NFPA 1981
Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service

1997 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

IMPORTANT NOTICE ABOUT THIS DOCUMENT

NFPA codes, standards, recommended practices, and guides, of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its codes and standards.

The NFPA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this document available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does the NFPA list, certify, test or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

NOTICES

All questions or other communications relating to this document and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA documents during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

Users of this document should be aware that this document may be amended from time to time through the issuance of Tentative Interim Amendments, and that an official NFPA document at any point in time consists of the current edition of the document together with any Tentative Interim Amendments then in effect. In order to determine whether this document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments, consult appropriate NFPA publications such as the *National Fire Codes*® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed above.

A statement, written or oral, that is not processed in accordance with Section 5 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

The NFPA does not take any position with respect to the validity of any patent rights asserted in connection with any items which are mentioned in or are the subject of this document, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on this document. Users of this document are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Users of this document should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action that is not in compliance with applicable laws, and this document may not be construed as doing so.

NFPA 1981

Standard on

Open-Circuit Self-Contained Breathing Apparatus for the Fire Service

1997 Edition

This edition of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service,* was prepared by the Technical Committee on Respiratory Protection and Personal Alarm Equipment, released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held 19–22 May 1997, in Los Angeles, California. It was issued by the Standards Council on 24 July 1997, with an effective date of 15 August 1997, and supersedes all previous editions.

This edition of NFPA 1981 was approved as an American National Standard on 15 August 1997.

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 17 May 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 19 May 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 that fire fighters' SCBA can be exposed to during use and storage. These requirements are in addition to the basic NIOSH/MSHA certification requirements, and now NFPA 1981 applies only 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.

Since 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, 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.

Since the third edition, the entire project for fire service protective clothing and equipment was reorganized, in January 1995, by the Standards Council. The new project has 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 into the new Technical Committee on Respiratory Protection and Personal Alarm Equipment.

This fourth edition incorporates new requirements for surrogate cylinders to replace the actual breathing gas cylinders during the vibration testing to assure a higher level of safety during this rigorous test. A new requirement for redundant end-of-service-time indicators was added to provide a better level of safety in case of failure of one end-of-service-time indicator. Different effective dates were allowed for specific parts of the requirements.

Special recognition is offered to Committee Chairman Alexander W. Santora, Deputy Fire Chief, New York City Fire Department, New York, who is stepping down as the chairperson and leaving the Committee. Chief Santora's dedication to fire service safety and his leadership have greatly enhanced safety for all fire fighters. Many improvements to fire service SCBA have evolved during his service on this Committee and on the subcommittee that existed under the former committee structure. Chief Santora also contributed his considerable expertise in several different protective clothing and equipment areas within the overall project. His professionalism and tireless efforts to improve fire service safety are an outstanding credit to him and to the New York City Fire Department. We will miss you, Chief, but accept our sincerest thanks for all you have done for the fire service.

The fourth edition was presented to the Association membership at the 1997 Annual Meeting in Los Angeles, California on 22 May 1997.

Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment

Richard M. Duffy, *Chair*
Int'l Assn. of Fire Fighters, DC [L]
Rep. Int'l Assn. of Fire Fighters

Wayde B. Miller, *Secretary*
Mine Safety Appliances Co., PA [M]
Rep. Compressed Gas Assoc.

Thomas Augherton, Safety Equipment Inst., VA [RT]
Dennis W. Browner, Scott Aviation, NC [M]
Rep. Industrial Safety Equipment Assn.
Robert H. Chiostergi, Southern Mills Inc., GA [M]
Loui Clem, Alpine Center for Rescue Studies, CO [U]
Rep. Nat'l Assn. for Search and Rescue
Robert A. Freese, Globe Mfg. Co., NH [M]
William L. Grilliot, Morning Pride Mfg. Co., OH [M]
Rep. Fire and Emergency Mfrs. and Services Assn. Inc.
Virgil Hathaway, San Diego Fire Dept., CA [U]
Rep. Southern Area Fire Equipment Research
James S. Johnson, Lawrence Livermore Nat'l Labs, CA [RT]
Cy Long, Texas Commission on Fire Protection, TX [E]
David G. Matthews, United Kingdom Fire Brigades Assn., England [SE]
Rep. Int'l Standards Organization
Jim Minx, Oklahoma State Firefighters Assn., OK [C]
Bob Montgomery, Hoechst Celanese Corp, NC [M]
Ted Putnam, USDA Forest Service, MT [E]
Jeffrey O. Stull, Int'l Personnel Protection, Inc., TX [SE]
Frank P. Taylor, Lion Apparel, Inc., OH [M]
Robert D. Tutterow, Jr., Charlotte Fire Dept., NC [M]
Rep. Fire Industry Equipment Research Organization
Bruce H. Varner, City of Carrollton Fire Dept., TX [U]
Rep. Int'l Fire Service Training Assn.
Harry Winer, U.S. Navy, MA [RT]
Thomas L. Wollan, Underwriters Laboratories, Inc., NC [RT]

Alternates

Janice C. Bradley, Industrial Safety Equipment Assn.
(Alt. to D. W. Browner)
Mark B. Chambers, Texas Commission on Fire Protection, TX [E]
(Alt. to C. Long)
Nicholas J. Curtis, Lion Apparel, Inc., OH [M]
(Alt. to F. P. Taylor)
Robert Dahl, The DuPont Co., DE [M]
(Alt. to B. Montgomery)
Patricia A. Freeman, Globe Mfg. Co., NH [M]
(Alt. to R. A. Freese)
Patricia A. Gleason, Safety Equipment Inst., VA [RT]
(Alt. to T. Augherton)
William M. Lambert, Mine Safety Appliances Co., PA [M]
(Alt. to W. B. Miller)
Daniel P. Ryan, Underwriters Laboratories Inc., NC [RT]
(Alt. to T. L. Wollan)

Nonvoting

Don R. Forrest, United Firefighters of Los Angeles City, CA
Bryan C. Heirston, Oklahoma State Dept. of Labor, OK
Rep. Int'l Assn. of Fire Fighters
Richard Mangan, USDA Forest Service, MT
Kirk H. Owen, Plano Fire Dept., TX
Rep. NFPA Fire Service Section
Christopher B. Preu, Louisville Division of Fire, KY
Alexander W. Santora, New York City Fire Dept., NY
Jerry L. Swinford, Texas Commission on Fire Protection, TX

Bruce W. Teele, NFPA Staff Liaison

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.

