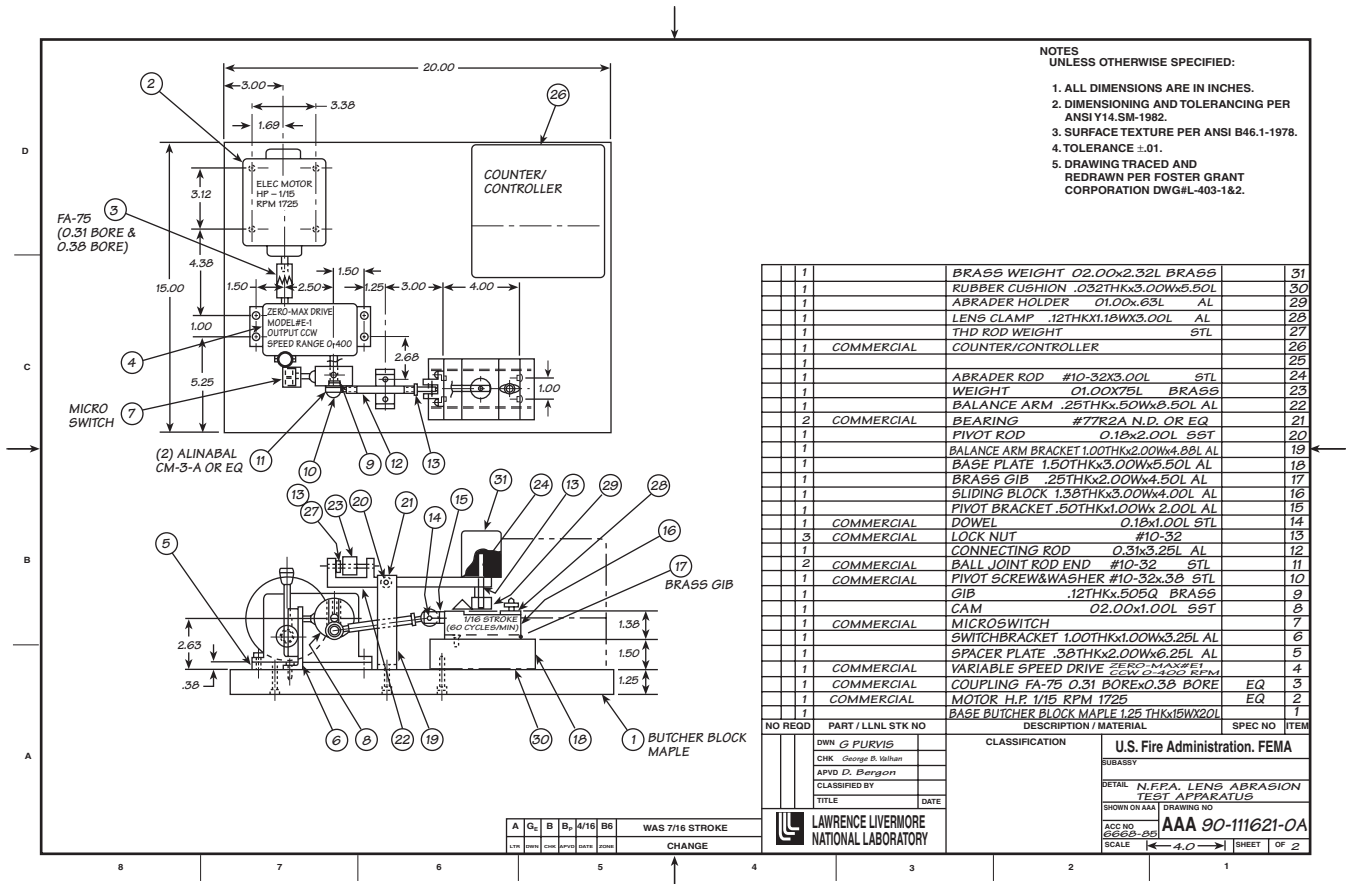


FIGURE 8.9.4(a) Lens Abrasion Tester.

**8.9.5.6.3** Care shall be exercised to maintain the orientation described in 8.9.5.6.2 for each abrasive disc throughout the testing.

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

**8.9.5.7.1** The stroking arm shall be leveled to  $\pm 3$  degrees by adjusting the threaded pin.

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

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

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

**8.9.5.9** The set-up specimen shall be replaced with one of the six specimens to be tested.

**8.9.5.10** The 1000 g,  $\pm 5$  g (2.2 lb,  $\pm 0.18$  lb) test weight shall be installed on the pin above the test specimen.

**8.9.5.11** The test shall be run for 200 cycles,  $\pm 1$  cycle. One cycle shall consist of a complete revolution of the eccentric wheel.

**8.9.5.12** The length of stroke shall be 14.5 mm ( $\frac{9}{16}$  in.), producing a pattern 38 mm ( $1\frac{1}{2}$  in.) long.

**8.9.5.12.1** The frequency of the stroke shall be 60 cycles,  $\pm 1$  cycle, per minute.

**8.9.5.12.2** The center of the stroke shall be within  $\pm 2$  mm ( $\pm \frac{1}{16}$  in.) of the center of the specimen.

**8.9.5.13** The specimen shall be removed and cleaned following the procedure specified in 8.9.3.4.

**8.9.5.14** The abrasive disc shall be discarded.

**8.9.5.15** The haze of the specimen shall be measured following the procedure specified in 8.9.5.1.

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

**8.9.5.17** The testing steps specified in 8.9.3.4 through 8.9.5.16 shall be repeated five times with a new specimen and abrasive disc.

## 8.9.6 Report.

**8.9.6.1** The six delta haze values shall be recorded, and the values shall be averaged and reported.

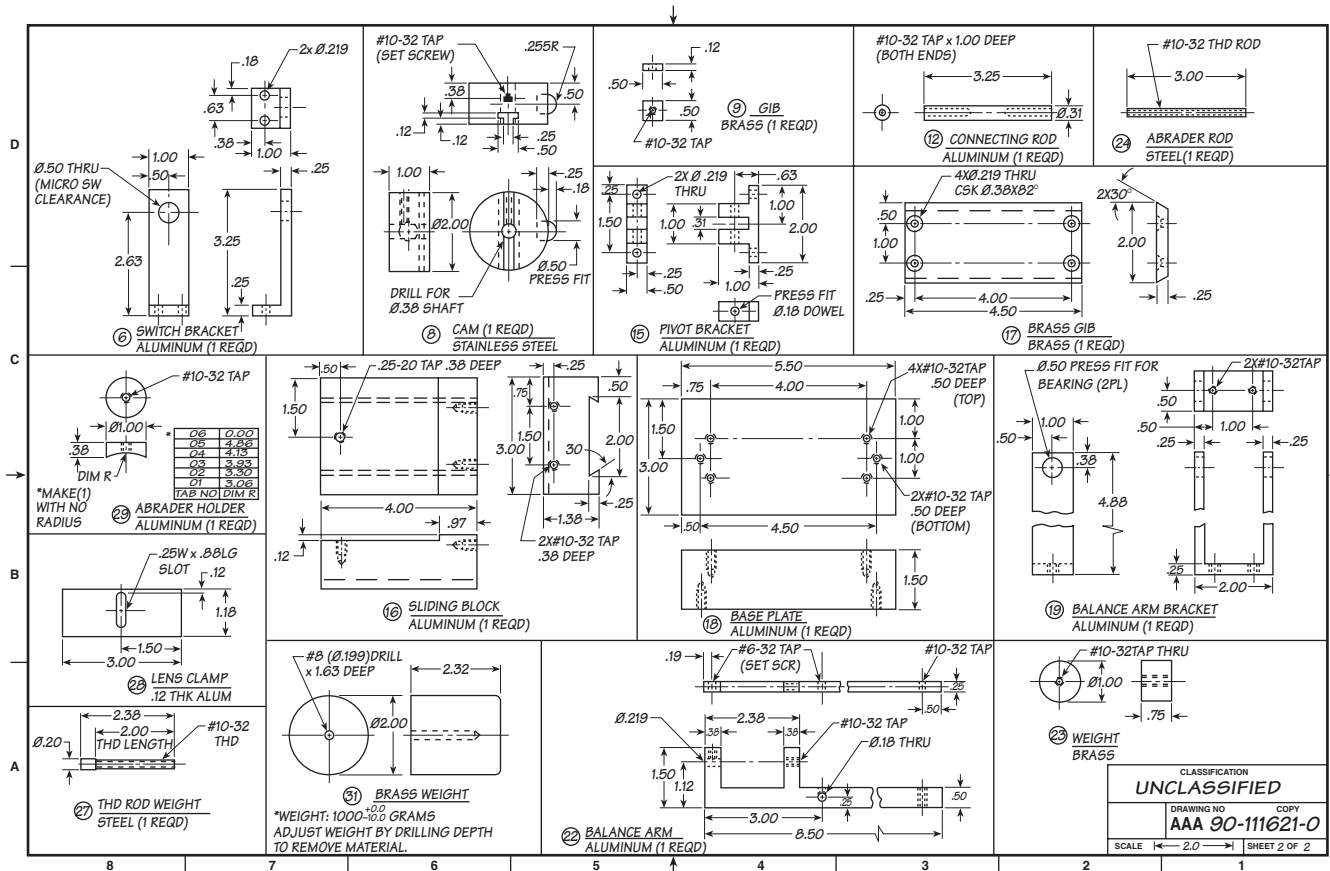
**8.9.6.2** The average value shall be used to determine pass or fail.

## 8.9.7 Interpretation.

**8.9.7.1** The average delta haze shall be used to determine pass or fail performance.

**8.9.7.2** Failure of the average value shall constitute failure for the entire sample.





**FIGURE 8.9.4(b) Lens Abrasion Tester (details).**

### 8.10 Nonelectronic Communications Test.

**8.10.1 Application.** This test method shall apply to complete SCBA facepieces and second stage regulator(s).

**8.10.2 Samples.** Each sample to be tested shall be as specified in 4.3.9 with all voice communications systems installed, including supplementary voice communications systems, and in the “off” mode in accordance with the manufacturer’s instructions.

### 8.10.3 Specimen Preparation.

**8.10.3.1** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.10.3.2** Specimens for conditioning shall be complete medium-size SCBA facepiece(s) and inner mask(s), with the second stage regulator(s) installed in the “as worn” position as specified by the manufacturer.

#### 8.10.4 Apparatus.

**8.10.4.1** Testing shall be conducted in a chamber having the following minimum characteristics:

- (1) Minimum room dimensions: 4.6 m long  $\times$  3.1 m wide  $\times$  2.7 m high (15 ft long  $\times$  10 ft wide  $\times$  9 ft high)
- (2) Construction: hemi-anechoic
- (3) Ambient noise level inside chamber: NC-25
- (4) Walls and ceiling:  $\geq 90$  percent absorptive for 100 Hz

**8.10.4.1.1** All surfaces above the floor shall be acoustically treated for internal acoustic absorption, as well as for external noise mitigation.

**8.10.4.2** A G.R.A.S. KEMAR Head and Torso Simulator (HATS) Type 45BM shall be used for testing.

**8.10.4.2.1** The mouth simulator shall be capable of producing 112 dB/1 kHz sine tone at 25 mm (1 in.) with the mouth reference point unequalized, and the total harmonic distortion (THD) shall be  $\leq 3$  percent.

**8.10.4.2.2** The mouth simulator frequency response shall be able to be equalized flat  $\pm 1$  dB between 100 Hz and 10 kHz, and the response shall be  $-15$  dB or less at 100 Hz and  $-20$  dB or less at 15 kHz.