Technical Committee on Respiratory Protection and Personal Alarm Equipment

Alexander W. Santora, *Chair*
New York City Fire Dept., NY [U]

Paul D. Hiltman, *Secretary*
Int'l Safety Instruments, Inc., GA [M]

Thomas Augherton, Safety Equipment Inst., VA [RT]

Eric Beck, Mine Safety Appliances Co., PA [M]

Mark Crandall, Detex Corp., TX [M]

Kenneth R. Ethridge, Texas Commission on Fire Protection, TX [E]

Don R. Forrest, United Firefighters of Los Angeles City, CA [L]

Rep. Int'l Assn. of Fire Fighters

Eugene Giorgini, Scott Aviation, NY [M]

A. Ira Harkness, U.S. Navy Coastal Systems Station, FL [RT]

James S. Johnson, Lawrence Livermore Nat'l Labs, CA [RT]

Robert A. Kolenda, City of Pittsburgh, Bureau of Fire, PA [U]

Roy Kenneth Lane, Raleigh Fire Dept., NC [U]

Patrick J. McLaughlin, Litton Instruments & Life Support, IA [M]

Robert W. O'Gorman, Inchcape Testing Services NA, Inc., NY [RT]

Ray F. Reed, Dallas Fire Dept., TX [U]

Brian J. Sharkey, USDA Forest Service, MT [RT]

Leo W. Stoltz, Nat'l Draeger, Inc., PA [M]

Alternates

Donald G. Beason, Lawrence Livermore Nat'l Lab, CA [RT]
(Alt. to J. S. Johnson)

Carrol E. Burtner, Safety Equipment Inst., VA [RT]
(Alt. to T. Augherton)

Vasilios M. Christodoulou, New York City Fire Dept., NY [U]
(Alt. to A. W. Santora)

Richard A. Erth, Mine Safety Appliances Co., PA [M]
(Alt. to E. Beck)

Darius L. Goodin, U.S. Navy Coastal Systems Station, FL [RT]
(Alt. to A. I. Harkness)

Robert E. Gray, Int'l Safety Instruments, Inc., GA [M]
(Alt. to P. D. Hiltman)

Richard H. Weaver, Nat'l Draeger, Inc., PA [M]
(Alt. to L. W. Stoltz)

Nonvoting

Glen E. Gardner, U.S. Occupational Safety & Health Adm., DC

Bruce W. Teele, NFPA Staff Liaison

Committee Scope: This Committee shall have primary responsibility for documents on protective equipment that provides respiratory protection for fire fighters or other emergency services responders during incidents involving operations conducted in hazardous or oxygen-deficient atmospheres. These operations include the activities of rescue, fire suppression, hazardous materials mitigation, and property conservation where exposures to an oxygen-deficient atmosphere or an atmosphere contaminated with harmful particulate, fog, fume, mist, gas, smoke, spray, or vapor will or could occur.

This committee shall also have primary responsibility for documents on personal monitor/alarm/distress devices for responders operating in hazardous atmopheres or in harzard areas at incidents where entrapment, disorientation, or other responder personal emergency could occur.

Additionally, this committee shall have primary responsibilty for documents on the selection, care, and maintenance or respiratory and personal alarm equipment by fire and emergency services organizations and personal.

These lists represent the membership at the time each Committee was balloted on text of this edition. Since that time, changes in the membership may have occured. A key to classifications is found at the back of this document.

NOTE: This list represents the membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Contents

NFPA 1981

Standard on

Open-Circuit Self-Contained Breathing Apparatus for the Fire Service

1997 Edition

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

Inforamtion on referenced publications can be found in Chapter 7 and Appendix B.

Chapter 1 Administration

1-1 Scope.

1-1.1* This standard shall specify the minimum documentation, design criteria, performance criteria, test methods, and certification for open-circuit self-contained breathing apparatus (SCBA) used during fire fighting, rescue, and other hazardous operations.

1-1.2 This standard shall not apply to closed-circuit self-contained breathing apparatus.

1-1.3 The requirements of this standard shall not apply to accessories that might be attached to any open-circuit self-contained breathing apparatus other than as specifically addressed herein.

1-1.4 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 provide minimum requirements for open-circuit SCBA designed to provide respiratory protection for the wearer from the products of combustion, hazardous or toxic atmospheres, oxygen-deficient atmospheres, particulate, and other such IDLH (Immediately Dangerous to Life and Health) atmospheres that might exist at the scene of an emergency.

1-2.2 An additional purpose of this standard shall be to provide requirements to ensure that accessories do not degrade the performance of the SCBA.

1-2.3* Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all situations to which personnel can be exposed.

1-2.4 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 Effective Dates.

1-3.1 The effective date for this standard shall be 15 August 1997; however, the specific Sections herein shall have independent effective dates.

1-3.2 The effective date for ISO registration specified in Section 2-6 shall be 1 September 1999.

1-3.3 The effective date for redundant end-of-service-time indicators specified in Section 4-2 shall be 1 September 1999.

1-4 Definitions.

Accessory. An item, provided by the SCBA manufacturer for use with its SCBA, that is attached to the SCBA but is not necessary for the SCBA to meet the requirements of this standard.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

Basic Plane. The plane through the centers of the external ear openings and the lower edges of the eye sockets.

Breathing Air. See Compressed Breathing Gas.

Breathing Air/Gas Container. See Breathing Gas Cylinder.

Breathing Gas 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.

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.

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

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

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.

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

Component. Any material, part, or subassembly providing the required protection that is used in the construction of the SCBA.

Compressed Breathing Gas.* A respirable gas mixture stored in a compressed state and supplied to the user in a gaseous form.

Cylinder. See Breathing Gas Cylinder.

Demand SCBA. See Negative Pressure SCBA.

Drip. To run or fall in drops or blobs.

End-of-Service-Time Indicator. A warning device on an SCBA that warns the user that the end of the service time of the SCBA is approaching.

Fabric Component. Any pliable, natural, or synthetic material(s), or combination thereof, made by weaving, felting, forming, or knitting.

Facepiece. The component of an SCBA that covers as a minimum the wearer's nose, mouth, and eyes.

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

Gas. An aeriform fluid that is in a gaseous state at standard temperature and pressure.

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

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

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.

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 identified standards or has been tested and found suitable for a specified purpose.

Melt. To change from solid to liquid, or become consumed, by action of heat.

Midsagittal Plane. The plane, perpendicular to the basic and coronal planes, that bisects the head symmetrically.

Model. The collective term used to identify identical SCBA of the same basic design from a single manufacturer produced by the same manufacturing and quality assurance procedures that are covered by the same certification.

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.

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 Title 42, *Code of Federal Regulations,* Part 84, Subpart H (42 *CFR* 84). For the NIOSH certification to remain in effect, the SCBA must be used and maintained in the approved condition.

Open-Circuit SCBA. An SCBA in which exhalation is vented to the atmosphere and not rebreathed. There are two types of open-circuit SCBA: negative pressure or demand type and positive pressure or pressure demand type.

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

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.

Pressure Demand SCBA. See Positive Pressure SCBA.

Product Label. A label or marking affixed to the SCBA by the manufacturer, containing general information, care, maintenance, or similar data. This product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark shall be permitted to be attached to it or be part of it. *(See also Labeled.)*

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.

SCBA. See Self-Contained Breathing Apparatus.

Self-Contained Breathing Apparatus (SCBA). A respirator worn by the user that supplies a respirable atmosphere that is either carried in or generated by the apparatus and is independent of the ambient environment.

Service Time. See Rated Service Time.

Shall. Indicates a mandatory requirement.

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

1-5 Units.

1-5.1 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. Equivalent values in parentheses shall not be considered as the requirement, as these values might be approximate.

Chapter 2 Certification

2-1 General.

2-1.1 Prior to certification of SCBA to the requirements of this standard, SCBA shall be NIOSH certified.

2-1.1.1 SCBA shall have NIOSH certification as positive pressure.

2-1.1.2* SCBA shall have a NIOSH certified rated service time of at least 30 minutes.

2-1.1.3 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.

2-1.2 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 to the certification program specified in Section 2-2 and shall be in addition to, and shall not be construed to be the same as, the NIOSH certification as specifically defined in Section 1-4.

2-1.3 All certification shall be performed by a certification organization that meets at least the requirements specified in Section 2-2, and that is accredited for personal protective equipment in accordance with ANSI Z34.1, *American National Standard for Third-Party Certification Programs for Products, Processes, and Services.*

2-1.4 Compliant SCBA shall be labeled and listed. Compliant SCBA shall also have a product label that meets the requirements specified in Section 3-1.

2-1.5 Where accessories are to be attached to or integrated with the SCBA, they shall be tested with and certified as part of the SCBA under this standard.

2-1.6 SCBA shall meet all of the design and performance requirements of this standard with accessories installed. Accessories shall not be required to meet any of the performance requirements of this standard other than as specified herein.

2-2 Certification Program.

2-2.1* The certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified. The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

2-2.2 The certification organization shall refuse to certify products to this standard that do not comply with all requirements of this standard.

2-2.3* The contractual provisions between the certification organization and the manufacturer shall specify that certification is contingent upon compliance with all applicable requirements of this standard. There shall be no conditional, temporary, or partial certifications. Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not manufactured in compliance with all applicable requirements of this standard.

2-2.4* The certification organization shall have available laboratory facilities and equipment for conducting proper tests, a program for calibration of all instruments shall be in place and operating, and procedures shall be in use to ensure proper control of all testing. Good practice shall be followed regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

2-2.5 The certification organization shall require the manufacturer to establish and maintain a program of production inspection and testing that at least meets the requirements of Sections 2-5 and 2-6. 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.

2-2.6 The certification organization and the manufacturer shall evaluate any changes affecting the form, fit, or function of the certified product to determine its continued certification to this standard.

2-2.7* The certification organization shall have a follow-up inspection program of the manufacturing facilities of the certified product, with at least two random and unannounced visits per 12-month period. 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. Sample product shall be inspected and tested by the certification organization to verify the product's continued compliance.

2-2.8 The certification organization shall have a program for investigating field reports alleging malperformance or failure of listed products.

2-2.9* The certification organization shall require the manufacturer to have a product recall system as part of the manufacturer's quality assurance program.

2-2.10 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.

2-2.11 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.

2-3* Inspection and Testing.

2-3.1 Four identical SCBA that are selected from the manufacturer's production SCBA and that are to be certified to this standard shall be subjected to the tests specified in Categories A, B, C, and D of Table 2-3.1, for each test series. 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 listed in Category C, and the fourth SCBA shall be subjected to the tests listed in Category D, as shown in Table 2-3.1. SCBA components shall be subjected to the tests specified in Category E of Table 2-3.1.

Table 2-3.1 Test Series

Test Order	Category A (SCBA #1)	Category B (SCBA #2)	Category C (SCBA #3)	Category D (SCBA #4)	Category E (Component Tests)
1.	Air Flow Section 6-1	Air Flow Section 6-1	Air Flow Section 6-1	Air Flow Section 6-1	Fabric Flame Resistance S ection 6-4
2.	Communications Performance Section 6-10	Accelerated Corrosion Resistance Section 6-7	Vibration Resistance Section 6-3	Heat and Flame Resistance Section 6-11	Fabric Heat Resistance Section 6-5
3.	Environmental Temperature Section 6-2				Thread Heat Resistance Section 6-6
4.	Particulate Resistance Section 6-8				Facepiece Lens Abrasion Resistance Section 6-9

2-3.2 SCBA shall be initially tested and shall meet the performance requirements of three separate test series of Categories A, B, C, and D, as specified in Table 2-3.1. All tests within Categories A, B, C, and D shall be conducted in the order specified and are designed as cumulative damage tests.

2-3.3 SCBA fabric, thread, and lens components shall be initially tested and shall meet the performance requirements of one test series of Category E, as specified in Table 2-3.1. SCBA component testing in Category E shall be conducted on test specimens as specified in each respective test method.

2-3.4 After certification, compliant SCBA shall be tested annually within 12 months from previous tests and shall meet the performance requirements of one test series of Categories A, B, C, D, and E, as specified in Table 2-3.1. This requirement shall be waived every fifth year when the testing required by 2-3.4.1 is conducted.

2-3.4.1 Compliant SCBA shall be tested and shall meet the performance requirements of three separate test series of Categories A, B, C, and D, as specified in Table 2-3.1, every fifth year from the date of the initial certification testing specified in 2-3.2.

2-3.4.2 SCBA components shall be tested and shall meet the performance requirements of one test series of Category E, as specified in Table 2-3.1, every fifth year from the date of initial certification testing specified in 2-3.3.

2-3.5 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. 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. 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.

2-3.6 No adjustment, repair, or replacement of parts shall be permitted to any SCBA being tested in accordance with this standard. Breathing gas cylinders shall be permitted to be filled as required.

2-3.7 Inspection and testing for determining compliance with the design requirements of this standard shall be performed on a complete SCBA unless otherwise specified within this standard.

2-3.8 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 accessories that are different from those on the original SCBA tested.

2-3.9 Any modifications made to an SCBA, or any 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 certifying the modified SCBA as being compliant with this standard.

2-3.10 Inspection by the certification organization shall include a review of all product labels to ensure that all required label attachments, compliance statements, certification statements, and other product information are at least as specified in Section 3-1.

2-3.11 Inspection by the certification organization shall include a review of the user information required by Section 3-2 to ensure that the information has been developed and is available.

2-3.12 Inspection by the certification organization for determining compliance with the design requirements specified in Chapter 4 shall be performed on whole or complete products.