**8.10.4.3** The sound pressure level (SPL) meter having the following characteristics shall be used:

- (1) The SPL meter shall be capable of applying an equivalent continuous sound pressure level (Leq) using an A-weighted filter.
- (2) The SPL meter shall have a dynamic range from 30 dB (or less) to 130 dB (or more).
- (3) The SPL meter shall display the measurement to at least one decimal place.

**8.10.4.4** The signal/pink noise analog audio signal generators having the following characteristics shall be used.

**8.10.4.4.1** One generator shall be capable of playing wave files in the following format: 48 kHz, 16-bit mono at the output level of 0 dB, FS = 18 dBu, according to EBU Technical Recommendation R68, *Alignment level in digital audio production equipment and in digital audio recorders*.

**8.10.4.4.2** The second generator shall be capable of generating pink noise and sine waves from –80 dBu to –2 dBu in one digit steps, with a THD+N of –90 dB (0.0032 percent) at 8 dBu noise floor type 25uv, and shall also have the following characteristics:

- (1) A frequency range of 10 Hz to 20 kHz in one digit steps  $\pm 0.01$  percent
- (2) An amplitude accuracy of within  $\pm 0.5$  dB or less

**8.10.4.5** A digital equalizer having the following characteristics shall be used:

- (1) The digital equalizer shall be capable of at least two concurrently selectable equalizer sections:
  - (a) One 31-band graphic with an adjustment range of at least  $\pm 18$  dB
  - (b) A 10-band parametric with an adjustment range of at least  $\pm 18$  dB
- (2) The digital equalizer shall have a dynamic range of 112 dB.
- (3) The digital equalizer shall be capable of equalizing the frequency response of the HATS mannequin of  $\pm 1$  dB flat between 100 Hz and 10 kHz, applying a 180 Hz high pass filter with a slope of –24 dB octave, and a 10 Hz low pass filter with a slope of –24 dB octave (–15 dB at 100 Hz, –20 dB at 15 kHz).

**8.10.4.6** A powered speaker having the following characteristics shall be used:

- (1) The sensitivity shall be  $\geq 84$  dB at one watt at 1 meter.
- (2) The frequency response shall be rated at  $\leq 80$  Hz to  $\geq 13$  kHz.
- (3) The amplifier shall deliver  $\geq 10$  watts with a total harmonic distortion  $< 1$  percent.

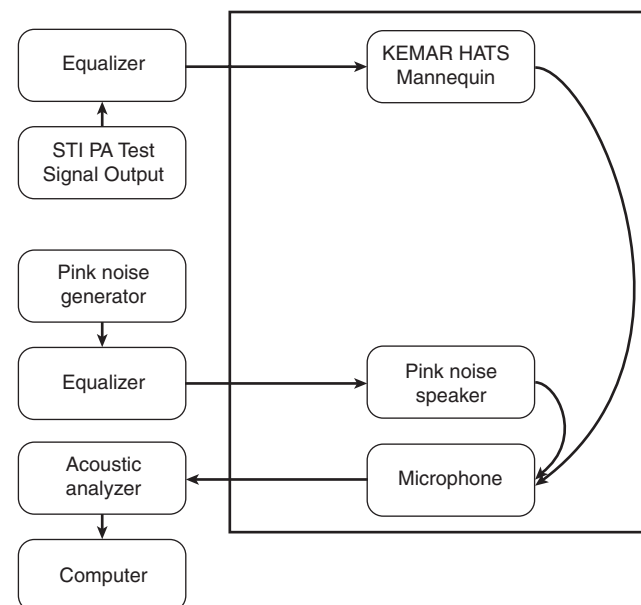
**8.10.4.7** A microphone having the following characteristics shall be used:

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

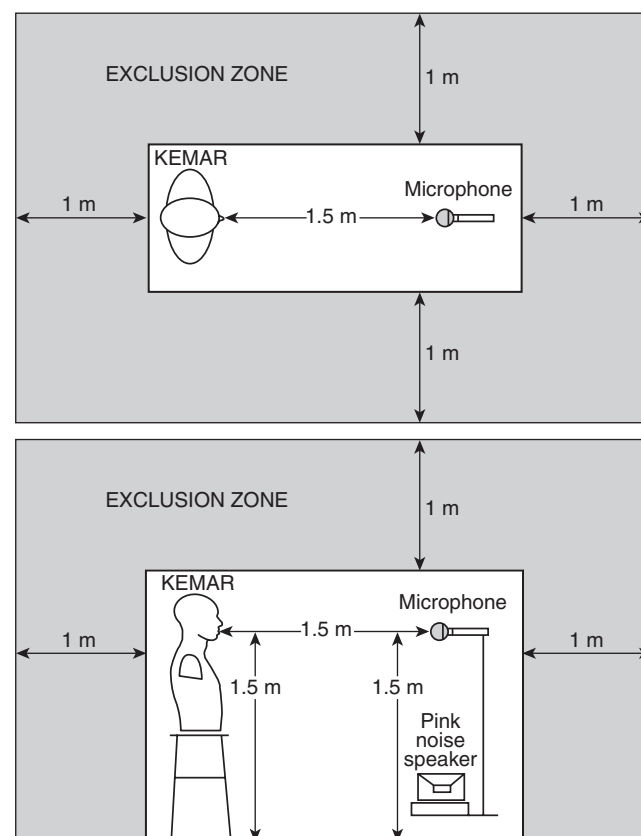
**8.10.4.8** A Speech Transmission Index (STI) analyzer having the following characteristics shall be used:

- (1) The STI PA analyzer shall be capable of measuring and displaying a single value STI PA result to two decimal places with a seven octave band modulated noise test signal using the Netherlands Organization for Applied Scientific Research (TNO) verified algorithm.
- (2) The STI PA analyzer shall conform to IEC-60268, *Sound System Equipment — Part 16: Objective Rating of Speech Intelligibility by Speech Transmission Index*.

**8.10.4.9** All of the apparatus identified in 8.10.4.2, 8.10.4.3, 8.10.4.4, 8.10.4.5, 8.10.4.6, and 8.10.4.7 shall be located in the hemi-anechoic chamber and arranged as shown in Figure 8.10.4.9(a) and Figure 8.10.4.9(b).



**FIGURE 8.10.4.9(a) Hemi-Anechoic Chamber.**



**FIGURE 8.10.4.9(b) HATS Test Mannequin Position.**

**8.10.4.10** The HATS test mannequin shall be positioned in the chamber in the following manner as shown in Figure 8.10.4.9(a) and Figure 8.10.4.9(b).

**8.10.4.10.1** The distance between the HATS test mannequin and the microphone shall be 1.5 m, +25 mm/-0 mm (5 ft, +1 in./-0 in.), and they shall be facing each other.

**8.10.4.10.2** The distance between the HATS test mannequin mouth reference point (MRP) and the floor shall be 1.5 m, +25 mm/-0 mm (5 ft, +1 in./-0 in.).

**8.10.4.10.3** The distance between the microphone and the floor shall be 1.5 m, +25 mm/-0 mm ( $\pm 5$  ft, +1 in./-0 in.).

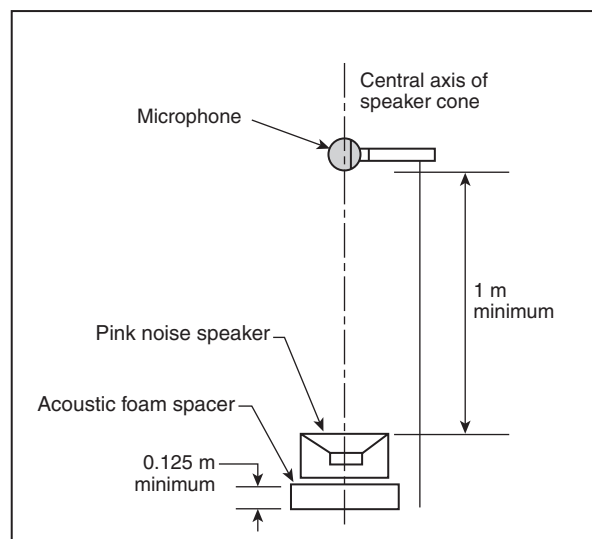
**8.10.4.11** The test chamber shall be filled with broadband pink noise with a tolerance of  $\pm 1$  dB per octave band from 100 Hz to 10 kHz.

**8.10.4.12** The pink noise speaker shall be placed directly beneath the microphone and oriented such that the central axis of the speaker cone is directly facing the microphone.

**8.10.4.12.1** The speaker shall be situated on top of a block of isolating acoustic foam such that no part of the speaker box is contacting the floor or the microphone stand, to prevent conduction of sound to the microphone.

**8.10.4.12.2\*** The height of the speaker off the floor shall be at least 0.125 m (5 in.), as measured from the bottom of the speaker box, and the distance between the speaker and microphone shall be no less than 1 m (40 in.), as measured from the top of the speaker grille/enclosure.

**8.10.4.12.3** The pink noise speaker shall be placed as indicated in Figure 8.10.4.12.3.



**FIGURE 8.10.4.12.3 Test Chamber.**

**8.10.4.13** The pink noise speaker shall be fully equalized flat, from 100 Hz to 10 kHz, to within  $\pm 1$  dB on a relative scale in  $\frac{1}{3}$  octave bands, as measured at the microphone position.

**8.10.4.14** The STI test signal from the mannequin shall be adjusted to achieve an A-weighted sound level of 97 dB,  $\pm 0.5$  dB at the mouth reference point (MRP), 50 mm,  $\pm 3$  mm (2 in.  $\pm \frac{1}{8}$  in.) from the test mannequin's mouth.

**8.10.4.14.1** The microphone used for calibrating the STI signal shall be omnidirectional and oriented in a horizontal front-facing manner.

**8.10.4.14.2** The STI signal shall be equalized flat to within  $\pm 1$  dB on a relative scale in  $\frac{1}{3}$  octave bands as measured at the MRP of the HATS.

**8.10.4.14.3** The HATS shall be calibrated as follows:

- (1) Equalize flat with pink noise to 97 dBA from 100 Hz – 10 kHz to  $\pm 1$  dB on a  $\frac{1}{3}$  octave scale.
- (2) Reduce the levels for the 125 Hz octave band (the 100, 125, 160  $\frac{1}{3}$  octave bands) by 10 dB.
- (3) Reduce the levels for the 250 Hz octave band (the 200, 250, 315  $\frac{1}{3}$  octave bands) by 2 dB.
- (4) Apply the STI PA signal and adjust the Sound Pressure Level (SPL) to 97 dBA,  $\pm 0.5$  dBA.

**8.10.4.15** The gain of the powered speaker amplifier used to generate the pink noise shall be adjusted to achieve an A-weighted sound level of 15 dB,  $\pm 0.5$  dB below the signal level generated as identified in 8.10.4.14, measured at the microphone placed as identified in 8.10.4.10.1 and 8.10.4.10.3.

### 8.10.5 Procedure.

**8.10.5.1** The method for measuring the Speech Transmission Index (STI) shall be as specified in IEC 60268, *Sound System Equipment — Part 16: Objective Rating of Speech Intelligibility by Speech Transmission Index*, with the modified apparatus specified in 8.10.4.

**8.10.5.2** The medium-size facepiece with inner mask and second stage regulator in the normal use mode shall be fitted to the HATS test mannequin in the following manner:

- (1) Place the chin of the mannequin in the “chin cup” of the facepiece.
- (2) Place the facepiece to seal against the face of the HATS test mannequin.
- (3) Pass the head harness of the facepiece over the HATS test mannequin and tighten it in a manner that maintains the symmetry of the facepiece on the HATS test mannequin, using talc to minimize friction between the HATS test mannequin and the strap.
- (4) Tighten the straps to a tension of 50 N (11.2 lbf).