2-3.13 Where SCBA is provided with an accessory or accessories that are attached to or integrated with the SCBA, such accessories shall be tested with the SCBA in accordance with this standard. Accessories shall not be required to meet any of the performance requirements of this standard other than as specified herein.

2-3.14 Where certification testing includes an SCBA with an accessory or accessories, each accessory shall be certified as complying with 4-1.3 and 4-1.4, as applicable.

2-4 Recertification.

2-4.1 All SCBA models that are labeled as being compliant with this standard shall undergo recertification on an annual basis. This recertification shall include inspection and evaluation to all design requirements and testing to all performance requirements as required by 2-3.4 and 2-3.7 on all manufacturer models and components.

2-4.2 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. The manufacturer shall provide such data, upon request, to the purchaser or authority having jurisdiction.

2-5 Manufacturer's Quality Assurance Program.

2-5.1 The manufacturer shall provide and maintain a quality assurance program that includes a documented inspection and product recall system. The manufacturer shall have an inspection system to substantiate conformance to this standard.

2-5.2 The manufacturer shall maintain written inspection and testing instructions. The instructions shall prescribe inspection and testing of materials, work in process, and completed articles. Criteria for acceptance and rejection of materials, processes, and final product shall be part of the instructions.

2-5.3 The manufacturer shall maintain records of all pass/fail tests. Pass/fail records shall indicate the disposition of the failed material or product.

2-5.4 The manufacturer's inspection system shall provide for procedures that assure the latest applicable drawings, specifications, and instructions are used for fabrication, inspection, and testing.

2-5.5 The manufacturer shall, as part of the quality assurance program, maintain a calibration program of all instruments used to ensure proper control of testing. The calibration program shall be documented as to the date of calibration and performance verification.

2-5.6 The manufacturer shall maintain a system for identifying the appropriate inspection status of component materials, work in process, and finished goods.

2-5.7 The manufacturer shall establish and maintain a system for controlling nonconforming material, including procedures for the identification, segregation, and disposition of rejected material. All nonconforming materials or products

shall be identified to prevent use, shipment, and intermingling with conforming materials or products.

2-5.8 The manufacturer's quality assurance program shall be audited by the certification organization to determine that the system is sufficient to ensure continued product compliance with this standard.

2-6 ISO Registration for Manufacturers.

2-6.1 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 2-2.9.

2-6.2 The manufacturer shall be registered to ISO 9001, *Quality Systems — Model for Quality Assurance in Design, Development, Production, Installation, and Servicing.*

2-6.3 All subassemblies of SCBA defined on the NIOSH approval label and final assembly of SCBA components into an SCBA shall be accomplished in a facility that is registered at least to ISO 9002, *Quality Systems — Model for Quality Assurance in Production, Installation, and Servicing.*

2-6.4 The ISO registration requirements shall have an effective date of 1 September 1999.

2-6.5 Until 1 September 1999, or until the date the manufacturer becomes ISO registered, whichever date occurs first, the manufacturer shall comply with Section 2-5.

Chapter 3 Labeling and Information

3-1 Product Label Requirements.

3-1.1 In addition to the NIOSH approval label, each SCBA shall have a product label permanently and conspicuously attached to the SCBA.

3-1.2 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label.

3-1.3 The certification organization's label, symbol, or identifying mark shall be attached to the product label or be part of the product label.

3-1.4 All worded portions of the required product label shall be at least in English.

3-1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

3-1.6 The following statement shall be legibly printed on the product label. All letters and numbers shall be at least $^{1}/_{16}$ in. (1.5 mm) high:

"THIS SCBA MEETS THE REQUIREMENTS OF NFPA 1981, *STANDARD ON OPEN-CIRCUIT SELF-CONTAINED BREATHING APPARATUS FOR THE FIRE SERVICE,* 1997 EDITION."

3-1.7 SCBA components, as listed on the NIOSH approval labels, shall be marked directly on the component with either the lot number, serial number, or year and month of manufacture.

3-2 User Information.

3-2.1 The SCBA manufacturer shall provide at least the training material and user instructions specified within this section with each SCBA.

3-2.2 Upon request at the time of purchase, the manufacturer shall provide to the purchaser an information sheet with each SCBA that documents at least the following:

(a) Manufacturing performance tests conducted at time of manufacture, and the results

(b) Date of manufacture

(c) Model number

(d) Serial number

(e) Lot number, if applicable

(f) Hydrostatic test dates and results, if applicable

3-2.3 Information or training materials regarding pre-use shall be provided at least on the following areas:

(a) Safety considerations

(b) Limitations of use

(c) Charging breathing gas cylinders

(d) Breathing gas quality

(e) Marking recommendations and restrictions

(f) Warranty information

(g) Recommended storage practices

(h) Mounting on/in vehicles or fire apparatus

3-2.4 Information or training materials regarding periodic inspections shall be provided at least on inspection frequency and details.

3-2.5 Information or training materials regarding donning and doffing shall be provided at least on the following areas:

(a) Donning and doffing procedures

(b) Adjustment procedures

(c) Interface issues

3-2.6 Information or training materials regarding use shall be provided at least on the following areas:

(a) Pre-use checks

(b) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*

(c) Recharging breathing gas cylinders

3-2.7* Information or training materials regarding periodic maintenance and cleaning shall be provided at least on the following areas:

(a) Cleaning instructions and precautions

(b) Disinfecting procedures

(c) Maintenance frequency and details

(d) Methods of repair, where applicable

3-2.8 Information or training materials regarding retirement shall be provided at least on replacement/retirement considerations.

Chapter 4 Design Requirements

4-1 General.

4-1.1 All electric circuits integral to an SCBA, or to any SCBA accessories, shall meet the requirements for Class I, Division I hazardous locations specified in ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations.*

4-1.2 All hardware, brackets, and snaps or other fasteners of SCBA or any accessories shall be free of rough spots, burrs, or sharp edges.

4-1.3 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.

4-1.4 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. In all cases, such accessories shall not degrade the performance of the SCBA.

4-2 End-of-Service-Time Indicators.

4-2.1 The requirements of this section shall have an effective date as specified in Section 1-3, Effective Dates.

4-2.2 All SCBA shall be equipped with at least two active end-of-service-time indicators, one of which shall not be solely an auditory warning.

4-2.3 Each end-of-service-time indicator shall meet the activation requirements of NIOSH certification as specified in 42 *CFR* 84.

4-2.4 The design of the end-of-service-time indicators shall be such that the failure of either end-of-service-time indicator shall not affect the activation and operation of the other end-of-service-time indicator(s).

Chapter 5 Performance Requirements

5-1* Air Flow Performance.

5-1.1 SCBA shall be tested for air flow performance as specified in Section 6-1, Air Flow Performance Test, and the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column nor greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the test begins until the time the test is concluded.

5-2 Environmental Temperature Performance.

5-2.1 SCBA shall be tested for environmental temperature performance as specified in Section 6-2, Environmental Temperature Tests.

5-2.1.1 When tested for cold environment as specified in 6-2.4, the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column nor greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the air flow test begins until the time the test is concluded.

5-2.1.2 When tested for hot environment as specified in 6-2.5, the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the air flow test begins until the time the test is concluded.

5-2.1.3 When tested for hot-to-cold environment as specified in 6-2.6, the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the air flow test begins until the time the test is concluded.

5-2.1.4 When tested for cold-to-hot environment as specified in 6-2.7, the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the test begins until the time the air flow test is concluded.

5-3 Vibration Resistance Performance.

5-3.1 SCBA shall be tested for vibration resistance as specified in Section 6-3, Vibration Tests, and the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the air flow test begins until the time the test is concluded.

5-4 Fabric Flame Resistance Performance.

5-4.1 Specimens of the fabric components of SCBA that are used to secure the SCBA to the wearer shall be tested for flame resistance as specified in Section 6-4, Fabric Flame Tests, and shall have an average char length of not more than 4.0 in. (101.6 mm), shall have an average afterflame of not more than 2.0 seconds, and shall not melt or drip.

5-5 Fabric Heat Resistance Performance.

5-5.1 Specimens of the fabric components of SCBA that are used to secure the SCBA to the wearer shall be tested for heat resistance as specified in Section 6-5, Fabric Heat Tests, and shall not melt or ignite.

5-6 Thread Heat Resistance Performance.

5-6.1 Specimens of thread used in SCBA components shall be tested for heat resistance as specified in Section 6-6, Thread Heat Test, and shall not melt or ignite.

5-7 Accelerated Corrosion Resistance Performance.

5-7.1 SCBA shall be tested for corrosion resistance as specified in Section 6-7, 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. In addition, the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the air flow test begins until the time the test is concluded.

5-8 Particulate Resistance Performance.

5-8.1 SCBA shall be tested for particulate resistance as specified in Section 6-8, Particulate Test, and the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm) water column above ambient pressure from the time the air flow test begins until the time the test is concluded.

5-9* Facepiece Lens Abrasion Resistance Performance.

5-9.1 Specimen SCBA facepiece lenses shall be tested for abrasion resistance as specified in Section 6-9, Facepiece Lens Abrasion Test, and the average value of the tested specimens shall not exhibit a delta haze greater than 14 percent.

5-10* Communications Performance.

5-10.1 SCBA incorporating specimens of the SCBA's primary communication means, as identified by the SCBA manufacturer, shall be tested for communications performance as specified in Section 6-10, Communication Test, and shall have an average calculated value of not less than 72 percent.

5-11 Heat and Flame Resistance Performance.

5-11.1 SCBA shall be tested for heat and flame resistance as specified in Section 6-11, Heat and Flame Test, and the SCBA facepiece pressure shall not be less than 0.00 in. (0.00 mm) water column and shall not be greater than $3^1/_2$ in. (89 mm)

water column above ambient pressure from the time the test begins until the time the test is concluded.

5-11.2 When the SCBA and SCBA accessories are tested as specified in Section 6-11, Heat and Flame Test, no components of the SCBA and no accessories shall have an afterflame of more than 2.2 seconds.

5-11.3 When the SCBA are tested as specified in Section 6-11, Heat and Flame Test, 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.

5-11.4 When the SCBA facepiece is tested as specified in Section 6-11, Heat and Flame Test, the facepiece lens shall not obscure vision below the 20/100 vision criterion.

Chapter 6 Test Methods

6-1 Air Flow Performance Test.

6-1.1* The facepiece of the SCBA being tested shall be secured to Scott Aviation Model No. 803608-01 or 803608-02 test headform or equivalent. The facepiece shall be secured to the headform to assure that an initial pressure of 1.0 in., ±0.1 in. (25.4 mm, ±2.5 mm) water column below ambient shall not decay by more than 0.2 in. (5.1 mm) water column in 5 seconds.

6-1.2 The remaining components of the SCBA shall be mounted in accordance with Figure 6-1.2 to simulate its typical wearing position, as specified by the manufacturer, on a fire fighter.

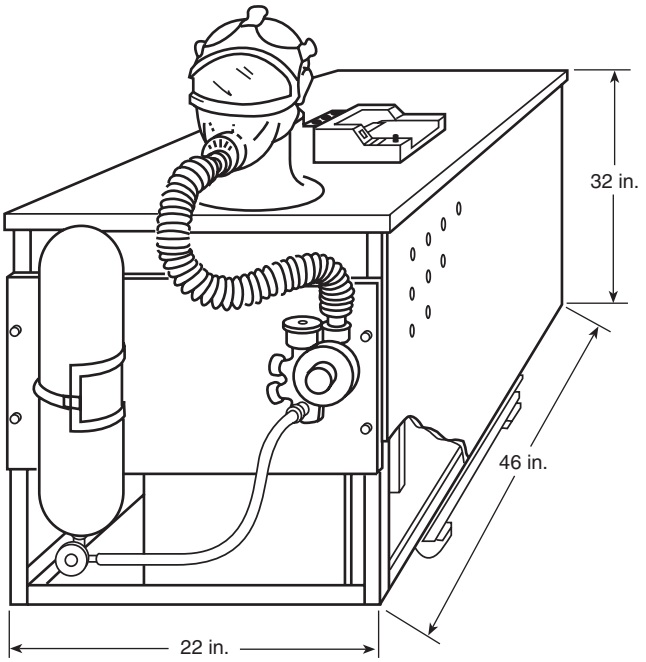


Figure 6-1.2 Typical breathing machine configuration for air flow performance test.

6-1.3 A pressure probe shall be attached to the test headform to monitor facepiece pressure. The pressure probe shall be a 0.25 in. (6.4 mm) OD. with 0.062-in. (1.6-mm) wall thickness metal tube having one open end and one closed end. The closed end shall have four equally spaced holes, each 0.062 in., ±0.005 in. (1.6 mm, ±0.1 mm), and each shall be positioned 0.250 in., ±0.02 in. (6.4 mm, ±0.5 mm) from the end of the pressure probe.

6-1.4 The closed end of the pressure probe shall extend through the test head form, exiting out the center of the left eye. The pressure probe shall extend 0.50 in., +0.06/-0.0 in. (12.7 mm, +1.5/-0.0 mm) outward from the surface of the center of the left eye.

6-1.5 The open end of the pressure probe shall extend a maximum of 18 in. (457 mm) and a minimum of 1.0 in. (25.4 mm) outward from the back surface of the test headform.