**8.10.5.3** Three medium-size facepieces shall be tested in the chamber having an ambient noise field as specified in 8.10.4.11 through 8.10.4.15. Each facepiece shall be mounted as specified in 8.10.5.2 and then tested as follows:

- (1) Three separate measurements shall be recorded for each donning of the facepiece.
- (2) Five separate donnings shall be performed.
- (3) Total of 45 measurements: 3 (facepieces)  $\times$  3 (measurements)  $\times$  5 (donnings) = 45 measurements.

### 8.10.6 Report.

**8.10.6.1** The STI PA signal Sound Pressure Level (SPL) per octave band, the Modulation Transfer Index per octave band, and overall STI score at the mouth reference point (MRP) described in 3.3.31 shall be recorded and reported.

**8.10.6.2** The STI PA signal SPL per octave band, the Modulation Transfer Index per octave band, and overall STI score at the microphone measurement point (MMP) described in 3.3.30 shall be recorded and reported.

**8.10.6.3** The pink noise SPL per octave band at the MMP described in 3.3.30 shall be recorded and reported.

**8.10.6.4** The STI score for each facepiece measurement sampled as described in 8.10.5.3 (a total of 45 scores) shall be

recorded and reported, and the starting time of each facepiece donning shall be recorded.

**8.10.6.5** The average for each donning shall be calculated, recorded, and reported. There shall be a total of 15 averages of 3 measurements (5 averages for each of the 3 facepiece samples). See Figure 8.10.6.5.

#### **8.10.7 Interpretation.**

**8.10.7.1** The averages calculated in 8.10.6.5 shall be used to determine a pass or fail per Section 7.10.

**8.10.7.2** If any of the 15 averages score less than the minimum threshold specified in Section 7.10, the facepiece shall be considered to have failed and shall be reported as such.

**8.10.7.3** If all of the 15 averages score equal to or greater than the minimum threshold specified in Section 7.10, the facepiece shall be considered to have passed and shall be reported as such.

### **8.11 Heat and Flame Test.**

**8.11.1 Application.** This test method shall apply to complete SCBA.

**8.11.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

#### **8.11.3 Specimen Preparation.**

**8.11.3.1** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.11.3.2** Specimens for conditioning shall be complete SCBA.

#### **8.11.4 Apparatus.**

**8.11.4.1** A test mannequin meeting the requirements specified in Figure 8.11.4.1 shall be provided.

**8.11.4.2** Both the calibration mannequin and the heat and flame test mannequin shall have protective coverings.

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

**8.11.4.2.2** The protective coverings shall be designed and constructed to provide coverage over the surface of the mannequins.

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

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

**8.11.4.3** A test headform meeting the requirements specified in 8.1.4.1 shall be used on the test mannequin.

**8.11.4.4** The test headform shall be attached to the breathing machine as specified in Figure 8.1.4.9, with the modification that a 38 mm (1½ in.) I.D. breathing hose, not longer than 7.6 m (25 ft), shall be interconnected between the breathing machine and the throat tube of the test mannequin headform.

**8.11.4.5** The test headform shall be covered with an undyed aramid hood for protection of the headform during testing.

**8.11.4.5.1** The protective hood shall meet the hood requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

**8.11.4.5.2** The protective hood, when placed on the test headform, shall not affect the seal of the facepiece to the headform.

**8.11.4.5.3** The protective hood shall not cover or protect any part of the facepiece or the facepiece retention system that holds the facepiece to the headform.

**8.11.4.6** The heat and flame test apparatus shall be as specified in Figure 8.11.4.6.

**8.11.4.6.1** The test oven shall be a horizontal forced circulating air oven with a range of flow of 38 m/min to 76 m/min (125 ft/min to 250 ft/min).

**8.11.4.6.2** The test oven shall have minimum dimensions of 915 mm depth × 915 mm width × 1.22 m height (36 in. depth × 36 in. width × 48 in. height).

#### **8.11.5 Procedure.**

**8.11.5.1** The SCBA shall be mounted on the test mannequin to simulate the correct wearing position on a person as specified by the SCBA manufacturer's instructions.

**8.11.5.2** The facepiece shall be mounted and tested on the test headform as specified in 8.1.4.1.

**8.11.5.3** For calibration prior to the heat and flame test, the mannequin for calibration shall be the same as the test mannequin specified in 8.11.4.1 and shall be exposed to direct flame contact for 10 seconds using the heat and flame test apparatus.

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

**8.11.5.3.2** The average mean of all peak temperature readings specified in 8.11.5.3.1 shall be no higher than 950°C (1742°F).

**8.11.5.4** The test oven recovery time, after the door is closed, shall not exceed 1.0 minute.

**8.11.5.5** The airflow performance test shall be conducted as specified in 8.1.5, with modifications to the ventilation rate specified in 8.11.5.7 with the test temperatures specified in 8.11.5.3 and 8.11.5.8.

**8.11.5.5.1** The variation in pressure extremes caused by the heat and flame test mannequin configuration shall be determined as specified in 8.11.5.5.2 and 8.11.5.5.3.

**8.11.5.5.2** The airflow performance test as specified in Section 8.1, Airflow Performance Test, shall be carried out using the configuration specified in 8.11.4.4 at the same ventilation rates.

**8.11.5.5.3** The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 8.11.4.4 from the values obtained using the configuration specified in Section 8.1, Airflow Performance Test.

**8.11.5.6** The airflow performance test shall continue through the drop test specified in 8.11.5.15.

**8.11.5.7** The ventilation rate shall be set at 40 L/min, ±2 L/min, with a respiratory frequency of 24 breaths/min, ±1 breath/min at ambient conditions as specified in 8.1.3.2.



## Sample Recording Sheet for STI Test

### 1. Tested Per Procedure:

\_\_\_\_\_ 7.10 Nonelectronic Communications Performance Requirements.

\_\_\_\_\_ 7.17 Supplementary Voice Communications System Performance Requirements.

### 2. Setup Information:

#### STIPA Signal data at Mouth Reference Point (MRP)

#	STI	Sound Pressure Levels							Modulation Transfer Index						
		125	250	500	1000	2000	4000	8000	125	250	500	1000	2000	4000	8000
1															
2															
3															
4															

1 — Initial measurement prior to fireplace testing started

2 — Final measurement after fireplace testing commenced

3 & 4 — Supplemental measurements for testing breaks greater than 1 hour during testing

#### STIPA Signal data at Microphone Measurement Point (MMP)

#	STI	Sound Pressure Levels							Modulation Transfer Index						
		125	250	500	1000	2000	4000	8000	125	250	500	1000	2000	4000	8000
1															
2															
3															
4															

1 — Initial measurement prior to fireplace testing started

2 — Final measurement after fireplace testing commenced

3 & 4 — Supplemental measurements for testing breaks greater than 1 hour during testing

#### Pink Noise data at Microphone Measurement Point (MMP)

#	STI	Sound Pressure Levels							Modulation Transfer Index						
		125	250	500	1000	2000	4000	8000	125	250	500	1000	2000	4000	8000
1															
2															
3															
4															

1 — Initial measurement prior to fireplace testing started

2 — Final measurement after fireplace testing commenced

3 & 4 — Supplemental measurements for testing breaks greater than 1 hour during testing

FIGURE 8.10.6.5 Sample Recording Sheet for STI Test.



**3. Measurement Information**

- Record STI score per facepiece/donning/measurement
- Use the notes column to indicate Pass/Fail and/or observations
- Extra rows are provided if necessary

**Faceplate Sample 1**

Don #	STI Scores				Notes
	Meas 1	Meas 2	Meas 3	Avg	
1					
2					
3					
4					
5					

**Faceplate Sample 2**

Don #	STI Scores				Notes
	Meas 1	Meas 2	Meas 3	Avg	
1					
2					
3					
4					
5					

**Faceplate Sample 3**

Don #	STI Scores				Notes
	Meas 1	Meas 2	Meas 3	Avg	
1					
2					
3					
4					
5					

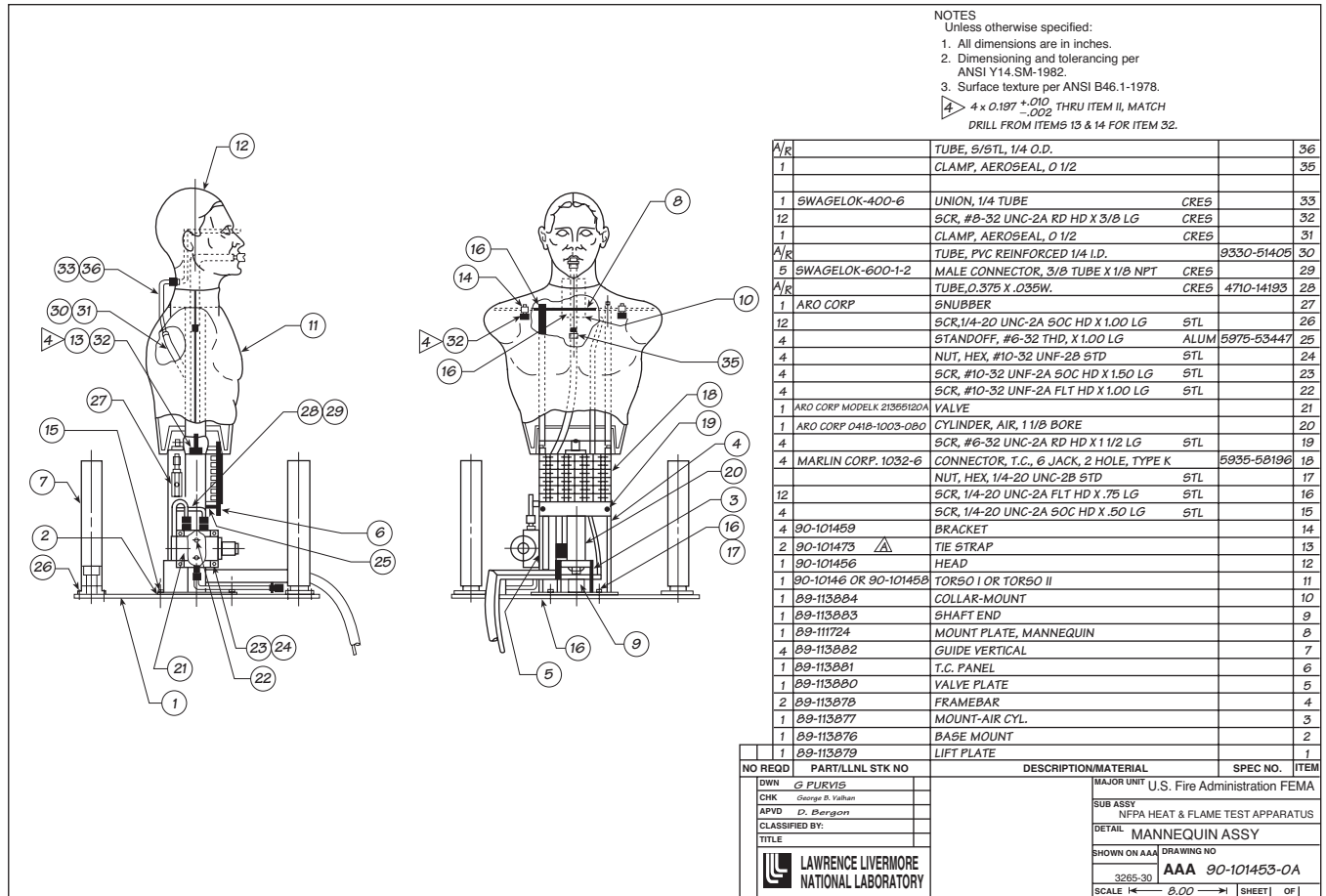
**4. Pass/Fail**

Indicate whether the facepiece passed or failed as whole per 8.10.7.1 or 8.25.7.1 respectively

\_\_\_\_\_ PASS

\_\_\_\_\_ FAIL

**FIGURE 8.10.6.5** *Continued*



**8.11.5.8** The SCBA mounted on the test mannequin shall be placed in the test oven that has been preheated to 95°C, ±2°C (203°F, ±4°F).

**8.11.5.9** After the test oven door is closed and the oven temperature recovers to 95°C (203°F), the test exposure time of 15 minutes shall begin.

**8.11.5.10** At the completion of the 15-minute exposure, the ventilation rate shall be increased to 103 L/min,  $\pm 3$  L/min, as specified in 8.1.4.10.7.

**8.11.5.11** The oven door shall be opened, and the SCBA mounted on the test mannequin shall be moved out of the oven and into the center of the burner array.

**8.11.5.12** The SCBA shall then be exposed to direct flame contact for 10 seconds, +0.25 second/−0.0 seconds.

**8.11.5.13** This exposure shall begin within 20 seconds of removal of the SCBA from the test oven.

**8.11.5.14** The SCBA shall be observed for any afterflame, and the afterflame duration shall be recorded to determine pass or fail as specified in 7.11.2.

**8.11.5.15** Within 20 seconds after the direct flame exposure has been completed, the SCBA mounted on the test mannequin shall be raised 150 mm, +6 mm/−0 mm (6 in., +¼ in./−0 in.) and dropped freely.

**8.11.5.16** The SCBA shall be observed to determine pass or fail performance as specified in 7.11.3.

**8.11.5.17** The facepiece pressure during the entire test shall be read from the strip chart recorder and corrected by adding the value of the difference in pressure calculated in 8.11.5.5.1 to determine pass or fail as specified in 7.11.1.

**8.11.5.18** Any pressure spike caused by the impact of the drop test and measured within a duration of three cycles of the breathing machine after the apparatus drop shall be disregarded.

**8.11.5.19** The SCBA facepiece and HUD shall be removed from the test headform and shall be donned by a test subject without touching the facepiece lens or HUD.

**8.11.5.19.1** The test subject shall have visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses.

**8.11.5.19.2** The test subject shall then observe the HUD display to see that visual alert signal(s) have activated.

**8.11.5.19.3** The test subject shall identify the visual alert signals that are activated.

**8.11.5.20** The SCBA facepiece, removed from the test headform and donned by the test subject as specified in 8.11.5.19, shall be used for determining facepiece lens vision.

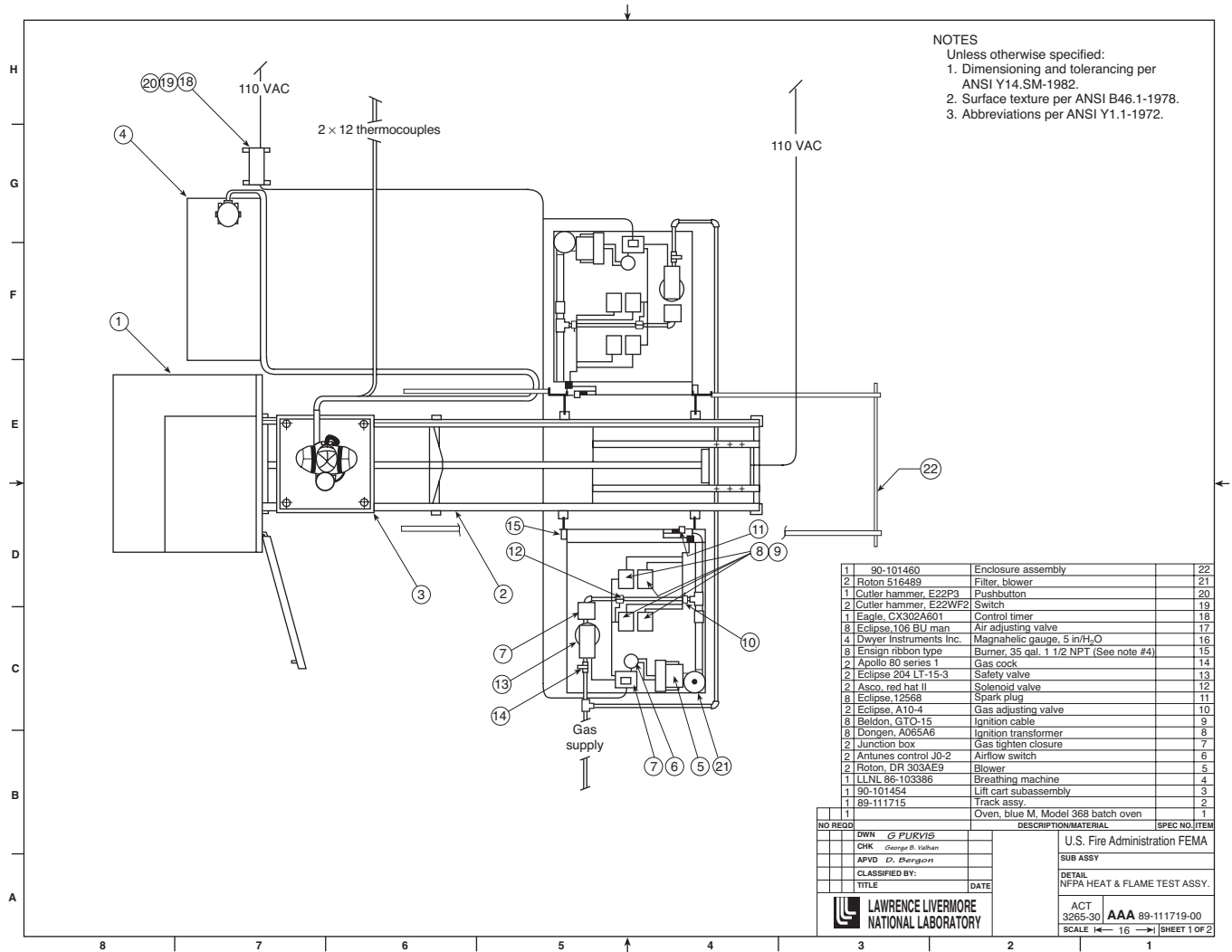


FIGURE 8.11.4.6 Heat and Flame Test Apparatus.

**8.11.5.20.1** The test shall be conducted using a standard 6.1 m (20 ft) eye chart with normal lighting range of 120 to 150 ft-candles at the chart and with the test subject positioned at a distance of 6.1 m (20 ft) from the chart.

**8.11.5.20.2** The test subject shall then read the standard eye chart at some point through the nominal center of the lens of the facepiece to determine pass or fail performance as specified in 7.11.4.

**8.11.5.20.3** The nominal center of the lens shall be the area bounded by a line 50 mm (2 in.) above, 50 mm (2 in.) below, 50 mm (2 in.) left, and 50 mm (2 in.) right of the intersection of the basic and mid-sagittal planes.

**8.11.5.21** The activation of the EOSTI shall be observed.

#### 8.11.6 Report.

**8.11.6.1** The facepiece pressure peak inhalation and peak exhalation shall be recorded and reported for each test condition.

**8.11.6.2** Any afterflame beyond 2.2 seconds shall be recorded and reported.

**8.11.6.3** The facepiece lens vision shall also be recorded and reported.

**8.11.6.4** The activation and operation or failure to activate and operate of EOSTI shall be recorded and reported.

**8.11.6.5** The activation and identification of HUD visual alert signals shall be recorded and reported.

#### 8.11.7 Interpretation.

**8.11.7.1** Pass or fail performance shall be based on any observed afterflame, the peak inhalation and exhalation values, and the facepiece vision value.

**8.11.7.2** Failure to meet any of the test condition requirements shall constitute failure of the SCBA.

**8.11.7.3** Failure of any EOSTI alarm signals to activate and remain active during the test shall constitute failing performance.

**8.11.7.4** Failure of the HUD to display the breathing air cylinder content or to display the visual alert signals during the test shall constitute failing performance.



## 8.12 Facepiece Carbon Dioxide Content Test.

**8.12.1 Application.** This test shall apply to all SCBA facepieces.

**8.12.2 Specimens.** Each SCBA facepiece model and size shall be tested.

**8.12.3 Specimen Preparation.** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.12.4 Procedure.** Specimens shall be tested as specified in Section 8.14 of EN 136, *Respiratory protective devices — Full face masks — Requirements, testing, marking*.

**8.12.5 Report.** The facepiece carbon dioxide content shall be recorded and reported for each test specimen.

### 8.12.6 Interpretation.

**8.12.6.1** The facepiece carbon dioxide content shall be used to determine pass or fail performance.

**8.12.6.2** One or more specimens failing this test shall constitute failing performance.

## 8.13 EOSTI Independent Activation Test.

**8.13.1 Application.** This test method shall apply to complete SCBA.

**8.13.2 Samples.** Samples for testing shall be selected as specified in 4.3.9.

**8.13.3 Specimen Preparation.** Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

### 8.13.4 Apparatus.

**8.13.4.1** Testing shall be performed using a calibrated pressure gauge accurate to within ±0.25 percent of full span and graduated in increments of 0.5 bar (7.5 psi) or smaller.

**8.13.4.2** A bleed valve capable of bleeding pressure at a rate not exceeding 50 bar (750 psi) per minute shall be used.

**8.13.4.3** An adapter shall be provided to connect the calibrated pressure gauge and bleed valve to the SCBA breathing air cylinder connection.

### 8.13.5 Procedure.

**8.13.5.1** Each SCBA test specimen shall be modified so that all EOSTI sensing mechanisms, other than the one being tested, are blocked to simulate failure.

**8.13.5.2** SCBA test specimens shall be tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.13.5.3** The adapter to connect the calibrated pressure gauge and bleed valve shall be installed at the breathing air cylinder connection on the SCBA test specimen.

**8.13.5.4** After pressurizing the SCBA test specimen breathing air cylinder to greater than 30 percent of cylinder rated service pressure, the pressure shall be bled to ambient pressure at a rate not greater than 50 bar (750 psi) per minute.

**8.13.5.5** The EOSTI alarm signal from the unblocked EOSTI shall function as specified in 7.13.1.

**8.13.5.6** This test shall be repeated for each EOSTI.

### 8.13.6 Report.

**8.13.6.1** The activation of the EOSTI alarm signal and the breathing air cylinder pressure at which the alarm signal activates shall be recorded and reported.

**8.13.6.2** The breathing air cylinder pressure at which the EOSTI alarm signal stops shall be recorded and reported.

**8.13.6.3** The proper functioning of the EOSTI alarm signal as specified in 7.13.1 shall be recorded and reported.

### 8.13.7 Interpretation.

**8.13.7.1** The proper activation and continued operation to the specified pressure shall be used to determine pass or fail performance.

**8.13.7.2** One or more specimens failing this test shall constitute failing performance.

## 8.14 EOSTI Recognition Test.

**8.14.1 Application.** This test method shall apply to complete SCBA.

**8.14.2 Samples.** Samples for testing shall be selected as specified in 4.3.9.

**8.14.3 Specimen Preparation.** Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

### 8.14.4 Apparatus.

**8.14.4.1** An adapter shall be provided that allows the person conducting the test to manually switch between a breathing air supply greater than 30 percent of the SCBA breathing air cylinder rated service pressure and a breathing air supply pressure of 18 bar, ±1 bar (265 psi, ±15 psi).