6-1.6 A maximum of a 5-ft (1.5-m) length of nominal 0.188 in. (4.8 mm) ID. flexible smoothbore tubing with a nominal 0.062-in. (1.6-mm) wall thickness shall be permitted to be connected from the open end of the pressure probe to the inlet of the pressure transducer.

6-1.7* A differential pressure transducer having the following characteristics shall be used:

(a) Range: 8.9 in. (226 mm) of water differential

(b) Linearity: ±0.5 percent Full Scale (FS) best straight line

(c) Line pressure effect: less than 1 percent FS zero shift/1000 psig

(d) Output: ±2.5 Vdc for +FS

(e) Output ripple: 10 mV peak to peak

(f) Regulation: FS output shall not change more than ±0.1 percent for input voltage change from 22 to 35 Vdc

(g) Temperature, operating: -65°F to 250°F (-54°C to 121°C)

(h) Temperature, compensated: 0°F to 160°F (-8°C to 71°C)

(i) Temperature effects: within 2 percent FS/100°F (55.6°C), error band

6-1.8* The differential pressure transducer shall be appropriately connected to a strip chart recorder having the following characteristics:

(a) A chart width of 9.8 in. (250 mm)

(b) A pen speed of at least 29.5 in./sec (750 mm/sec) (0.333 sec FS)

(c) An accuracy of ±0.25 percent FS

(d) An input voltage range of 1 V FS

(e) A span set at 0.98 in. (25 mm) of chart per 1.0 in. (25.4 mm) water column

6-1.9 The test headform shall be equipped with a stainless steel breathing tube having a 0.90-in. (22.9-mm) ID. with 0.024-in. (0.6-mm) wall thickness. The metal breathing tube shall be located on the centerline of the mouth and shall be flush with the test headform.

6-1.10 The metal breathing tube shall extend outward from either the back or the base surface of the test headform a minimum of 8 in. (203 mm) and a maximum of 18 in. (457 mm).

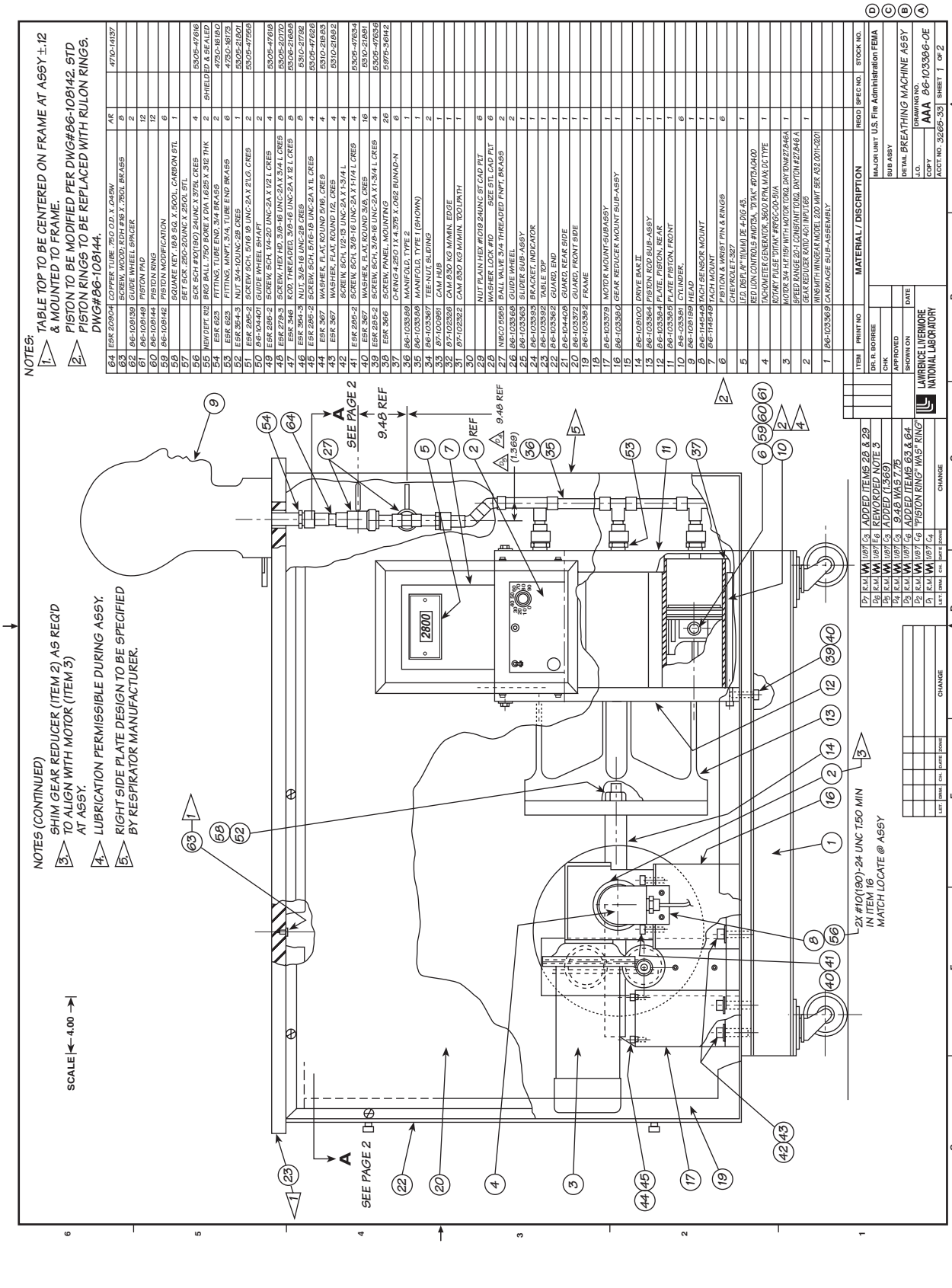
6-1.11 If flexible smoothbore tubing is used from the metal breathing tube to the inlet connection of the breathing machine, it shall have a maximum length of 4 ft (1.2 m) and a 0.75-in. (19.0-mm) ID. with nominal 0.125-in. (3.2-mm) wall thickness.

6-1.12* A Model 327-6 breathing machine, as shown in Figures 6-1.12(a), (b), and (c), shall be used. The breathing machine shall be set to the following characteristics:

(a) Ventilation rate: 103, ±3 L/min

(b) Respiratory frequency: 30, ±1 breaths/min

(c) Tidal volume: 3.4 nominal L



ITEM	PART NO	MATERIAL / DISCRIPTION	REQD	SPEC NO.	STOCK NO.
64	E6R 2090H	COPPER TUBE: .750 O.D. X .049W	AR		4710-14157
63	86-109139	SCREW, WOOD; EDH #16 X .750, BRASS	8		
62	86-109149	GUIDE WHEEL SPACER	2		
61	86-109144	PISTON PAD	12		
60	86-109144	PISTON RING	12		
59	86-109142	PISTON MODIFICATION	6		
58		SQUARE KEY: 188 SQ. X .500L, CARBON STL	1		
57		SET SCR .250-20UNC X .250L STL			
56		SCR SCH #10(190) 24UNC X .375L CRES	4		5305-47696
55	NEW DEPT #2	BRG BALL .750 BORE X DIA 1.625 X .312 THK	2		SHIELDED & SEALED
54	E6R 623	FITTING, TUBE END, 3/4 BRASS	2		4730-16190
53	E6R 623	FITTING, MNPT, 3/4, TUBE END BRASS	6		4730-16173
52	E6R 354-3	NUT 3/4-10UNC-2B CRES	1		5305-21801
51	E6R 285-2	SCREW SCH. 5/16 18 UNC-2A X 2LG. CRES	2		5305-47569
50	86-104401	GUIDE WHEEL SHAFT	2		
49	E6R 285-2	SCREW, SCH, 1/4-20 UNC-2A X 1½ L CRES	4		5305-47618
48	E6R 279-3	SCREW, HEX HD, 3/8-16 UNC-2A X 3/4 L CRES	8		5305-20170
47	E6R 346	ROD, THREADED, 3/8-16 UNC-2A X 12 L CRES	8		5306-21688
46	E6R 354-3	NUT, 3/8-16 UNC-2B CRES	8		5310-21792
45	E6R 285-2	SCREW, SCH, 5/16-18 UNC-2A X 1L CRES	4		5305-47626
44	E6R 367	WASHER, FLAT, ROUND 5/16, CRES	4		5310-21863
43	E6R 367	WASHER, FLAT, ROUND 1/2, CRES	4		5310-21862
42		SCREW, SCH, 1/2-13 UNC-2A X 1-3/4 L	4		
41	E6R 285-2	SCREW, SCH, 3/8-16 UNC-2A X 1-1/4 L CRES	4		5305-47634
40	E6R 367	WASHER, FLAT, ROUND 3/8, CRES	16		5310-21881
39	E6R 285-2	SCREW, SCH, 3/8-16 UNC-2A X1-3/4 L CRES	4		5305-47636
38	E6R 366	SCREW, PANEL, MOUNTING	26		5975-36142
37		O-RING 4.250 I.D X 4.375 X .062 BUNAD-N	6		
36	86-103389	MANIFOLD, TYPE 2	1		
35	86-103388	MANIFOLD, TYPE 1 (SHOWN)	1		
34	86-103367	TEE-NUT, SLIDING	2		
33	87-100991	CAM HUB	1		
32	87-102326	CAM 830 KG M/MIN. EDGE	1		
31	87-102323	CAM 830 KG M/MIN. TOOLPATH	1		
30					
29		NUT PLAIN HEX #1019 24UNC 5R CAD PLT	6		
28		WASHER, LOCK, #10 SIZE STL CAD PLT	6		
27	NIBCO 5566	BALL VALVE 3/4 THREADED FNPT, BRASS	2		
26	86-103368	GUIDE WHEEL	2		
25	86-103363	SLIDER SUB-ASSY	1		
24	86-103393	BRACKET, INDICATOR	1		
23	86-103392	TABLE TOP	1		
22	86-103362	GUARD, END	1		
21	86-104408	GUARD, REAR SIDE	1		
20	86-103372	GUARD, FRONT SIDE	1		
19	86-103382	FRAME	1		
18					
17	86-103378	MOTOR MOUNT-SUB ASSY	1		
16	86-103360	GEAR REDUCER MOUNT SUB-ASSY	1		
15					
14	86-108100	DRIVE BAR II	1		
13	86-103364	PISTON ROD SUB-ASSY	1		
12	86-103384	PLATE, PISTON, REAR	1		
11	86-103385	PLATE PISTON, FRONT	1		
10	86-035891	CYLINDER,	6		
9	86-108199	HEAD	1		
8	86-114548	TACH SENSOR MOUNT	1		
7	86-114549	TACH MOUNT	1		
6		PISTON & WRIST PIN & RINGS	6		
5		CHEYROLET-327	1		
		I.C.D. 180°LA" (11MM) DE. 4-216 45.			
4		RED LION CONTROLS #MDT5A, "DTAK" #DT5A04D	1		
		TACHOMETER GENERATOR, 3600 RPM, MAX DC TYPE			
3		ROTARY PULSE "DTAK" #RPGC-D05/5A	1		
		MOTOR 3/4 H.P 115V WITH MOTOR TORQ, DAYTON#2Z446A			
2		SPEED RANGE 20-1 CONSTANT TORQ, DAYTON #2Z546 A	1		
		GEAR REDUCER RATIO 40-1 MFG 1068			
1	86-103369	CARRIAGE SUB-ASSEMBLY	1		
		WINSMITH GEAR MODEL 220 UNIT SER K32 0211-0201			

Figure 6-1.12(a) Model 327-6 breathing machine.