**8.14.4.2** Each SCBA test specimen shall be tested separately by two individual test subjects.

**8.14.4.3** Test subjects shall wear full structural fire-fighting protective ensemble, including coat, trousers, helmet, hood, gloves, and footwear, that is certified as compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

**8.14.4.4** Testing shall be performed with test subjects walking at 5 km/hr, ±0.2 km/hr (3 mph, ±0.12 mph) on a treadmill at zero percent grade.

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

**8.14.4.6** Test subjects shall have “audiometrically normal” hearing as defined in Section 5.3 of ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems*, in the range of 500 Hz to 3000 Hz.

**8.14.4.7** Test subjects shall have had a physical examination conducted by a physician within the past 12 months of the date of testing.

**8.14.4.8** The treadmill shall be positioned in the test chamber specified in 8.14.4.5 in a location where the conditions for background noise, lighting, and distraction specified in 8.14.4.9 and 8.14.4.10 are met.



**8.14.4.9** The test chamber shall be filled with “pink” noise with a tolerance of 6 dB per octave band from 400 Hz to 4000 Hz and shall be adjusted to achieve an A-weighted sound level of 75 dB,  $\pm 2$  dB measured at each ear of the test subject when the subject is walking on the treadmill as specified in 8.14.4.4.

**8.14.4.9.1** The forward axis of the loudspeaker shall be located as far as possible from and pointed away from the test subject so as to create a quasi-uniform sound field at the test subject’s ears.

**8.14.4.9.2** More than one loudspeaker shall be permitted to be used to achieve the desired sound level.

**8.14.4.10** The area in the test chamber where the test subject’s head is positioned when the subject is standing in the walking location on the treadmill shall be artificially lighted to achieve a light level between 100 lux and 500 lux.

**8.14.4.11** A reading stand containing printed text shall be positioned relative to the treadmill as follows:

- (1) The vertical center of the text shall be in line with the center of the treadmill track within  $\pm 100$  mm ( $\pm 4$  in.).
- (2) The horizontal center of the text shall be at the same height,  $\pm 100$  mm ( $\pm 4$  in.), as the eye level of the test subject when the subject is standing in the walking position on the treadmill.
- (3) The text shall be at a distance from the test subject that permits the text to be read by the subject while the subject is walking on the treadmill.

#### **8.14.5 Procedure.**

**8.14.5.1\*** Each specimen to be tested shall be an SCBA modified such that all EOSTI sensing mechanisms other than the one being tested are blocked so as to simulate failure.

**8.14.5.2** Prior to testing, the special adapter specified in 8.14.4.1 shall be installed at the breathing air cylinder connection on the SCBA specimen and the cylinder replaced with the air source specified in 8.14.4.1.

**8.14.5.3** Each SCBA test specimen shall be modified so that all EOSTI sensing mechanisms, other than the one being tested, are blocked to simulate failure.

**8.14.5.4** SCBA test specimens shall be tested at an ambient temperature of  $22^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ,  $\pm 5^{\circ}\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.14.5.5** A test subject wearing the protective ensemble specified in 8.14.4.3 shall don the test specimen SCBA and begin walking on the treadmill in the ambient conditions specified in 8.14.4.9 and 8.14.4.10.

**8.14.5.6** While breathing from the SCBA, the test subject shall read aloud the printed text.

**8.14.5.7** The person conducting the testing shall switch from the breathing air supply at greater than 30 percent of cylinder rated service pressure to 18 bar,  $\pm 1$  bar (265 psi,  $\pm 15$  psi) at a random point between 30 seconds and 120 seconds from the commencement of the test.

**8.14.5.8** The test subject shall acknowledge recognition of the alarm signal immediately upon becoming aware of it by a gesture that has been predetermined between the test subject and the person performing the testing.

**8.14.5.9** The test shall be repeated by the second test subject.

**8.14.6 Report.** The time elapsed between the switch to low supply air pressure and the acknowledgement of recognition of the EOSTI alarm signal by the test subject shall be recorded and reported.

**8.14.7 Interpretation.** Failure of either of the two test subjects to acknowledge recognition of the EOSTI alarm signal within the time period specified in 7.13.2 shall constitute failing performance.

#### **8.15 HUD Wiring Connection Strength Test.**

**8.15.1 Application.** This test method shall apply to SCBA facepieces with HUD and any associated assemblies with interconnecting wiring.

**8.15.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

#### **8.15.3 Specimen Preparation.**

**8.15.3.1** Specimens for conditioning shall be SCBA facepieces with HUD and any associated assemblies with interconnecting wiring.

**8.15.3.2** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of  $22^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ,  $\pm 5^{\circ}\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.15.4 Apparatus.** A mass of known weight with the means for attachment to wiring shall be provided.

**8.15.5 Procedure.** A force of 156 N,  $\pm 9$  N (35 lbf,  $\pm 2$  lbf) shall be applied gradually, in an axial direction, to the wiring of the specimen being tested.

**8.15.6 Report.** Observations of the HUD functionality shall be recorded and reported.

**8.15.7 Interpretation.** Observation of HUD functionality in accordance with 6.3.5 shall be used to determine pass or fail performance.

#### **8.16 HUD Low Power Source Visual Alert Signal Test.**

**8.16.1 Application.** This test shall apply to all HUD low power source visual alert signals.

**8.16.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.16.3 Specimen Preparation.** Specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of  $22^{\circ}\text{C}$ ,  $\pm 3^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ,  $\pm 5^{\circ}\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.16.4 Apparatus.** A variable power source that is capable of supplying dc voltage of at least 30 percent more than the nominal power source voltage shall be provided.

#### **8.16.5 Procedure.**

**8.16.5.1** Each HUD shall be tested with a variable power source to determine that the low power source visual alert signal will activate at the voltage,  $\pm 3$  percent, that is specified by the manufacturer.

**8.16.5.2** Each HUD shall be tested with a variable power source to determine that the HUD will continue to display the visual information and visual alert signals down to the cease-proper-operation voltage,  $\pm 3$  percent, that is specified by the manufacturer.

**8.16.5.3** Each HUD power source shall be tested by discharging it at the nominal operating current specified by the manufacturer until the voltage falls to the level at which the HUD low power source visual alert signal illuminates as specified in 6.3.8.6.

**8.16.5.4** Upon reaching that voltage, the current drain shall be increased to the peak current drain of the power source specified by the manufacturer for all systems supplied by that power source. Under these conditions and for a period of at least 2 hours, the power source voltage shall remain above the voltage that would cause the HUD to cease proper operation.

#### **8.16.6 Report.**

**8.16.6.1** HUD shall be observed for activation of the low power source visual alert signal.

**8.16.6.2** HUD shall be observed for the display of the visual information and visual alert signals down to the cease-proper-operation voltage.

**8.16.6.3** The power source voltage shall be observed with respect to the cease-proper-operation voltage.

**8.16.6.4** The events in 8.16.6.1 through 8.16.6.3 shall be recorded and reported.

#### **8.16.7 Interpretation.**

**8.16.7.1** HUD low power source visual alert signal function shall be evaluated to determine pass or fail performance.

**8.16.7.2** HUD power source voltage greater than or equal to the cease-proper-operation voltage shall constitute pass.

### **8.17 HUD Visibility Test.**

#### **8.17.1 Darkness Test.**

**8.17.1.1 Application.** This test method shall apply to complete SCBA.

**8.17.1.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.17.1.3 Specimen Preparation.** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

#### **8.17.1.4 Apparatus.**

**8.17.1.4.1** The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft<sup>3</sup>).

**8.17.1.4.2** Testing shall be performed in a light-controlled enclosure designated as the “testing enclosure.” A diffused-light source that provides a luminance of 2 lux, ±1 lux shall be used to illuminate across the surface of the SCBA facepiece lens.

#### **8.17.1.5 Procedure.**

**8.17.1.5.1** The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses. Selected test subjects shall be able to read lowercase letters measuring 2.5 mm ( $\frac{3}{16}$  in.) in height at a distance of 305 mm (12 in.).

**8.17.1.5.2** The test subject shall don a complete SCBA.

**8.17.1.5.3** The test subject shall enter the testing enclosure and be positioned so that the SCBA facepiece is illuminated as specified in 8.17.1.4.2.

**8.17.1.5.4** The test subject shall wait 1 minute to allow the eyes to acclimate to the illumination.

**8.17.1.5.5** The SCBA shall be activated so as to activate the HUD.

**8.17.1.5.6** The cylinder shall be fully charged, and the HUD shall show full cylinder charge.

**8.17.1.5.7** The SCBA pressure shall be slowly decreased so as to activate all HUD visual displays.

#### **8.17.1.6 Report.**

**8.17.1.6.1** Each visual display of information and each visual alert signal as defined by the manufacturer’s instructions shall be observed for distinctness and identifiability.

**8.17.1.6.2** The test subject’s observations of distinctness and identifiability shall be recorded and reported.

#### **8.17.1.7 Interpretation.**

**8.17.1.7.1** The test subject’s ability to distinguish between each visual display of information and each visual alert signal as defined by the manufacturer’s instructions shall be observed, and the distinguishing features shall be distinct and identifiable.

**8.17.1.7.2** Failure of the test subject to be able to observe each visual display of information and each visual alert signal as distinct, identifiable, or both shall constitute failing performance.

#### **8.17.2 Light Test.**

**8.17.2.1 Application.** This test method shall apply to complete SCBA.

**8.17.2.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.17.2.3 Specimen Preparation.** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

#### **8.17.2.4 Apparatus.**

**8.17.2.4.1** The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft<sup>3</sup>).

**8.17.2.4.2** Testing shall be performed in a light-controlled enclosure designated as the “testing enclosure.” A diffused light source that provides a luminance of 10,000 lux, ±1000 lux shall be used to illuminate across the surface of the SCBA facepiece lens.

#### **8.17.2.5 Procedure.**

**8.17.2.5.1** The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses. Selected test subjects shall be able to read lowercase letters measuring 2.5 mm ( $\frac{3}{16}$  in.) in height at a distance of 305 mm (12 in.).

**8.17.2.5.2** The test subject shall don a complete SCBA.

**8.17.2.5.3** The test subject shall enter the testing enclosure and be positioned so that the SCBA facepiece is illuminated as specified in 8.17.2.4.2.

**8.17.2.5.4** The test subject shall wait 1 minute to allow the eyes to acclimate to the illumination.



**8.17.2.5.5** The SCBA shall be activated so as to activate the HUD.

**8.17.2.5.6** The cylinder shall be fully charged, and the HUD shall show full cylinder charge.

**8.17.2.5.7** The SCBA pressure shall be slowly decreased so as to activate all HUD visual displays.

**8.17.2.6 Report.**

**8.17.2.6.1** Each visual display of information and each visual alert signal as defined by the manufacturer's instructions shall be observed and shall be distinct and identifiable.

**8.17.2.6.2** The test subject's observations shall be recorded and reported.

**8.17.2.7 Interpretation.** The test subject's ability to distinguish among the visual displays of information and the visual alert signals as defined by the manufacturer's instructions shall be observed, and distinguishing features shall be distinct and identifiable.

**8.18 HUD Obscuration Test.**

**8.18.1 Application.** This test method shall apply to complete SCBA where there is a gap greater than 1 mm ( $\frac{1}{32}$  in.) between the HUD and the exterior surface of the SCBA facepiece lens.

**8.18.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.18.3 Specimen Preparation.** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C,  $\pm 3^\circ\text{C}$  (72°F,  $\pm 5^\circ\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.18.4 Apparatus.**

**8.18.4.1** Each test specimen to be tested shall be an SCBA with the facepiece modified by the application of a light-reducing film to the entire outer lens surface of the facepiece. The film shall exclude 94.5 percent to 95.5 percent of visible light.

**8.18.4.2** The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft<sup>3</sup>).

**8.18.4.3** Testing shall be performed in a light-controlled enclosure designated as the "testing enclosure." A diffuse light source that provides a luminance of 20 lux,  $+0/-5$  lux shall be used to illuminate across the surface of the SCBA facepiece lens.

**8.18.5 Procedure.**

**8.18.5.1** The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses.

**8.18.5.2** The test subject shall don a complete SCBA.

**8.18.5.3** The test subject shall enter the testing enclosure and be positioned so that the SCBA facepiece is illuminated as specified in 8.18.4.3.

**8.18.5.4** The test subject shall wait at least 1 minute to allow the eyes to acclimate to the illumination.

**8.18.5.5** The SCBA shall be activated so as to activate the HUD.

**8.18.5.6** The SCBA pressure shall be slowly decreased until the breathing air supply in the cylinder is exhausted.

**8.18.6 Report.**

**8.18.6.1** The test subject shall report which informational displays and visual alert signals were observed.

**8.18.6.2** The test subject's observations shall be recorded and reported.

**8.18.7 Interpretation.** The test subject's observations shall be compared to the manufacturer's specified informational displays and visual alert signals to determine pass or fail performance.

**8.19 HUD Disabling Glare Test.**

**8.19.1 Application.** This test method shall apply to complete SCBA.

**8.19.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.19.3 Specimen Preparation.** Prior to testing, test specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C,  $\pm 3^\circ\text{C}$  (72°F,  $\pm 5^\circ\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.19.4 Apparatus.**

**8.19.4.1** Testing shall be performed in a light-controlled enclosure designated as the "testing enclosure," with a diffused light source that provides a luminance of 2 lux,  $+0/-1$  lux measured at the surface of the reading text card.

**8.19.4.2** At least eight text cards for reading shall be provided. Each text card shall have 10 different randomly selected letters of 2.5 mm ( $\frac{3}{32}$  in.) in height printed in lowercase on the card.

**8.19.4.3** The SCBA breathing air cylinder shall be permitted to be replaced with a cylinder of lesser capacity. The breathing air capacity of the replacement cylinder shall be greater than 200 L (7.1 ft<sup>3</sup>).

**8.19.5 Procedure.**

**8.19.5.1** The selected test subjects shall have visual acuity of 20/20 in each eye uncorrected or corrected with contact lenses. Selected test subjects shall be able to read lowercase letters measuring 2.5 mm ( $\frac{3}{32}$  in.) in height at a distance of 305 mm (12 in.).

**8.19.5.2** The test subject shall enter the testing enclosure that is illuminated as specified in 8.19.4.1.

**8.19.5.3** The test subject shall wait at least 1 minute to allow the eyes to acclimate to the illumination.

**8.19.5.4** A text card as specified in 8.19.4.2 shall be used for each before-reading procedure and each after-reading procedure of a single test.

**8.19.5.5** Different text cards as specified in 8.19.4.2 shall be used for each test.

**8.19.5.6** With the test subject's vision blocked, the text card shall be placed in a fixed position inside the testing enclosure at a distance of 305 mm,  $+0/-25$  mm (12 in.,  $+0/-1$  in.) from the test subject's face.

**8.19.5.7** For the before-reading portion of the test procedure, the test subject shall read out loud the 10 letters on the text card.



**8.19.5.8** The test subject shall then don a complete SCBA.

**8.19.5.9** The SCBA shall be activated so as to activate the HUD.

**8.19.5.10** With the test subject's vision blocked, a different text card shall be placed in a fixed position inside the testing enclosure at a distance of 305 mm, +0/-25 mm (12 in., +0/-1 in.) from the test subject's SCBA facepiece lens.

**8.19.5.11** The SCBA cylinder pressure shall then be slowly decreased until the breathing air supply in the cylinder is exhausted.

**8.19.5.12** The after-reading portion of the test procedure shall be conducted while the cylinder pressure is being slowly decreased. The test subject shall read out loud the 10 letters on the text card.

#### **8.19.6 Report.**

**8.19.6.1** The test subject's visual acuity as required in 8.19.5.1 shall be recorded and reported.

**8.19.6.2** The test subject's ability to read the lowercase letters as required in 8.19.5.1 shall be recorded and reported.

**8.19.6.3** The test subject's reading of the 10 letters in the before-reading portion of the test as required in 8.19.5.7 shall be recorded and reported for each letter.

**8.19.6.4** The test subject's reading of the 10 letters in the after-reading portion of the test as required in 8.19.5.12 shall be recorded and reported for each letter.

#### **8.19.7 Interpretation.**

**8.19.7.1** The test subject's inability to read at least 9 of the 10 before-reading letters shall constitute failing performance.

**8.19.7.2** The test subject's inability to read at least 9 of the 10 after-reading letters shall constitute failing performance.

### **8.20 Cylinder Refill Breathing Performance Test.**

**8.20.1 Application.** This test method shall apply to complete SCBA.

**8.20.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.20.3 Specimen Preparation.** Prior to testing, test specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

#### **8.20.4 Apparatus.**

**8.20.4.1** The test apparatus shall be as specified in 8.1.4.

**8.20.4.2** An RIC UAC filling hose assembly shall be provided.

**8.20.4.3** The breathing air source shall provide a constant pressure equal to the rated service pressure of the SCBA breathing air cylinder, +0/-6.8 bar (+0/-100 psi).

#### **8.20.5 Procedure.**

**8.20.5.1** The SCBA shall be tested for airflow performance as specified in 8.1.5, with the modification that the test will begin with the SCBA breathing air cylinder pressurized to 25 percent of the rated pressure.

**8.20.5.2** The RIC UAC filling hose shall be connected to the constant pressure source.

**8.20.5.3** At 10 cycles, ±5 cycles of the breathing machine, the RIC UAC female fitting on the RIC filling hose shall be connected to the RIC UAC male fitting on the SCBA. The RIC UAC coupling shall remain connected until the air transfer is completed.

**8.20.5.4** The duration of the airflow performance test shall end 4 minutes after the air transfer has commenced per 8.20.5.3.

**8.20.6 Report.** The facepiece peak inhalation and exhalation pressure shall be recorded and reported.

**8.20.7 Interpretation.** The peak inhalation and peak exhalation pressures shall be used to determine pass or fail performance.

### **8.21 RIC UAC System Fill Rate Test.**

**8.21.1 Application.** This test method shall apply to complete SCBA.

**8.21.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.21.3 Specimen Preparation.** Prior to testing, the specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

#### **8.21.4 Apparatus.**

**8.21.4.1** An RIC UAC filling hose assembly shall be provided.

**8.21.4.2** The air source shall provide a constant pressure equal to the rated service pressure of the SCBA cylinder, +0/-6.8 bar (+0/-100 psi).

**8.21.4.3** Testing shall be performed using a timer capable of measuring elapsed time within the range of 0 to 5 minutes.

#### **8.21.5 Procedure.**

**8.21.5.1** The pressure of the SCBA breathing air cylinder shall be 0 bar (0 psi).

**8.21.5.2** The RIC UAC filling hose shall be connected to the constant pressure air source.

**8.21.5.3** With the SCBA breathing air cylinder valve fully open, the RIC UAC filling hose shall be connected to the RIC UAC male fitting.

**8.21.5.4** The test timer shall begin when the RIC UAC filling hose is connected to the SCBA.

**8.21.5.5** The pressure in the SCBA breathing air cylinder shall be monitored.

**8.21.5.6** When the pressure in the SCBA breathing air cylinder reaches 75 percent of the rated service pressure of the SCBA cylinder, the test timer shall be stopped.

**8.21.6 Report.** The elapsed time shall be observed, recorded, and reported.

**8.21.7 Interpretation.** The elapsed fill time shall be used to determine pass or fail.

### **8.22 Breathing Air Cylinder and Valve Assembly Retention Test.**

**8.22.1 Application.** This test method shall apply to complete SCBA assemblies.



### 8.22.2 Samples.

**8.22.2.1** Samples shall be complete SCBA.

**8.22.2.2** Samples shall be fitted with each of the SCBA manufacturer's breathing air cylinder and valve assemblies.

### 8.22.3 Specimen Preparation.

**8.22.3.1** One SCBA sample shall be tested with a cylinder and valve assembly as specified in 8.22.5.

**8.22.3.2** Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with RH of 50 percent, ±25 percent.

### 8.22.4 Apparatus.

**8.22.4.1** A test bench or similar fixture that can firmly fix a fully assembled SCBA to the test bench or fixture and that will not allow movement of the SCBA shall be used.

**8.22.4.2** Measurements shall be taken with a calibrated measuring device having a resolution of better than ±0.25 mm (±0.010 in.).

**8.22.4.3** Loops, straps, or pads shall be positioned on the valve to facilitate the application and measurement of an applied load to the intersection of the valve connection plane with the center line of the breathing air cylinder body.

### 8.22.5 Procedure.

**8.22.5.1** The specimen, fitted with the SCBA manufacturer's breathing air cylinder and valve assembly, shall be fixed to the backplate and harness assembly in accordance with the manufacturer's end user instructions provided with the SCBA.

**8.22.5.2** The fully assembled SCBA shall be firmly fixed to the test bench or fixture in a manner that prevents movement of the SCBA but shall not interfere with the breathing air cylinder and valve assembly retention method.

**8.22.5.3** The distances for each of the six directions specified in 8.22.5.4, the original starting positions, shall be measured and recorded.

**8.22.5.4** A force of 200 N (45 lbf) shall be applied to the intersection point specified in 8.22.4.3, in the six directions shown in Figure 8.22.5.4. The force shall be applied for a period of 10 seconds, +5/-0 seconds, allowing the measurements to be taken.

**8.22.5.5** Following the application of force for each direction, the distance for each of the six directions shall be measured and recorded.

### 8.22.6 Report.

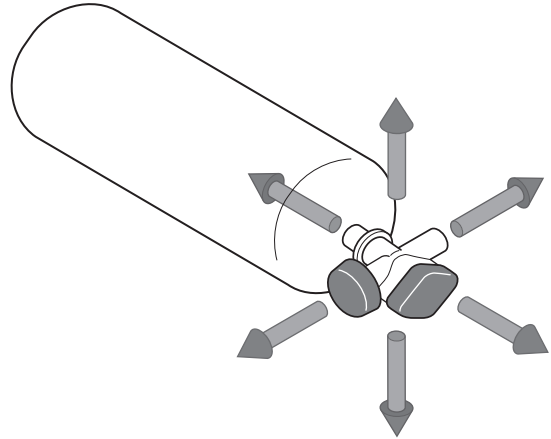
**8.22.6.1** The distance moved from the original starting position for each of the six directions shall be recorded and reported.

**8.22.6.2** No portion of the breathing air cylinder and valve assembly shall show movement greater than 25 mm (1 in.) from its original position prior to load application.

**8.22.7 Interpretation.** Movement of any part of the breathing air cylinder and valve assembly that exceeds 25 mm (1 in.) shall constitute failing performance.

## 8.23 Cylinder Connections and Accessibility Test.

**8.23.1 Application.** This test method shall apply to complete SCBA assemblies.



**FIGURE 8.22.5.4** Directions of Force Applied for Retention Testing.

### 8.23.2 Samples.

**8.23.2.1** Samples shall be complete SCBA.

**8.23.2.2** Samples shall be fitted with each of the SCBA manufacturer's air cylinder and valve assemblies.

### 8.23.3 Specimen Preparation.

**8.23.3.1** The SCBA manufacturer's cylinder and valve assembly shall be fixed to the backplate harness assembly following the manufacturer's end user instructions.

**8.23.3.2** Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F), with RH of 50 percent, ±25 percent.

### 8.23.4 Procedure.

**8.23.4.1** The specimen, fitted with each of the SCBA manufacturer's cylinder and valve assemblies, shall be fixed to the backplate and harness assembly in accordance with the manufacturer's end user instructions provided with the SCBA.

**8.23.4.2** Specimens shall be evaluated for accessibility, attachment, and detachment by a test subject with a hand that is categorized as large, and the test subject shall perform the test while wearing a size large structural fire fighting glove that is compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

**8.23.4.3** The test subject shall fully attach the cylinder and valve assembly to the SCBA and then fully detach the cylinder and valve assembly from the SCBA. The time in seconds to attach and then to detach the cylinder and valve assembly shall be measured.

**8.23.4.4** The test subject shall fully attach the breathing air fill hose to the RIC UAC connection and then fully detach the breathing air fill hose from the RIC UAC connection. The time in seconds to attach and then to detach the breathing air fill hose shall be measured.

### 8.23.5 Report.

**8.23.5.1** The time to fully attach and to fully detach the cylinder and valve assemblies, timed in 8.23.4.3, shall be recorded and reported.

**8.23.5.2** The time to fully attach and to fully detach the breathing air fill hose to and from the RIC UAC connection, timed in 8.23.4.4, shall be recorded and reported.

### **8.23.6 Interpretation.**

**8.23.6.1** One or more specimens failing the attachment and detachment times for the cylinder and valve assemblies shall constitute failing performance.

**8.23.6.2** One or more specimens failing the attachment and detachment times for the RIC UAC connection shall constitute failing performance.

### **8.24 Heat and Immersion Leakage Tests.**

**8.24.1 Application.** This test method shall apply to each electronic device of the SCBA required to meet the mandatory design requirements of Chapter 6.

#### **8.24.2 Samples.**

**8.24.2.1** The sample to be tested shall be as specified in 4.3.9.

**8.24.2.2** Samples for conditioning shall be complete SCBA.

#### **8.24.3 Specimens.**

**8.24.3.1** Prior to testing, specimens shall be conditioned for a minimum of 4 hours at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.24.3.2** The specimen shall be tested after conditioning within an oven specified in 8.24.4 at 177°C, +5°C/–0°C (350°F, +10°F/–0°F) for 15 minutes.

#### **8.24.4 Apparatus.**

**8.24.4.1** The test oven shall have an airflow rate of 38 m/min to 76 m/min (125 ft/min to 250 ft/min) at the standard temperature and pressure of 21°C (70°F) at 1 atmosphere measured at the center point of the oven.

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

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

**8.24.4.4** The test water container shall be capable of covering the uppermost point of the specimen SCBA with a depth of 1.5 m (4.9 ft) of water.

**8.24.4.5** The water temperature shall be 18°C, ±10°C (64°F, ±18°F).

#### **8.24.5 Procedure.**

**8.24.5.1** The SCBA shall be mounted on the test mannequin and tested for a watertight seal per 8.1.5.3. It shall then be placed in the test oven that has been preheated to 177°C, +5°C/–0°C (350°F, +10°F/–0°F).

**8.24.5.2** After the test oven door is closed and the oven temperature recovers to 177°C (350°F), the test exposure time of 15 minutes shall begin.

**8.24.5.3** Within 2 minutes, the specimen, mounted to the mannequin, shall be immersed in the test water container for 15 minutes. After 15 minutes, the specimen shall be removed from the test water container and shall be wiped dry.

**8.24.5.4** The specimen shall be subjected to 8.24.5.1 through 8.24.5.3 for six complete cycles.

**8.24.5.5** The specimen shall be removed following the sixth conditioning cycle, and testing shall begin within 30 seconds of removal from conditioning.

**8.24.5.6** The specimen's electronic components shall be operated in accordance with the manufacturer's instructions for normal use to determine the proper functioning.

**8.24.5.7** The specimen shall then be re-immersed in the test water container for an additional 5 minutes. The power source compartment(s) shall be open, and the power source shall not be installed.

**8.24.5.8** After the 5-minute immersion, the specimen shall be removed from the test water container and shall be wiped dry.

**8.24.5.9** The electronic compartment(s) of the specimen shall be opened and inspected for water leakage to determine pass or fail.

### **8.25 Supplementary Voice Communications System Performance Test.**

**8.25.1 Application.** This test method shall apply to complete SCBA facepiece(s) and second stage regulator(s).

**8.25.2 Samples.** Each sample to be tested shall be as specified in 4.3.9, with voice communications systems installed and in the "on" mode in accordance with the manufacturer's instructions.

#### **8.25.3 Specimen Preparation.**

**8.25.3.1** Prior to testing, specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent.

**8.25.3.2** Specimens for conditioning shall be complete medium-size SCBA facepiece(s) and inner mask(s) with the second stage regulator(s) installed in the "as worn" position as specified by the manufacturer.

**8.25.3.3** Signal processing options that use specific features of natural speech such as, but not limited to, pitch, formant analysis, and voice or non-voiced sound to enhance the speech intelligibility or the usability of Supplementary Voice Communications Systems shall be disabled during the STI test.

#### **8.25.4 Apparatus.**

**8.25.4.1** Testing shall be conducted in a chamber having the following characteristics:

- (1) Minimum room dimensions: 4.6 m long × 3.1 m wide × 2.7 m high (15 ft long × 10 ft wide × 9 ft high)
- (2) Construction: hemi-anechoic
- (3) Ambient noise level inside chamber: NC-25
- (4) Walls and ceiling: ≥90 percent absorptive for 100 Hz < f < 10000 Hz

**8.25.4.1.1** All surfaces above the floor shall be acoustically treated for internal acoustic absorption, as well as for external noise mitigation.

**8.25.4.2** A G.R.A.S. KEMAR Head and Torso Simulator (HATS) model 45BM shall be used for testing.

**8.25.4.2.1** The mouth simulator shall be capable of producing 112 dB/1 kHz sine tone at 25 mm (1 in.) with the mouth reference point unequalized, and the total harmonic distortion (THD) shall be ≤3 percent.

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



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

**8.25.4.3** The sound pressure level (SPL) meter having the following characteristics shall be used:

- (1) The SPL meter shall be capable of applying an equivalent continuous sound pressure level (Leq) using an A-weighted filter.
- (2) The SPL meter shall have a dynamic range from 30 dB (or less) to 130 dB (or more).
- (3) The SPL meter shall display the measurement to at least one decimal place.

**8.25.4.4** The signal/pink noise analog audio signal generators having the following characteristics shall be used.

**8.25.4.4.1** One generator shall be capable of playing wave files in the following format: 48 kHz, 16-bit mono at the output level of 0 dB, FS = 18 dBu, according to EBU Technical Recommendation R68, *Alignment level in digital audio production equipment and in digital audio recorders*.

**8.25.4.4.2** The second generator shall be capable of generating pink noise and sine waves from -80 dBu to -2 dBu in one digit steps, with a THD+N of -90 dB (0.0032 percent) at 8 dBu noise floor type 25uv, and shall also have the following characteristics:

- (1) A frequency range of 10 Hz to 20 Hz in one digit steps  $\pm 0.01$  percent
- (2) An amplitude accuracy of within  $\pm 0.5$  dB or less

**8.25.4.5** A digital equalizer having the following characteristics shall be used:

- (1) A digital equalizer shall be capable of at least two concurrently selectable equalizer sections:
  - (a) One 31-band graphic with an adjustment range of at least  $\pm 18$  dB
  - (b) A 10-band parametric with an adjustment range of at least  $\pm 18$  dB
- (2) The digital equalizer shall have a dynamic range of  $\geq 112$  dB.
- (3) The digital equalizer shall be capable of equalizing the frequency response of the HATS mannequin of  $\pm 1$  dB flat between 100 Hz and 10 kHz, applying a 180 Hz high pass filter with a slope of -24 dB octave, and a 10 Hz low pass filter with a slope of -24 dB octave (-15 dB at 100 Hz, -20 dB at 15 kHz).

**8.25.4.6** A powered speaker having the following characteristics shall be used:

- (1) The sensitivity shall be  $\geq 84$  dB at one watt at 1 meter.
- (2) The frequency response shall be rated at  $\leq 80$  Hz to  $\geq 13$  kHz.
- (3) The amplifier shall deliver  $\geq 10$  watts with a total harmonic distortion  $< 1$  percent.

**8.25.4.7** A microphone having the following characteristics shall be used:

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

**8.25.4.8** A Speech Transmission Index (STI) analyzer having the following characteristics shall be used:

- (1) The STI PA analyzer shall be capable of measuring and displaying a single value STI PA result to two decimal places with a seven octave band modulated noise test signal using the Netherlands Organization for Applied Scientific Research (TNO) verified algorithm.
- (2) The STI PA analyzer shall conform to IEC-60268, *Sound System Equipment — Part 16: Objective Rating of Speech Intelligibility by Speech Transmission Index*.

**8.25.4.9** All of the apparatus identified in 8.10.4.6 and 8.10.4.7 shall be located in the hemi-anechoic chamber and arranged as shown in Figure 8.10.4.9(a) and Figure 8.10.4.9(b).

**8.25.4.10** The HATS test mannequin shall be positioned in the chamber as shown in Figure 8.10.4.9(a) and Figure 8.10.4.9(b).

**8.25.4.10.1** The distance between the HATS test mannequin and the microphone shall be 1.5 m,  $\pm 25$  mm/ $-0$  mm (5 ft,  $\pm 1$  in./ $-0$  in.), and they shall be facing each other.

**8.25.4.10.2** The distance between the HATS test mannequin MRP and the floor shall be 1.5 m,  $\pm 25$  mm/ $-0$  mm (5 ft,  $\pm 1$  in./ $-0$  in.).

**8.25.4.10.3** The distance between the microphone and the floor shall be 1.5 m,  $\pm 25$  mm/ $-0$  mm (5 ft,  $\pm 1$  in./ $-0$  in.).

**8.25.4.11** The test chamber shall be filled with broadband pink noise with a tolerance of  $\pm 1$  dB per octave band from 100 Hz to 10 kHz.

**8.25.4.12** The pink noise speaker shall be placed directly beneath the microphone and oriented such that the central axis of the speaker cone is directly facing the microphone.

**8.25.4.12.1** The speaker shall be situated on top of a block of isolating acoustic foam such that no part of the speaker box is contacting the floor or the microphone stand, to prevent conduction of sound to the microphone.

**8.25.4.12.2\*** The height of the speaker off the floor shall be at least 0.125 m (5 in.), as measured from the bottom of the speaker box, and the distance between the speaker and microphone shall be no less than 1 m (40 in.), as measured from the top of the speaker grille/enclosure.

**8.25.4.12.3** The pink noise speaker shall be placed as indicated in Figure 8.10.4.12.3.

**8.25.4.13** The pink noise speaker shall be fully equalized flat, from 100 Hz to 10 kHz, to within  $\pm 1$  dB on a relative scale in  $\frac{1}{3}$  octave bands, as measured at the microphone position.

**8.25.4.14** The STI test signal from the mannequin shall be adjusted to achieve an A-weighted sound level of 97 dB,  $\pm 0.5$  dB at the mouth reference point (MRP), 50 mm,  $\pm 3$  mm (2 in.  $\pm \frac{1}{8}$  in.) from the test mannequin's mouth.

**8.25.4.14.1** The microphone used for calibrating the STI signal shall be omnidirectional and oriented in a horizontal front-facing manner.

**8.25.4.14.2** The STI signal shall be equalized flat to within  $\pm 1$  dB on a relative scale in  $\frac{1}{3}$  octave bands, as measured at the MRP of the HATS.

**8.25.4.14.3** The HATS shall be calibrated as follows:

- (1) Equalize flat with pink noise to 97 dBA from 100 Hz - 10 kHz to  $\pm 1$  dB on a  $\frac{1}{3}$  octave scale.
- (2) Reduce the levels for the 125 Hz octave band (the 100, 125, 160  $\frac{1}{3}$  octave bands) by 10 dB.



- (3) Reduce the levels for the 250 Hz octave band (the 200, 250, 315 ⅓ octave bands) by 2 dB.
- (4) Apply the STI PA signal and adjust the Sound Pressure Level (SPL) to 97 dBA,  $\pm 0.5$  dBA.

**8.25.4.15** The gain of the powered speaker amplifier used to generate the pink noise shall be adjusted to achieve an A-weighted sound level of 9 dB,  $\pm 0.5$  dB below the signal level generated as identified in 8.25.4.14, measured at the microphone placed as identified in 8.25.4.10.1 and 8.25.4.10.3.

#### 8.25.5 Procedure.

**8.25.5.1** The method for measuring the Speech Transmission Index (STI) shall be as specified in IEC 60268, *Sound System Equipment — Part 16: Objective Rating of Speech Intelligibility by Speech Transmission Index*, with the modified apparatus specified in 8.25.4.

**8.25.5.2** The medium-size facepiece with inner mask and second stage regulator in the normal use mode shall be fitted to the HATS test mannequin in the following manner:

- (1) Place the chin of the mannequin in the “chin cup” of the facepiece.
- (2) Place the facepiece to seal against the face of the HATS test mannequin.
- (3) Pass the head harness of the facepiece over the HATS test mannequin and tighten it in a manner that maintains the symmetry of the facepiece on the HATS test mannequin, using talc to minimize friction between the HATS test mannequin and the strap.
- (4) Tighten the straps to a tension of 50 N (11.2 lbf).

**8.25.5.3** Three medium-size facepieces shall be tested in the chamber having an ambient noise field as specified in 8.25.4.11 through 8.25.4.15. Each facepiece shall be mounted as specified in 8.25.5.2 and then tested as follows:

- (1) Record three separate measurements for each donning of the facepiece.
- (2) Perform five separate donnings.
- (3) Record a total of 45 measurements: 3 (facepieces)  $\times$  3 (measurements)  $\times$  5 (donnings) = 45 measurements.

#### 8.25.6 Report.

**8.25.6.1** The STI PA signal Sound Pressure Level (SPL) per octave band, the Modulation Transfer Index per octave band, and overall STI score at the mouth reference point (MRP) described in 3.3.31 shall be recorded and reported.

**8.25.6.2** The STI PA signal SPL per octave band, the Modulation Transfer Index per octave band, and overall STI score at the microphone measurement point (MMP) described in 3.3.30 shall be recorded and reported.

**8.25.6.3** The pink noise SPL per octave band at the MMP described in 3.3.30 shall be recorded and reported.

**8.25.6.4** The STI score for each facepiece measurement sampled as described in 8.25.5.3 (a total of 45 scores) shall be recorded and reported, and the starting time of each facepiece donning shall be recorded.

**8.25.6.5** The average for each donning shall be calculated, recorded, and reported. There shall be a total of 15 averages of 3 measurements (5 averages for each of the three facepiece samples). See Figure 8.10.6.5.

#### 8.25.7 Interpretation.

**8.25.7.1** The averages calculated in 8.25.6.5 shall be used to determine a pass or fail per Section 7.17.

**8.25.7.2** If any of the 15 averages score less than the minimum threshold specified in Section 7.17, the facepiece shall be considered to have failed and shall be reported as such.

**8.25.7.3** If all of the 15 averages score equal to or greater than the minimum threshold specified in Section 7.17 the facepiece shall be considered to have passed and shall be reported as such.

#### 8.26 Low Power Capacity Test.

**8.26.1 Application.** This test shall apply to all electronic devices required for SCBA by the requirements of Chapter 6.

**8.26.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

**8.26.3 Specimen Preparation.** Specimens shall be conditioned for a minimum of 4 hours and tested at an ambient temperature of 22°C,  $\pm 3^\circ\text{C}$  (72°F,  $\pm 5^\circ\text{F}$ ) and RH of 50 percent,  $\pm 25$  percent.

**8.26.4 Apparatus.** A variable power source that is capable of supplying dc voltage of at least 30 percent more than the nominal power source voltage shall be provided.

#### 8.26.5 Procedure.

**8.26.5.1** Each electronic device shall be tested with a variable power source to determine that the low power source visual alert signal will activate at the voltage specified by the manufacturer,  $\pm 3$  percent.

**8.26.5.2** Each electronic device shall be tested with a variable power source to determine that the electronic device will continue to operate down to the cease-proper-operation voltage specified by the manufacturer.

**8.26.5.3** Where multiple electronic devices that are part of the SCBA share a common power source, the minimum amount of power that causes the activation of the low power source visual alert signal shall be determined with all electronics sharing the common power source operating at their respective maximum power consumption under normal use.

**8.26.5.3.1** Each electronic device power source shall be tested by discharging it at the cumulative nominal operating current for all electronic devices utilizing the power source, as specified by the manufacturer, until the voltage falls to the level at which the electronic device low power source visual alert signal illuminates as specified in Section 7.19, Low Power Capacity.

**8.26.5.3.2** Upon reaching this voltage, the current drain shall be increased to the cumulative peak current drain of all electronic devices utilizing the power source, as specified by the manufacturer. Under these conditions and for a period of at least 2 hours, the power source voltage shall remain above the voltage that will cause the electronic device to cease proper operation.

#### 8.26.6 Report.

**8.26.6.1** The electronic device shall be observed for activation of the low power source visual alert signal.

**8.26.6.2** The electronic device shall be observed for the display of the low power source visual alert signal down to the cease-proper-operation voltage.

**8.26.6.3** The power source voltage shall be observed with respect to the cease-proper-operation voltage.



**8.26.6.4** The events in 8.26.6.1 through 8.26.6.3 shall be recorded and reported.

#### **8.26.7 Interpretation.**

**8.26.7.1** Electronic device low power source visual alert signal function shall be evaluated to determine pass or fail performance.

**8.26.7.2** Electronic device power source voltage equal to or greater than the cease-proper-operation voltage shall constitute passing performance.

#### **8.27 Emergency Breathing Safety System Cold Temperature Performance Test.**

**8.27.1 Application.** This test method shall apply to two complete SCBA.

**8.27.2 Samples.** Each sample to be tested shall be as specified in 4.3.9.

#### **8.27.3 Specimen Preparation.**

**8.27.3.1** Specimens for conditioning shall be two complete SCBA.

**8.27.3.2** Prior to testing, the SCBA shall be placed in an ambient environment of 22°C, ±3°C (72°F, ±5°F) and RH of 50 percent, ±25 percent for a minimum 12-hour dwell period.

**8.27.3.3** The air used in the SCBA breathing air cylinders shall comply with the quality requirements of NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*.

#### **8.27.4 Apparatus.**

**8.27.4.1** The SCBA shall be placed in an environmental chamber and positioned to simulate the normal wearing position of the SCBA on a person as specified by the manufacturer.

**8.27.4.2** During the cold temperature exposures, the SCBA shall be mounted on a Scott Aviation Model No. 803608-01 or 803608-02 test headform or equivalent.

**8.27.4.3** The thermocouple or other temperature-sensing element used shall be mounted within the chamber in a manner in which it will be exposed directly to the chamber atmosphere.

**8.27.4.4** Two test headforms shall be connected to two breathing machines specified in Section 8.1, Airflow Performance Test.

**8.27.4.5** The breathing machines shall be permitted to be located either inside or outside the environmental chamber.

#### **8.27.5 Procedure.**

**8.27.5.1** The variation in pressure extremes caused by the cold temperature performance test configuration shall be determined as specified in Section 8.27.5.1.

**8.27.5.1.1** For the receiving SCBA, the airflow performance test, as specified in Section 8.1, Airflow Performance Test, shall be carried out using the configuration specified in 8.2.4, with a breathing frequency set at 31, +1/–0 inhalation/exhalation cycles per minute and a tidal volume set at 3.4 L, ±0.1 L. The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 8.2.4 from the values obtained using the configuration specified in Section 8.1, Airflow Performance Test.

**8.27.5.1.2** For the donor SCBA, the airflow performance test, as specified in Section 8.1, Airflow Performance Test, shall be carried out using the configuration specified in 8.2.4, with a breathing frequency set at 29, +0/–1 inhalation/exhalation cycles per minute and a tidal volume set at 3.4 L, ±0.1 L. The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 8.2.4 from the values obtained using the configuration specified in Section 8.1, Airflow Performance Test.

**8.27.5.2** For the receiving SCBA, the facepiece pressure during each entire test shall be read from the strip chart recorder and corrected by adding the value of the difference in pressure calculated in 8.27.5.1.1 to determine pass or fail, as specified in 7.2.1.1.

**8.27.5.3** For the donor SCBA, the facepiece pressure during each entire test shall be read from the strip chart recorder and corrected by adding the value of the difference in pressure calculated in 8.27.5.1.2 to determine pass or fail as specified in 7.2.1.1.

**8.27.5.4** The receiving and donor SCBA shall be cold soaked at –32°C, ±1°C (–25°F, ±2°F) for a minimum of 12 hours.

**8.27.5.5** The receiving SCBA shall then be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, with a ventilation rate set at 103 L/min, ±3 L/min, at a chamber air temperature of –32°C, ±5°C (–25°F, ±10°F).

**8.27.5.5.1** For the EBSS cold temperature performance test, the airflow performance test shall begin after five cycles of the breathing machine and shall continue to operate through at least 36 bar (520 psi) of the donor SCBA cylinder inlet pressure.

**8.27.5.6** The donor SCBA shall then be tested for airflow performance as specified in Section 8.1, Airflow Performance Test, with a breathing frequency set at 29 +0/–1 inhalation/exhalation cycles per minute and a tidal volume set at 3.4 L, ±0.1 L, at a chamber air temperature of –32°C, ±5°C (–25°F, ±10°F).

#### **8.27.6 Report.**

**8.27.6.1** The facepiece peak inhalation pressure and peak exhalation pressure shall be recorded and reported for each test condition.

**8.27.6.2** The activation and operation of the donor SCBA EOSTI, or the failure of the donor SCBA EOSTI to activate and operate, shall be recorded and reported.

**8.27.6.3** The activation and identification of the donor SCBA HUD visual alert signals shall be recorded and reported.

#### **8.27.7 Interpretation.**

**8.27.7.1** The peak inhalation and peak exhalation shall be used to determine pass or fail performance for each test procedure.

**8.27.7.2** One or more specimens failing this test shall constitute failing performance.

**8.27.7.3** Failure of the donor SCBA EOSTI alarm signal to activate and remain active during the test shall constitute failing performance.

**8.27.7.4** Failure of the donor SCBA HUD to display the breathing air cylinder content or to display the visual alert signal during the test shall constitute failing performance.