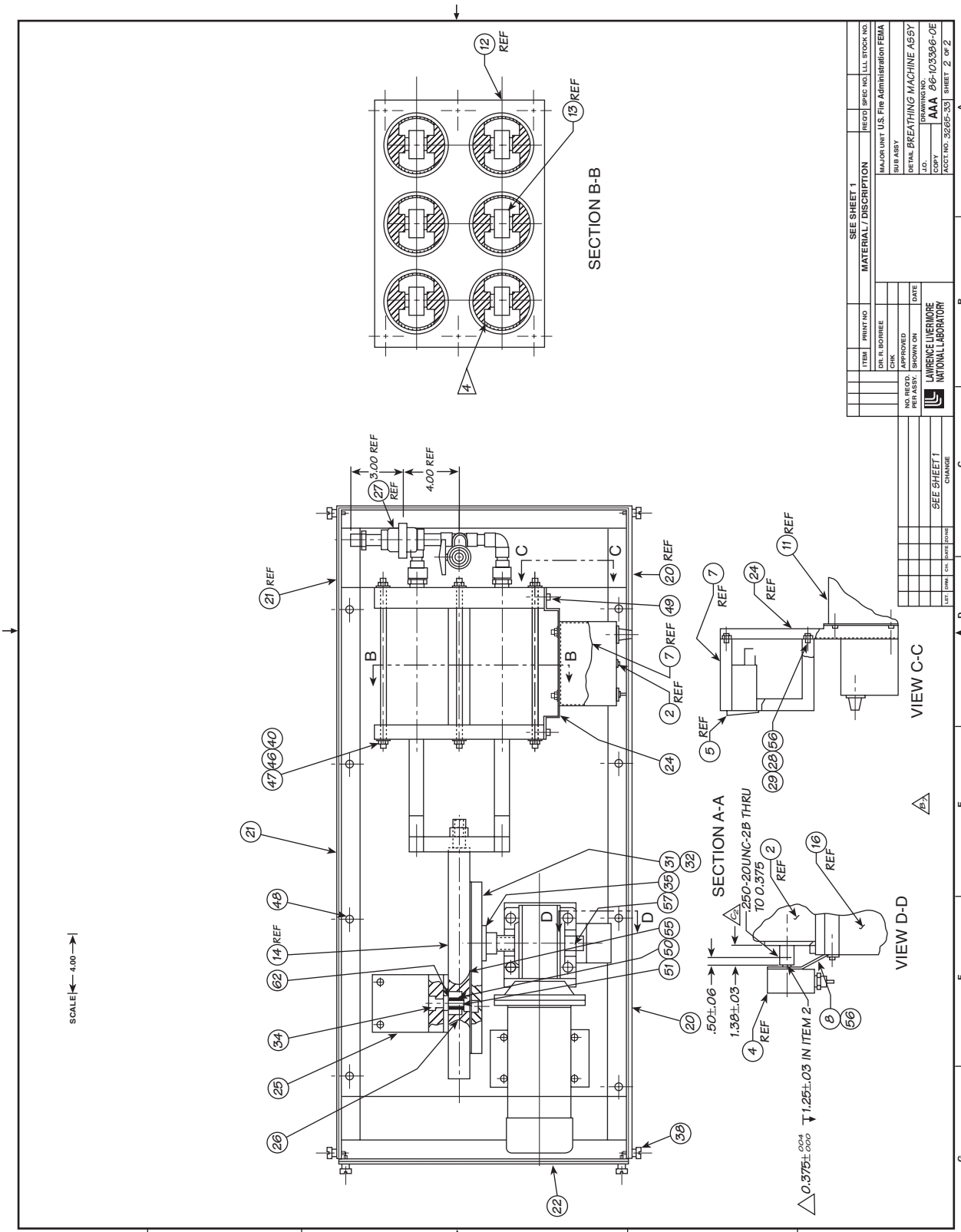


Figure 6-1.12(b) Model 327-6 breathing machine details.

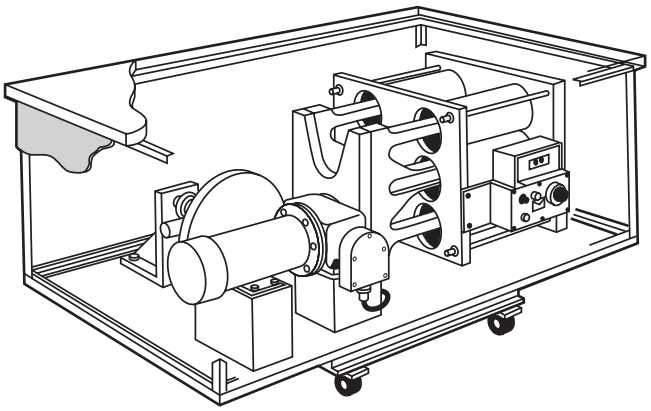


Figure 6-1.12(c) Model 327-6 breathing machine.

6-1.13 The test conditions shall be as follows:

(a) Ambient temperature: 72°F, ±5°F (22°C, ±3°C)

(b) Relative humidity: 50 percent, ±25 percent

(c) Barometric pressure: 725 mm Hg, +50/-70 mm Hg

6-1.13.1* The breathing air used in the SCBA breathing gas cylinders shall have a minimum air quality of Grade D as specified in ANSI/CGA G-7.1, *Commodity Specification for Air,* and shall have a dew point of -65°F (-54°C) or lower (24 ppm v/v or dryer) and shall have a maximum particulate level of 5 mg/m^3 air.

6-1.14* The test setup for conducting the air flow performance test shall be calibrated at least once each day before conducting tests and shall be verified at least once each day after testing. The calibration procedure utilized for the differential pressure transducer shall consist of confirming at least three different pressures between 0.0 in. and 5.0 in. (0.0 mm and 127 mm) water column. The pressure shall be measured using an incline manometer or equivalent with a scale measuring in increments of ±0.02 in. (±0.5 mm) water column or less.

6-1.15 The SCBA being tested shall utilize a fully charged breathing gas cylinder. The air flow performance test shall begin after 5 cycles of the breathing machine and continue to operate through 30 cycles of the breathing machine after actuation of the end-of-service-time indicator.

6-1.16 The facepiece pressure shall be read from the strip chart recorder to determine pass/fail.

6-2 Environmental Temperature Tests.

6-2.1 The environmental temperature tests specified in this section shall be permitted to be conducted in any sequence. After performing each test, the SCBA shall be placed in an ambient environment of 72°F, ±5°F (22°C, ±3°C) with a relative humidity of 50 percent, ±25 percent for a minimum 12-hour dwell period.

6-2.2 The SCBA shall be placed in an appropriate environmental chamber and positioned to simulate the normal wearing position of the SCBA on a fire fighter as specified by the manufacturer. A test headform as specified in 6-1.1 shall be equipped with a thermocouple or other temperature-sensing element to monitor SCBA test chamber temperature. The thermocouple or other temperature-sensing element used shall be attached to the test headform in a manner in which it will be directly exposed to the chamber atmosphere. The test headform shall be connected to the breathing machine in accordance with Section 6-1. The breathing machine shall be permitted to be located either inside or outside the environmental chamber.

6-2.3 The dwell period between environmental temperature tests shall be used for refilling the breathing gas cylinder and visually inspecting the SCBA for any gross damage that could cause unsafe test conditions.

6-2.4 The SCBA shall be cold soaked at -25°F, ±2°F (-32°C, ±1°C) for a minimum of 12 hours. The SCBA shall be tested as specified in Section 6-1 at an ambient temperature of -25°F, ±10°F (-32°C, ±5°C).

6-2.5 The SCBA shall be hot soaked at 160°F, ±2°F (71°C, ±1°C) for a minimum of 12 hours. The SCBA shall then be tested as specified in Section 6-1 at an ambient temperature of 160°F, ±10°F (71°C, ±5°C).

6-2.6 The SCBA shall be hot soaked at 160°F, ±2°F (71°C, ±1°C) for a minimum of 12 hours. The SCBA shall then be transferred to a chamber with an air temperature of -25°F, ±2°F (-32°C, ±1°C). The SCBA shall then be tested as specified in Section 6-1 at a chamber air temperature of -25°F, ±10°F (-32°C, ±5°C). The air flow performance test specified in Section 6-1 shall commence within 3 minutes after removal from hot soak.

6-2.7 The SCBA shall be cold soaked at -25°F, ±2°F (-32°C, ±1°C) for a minimum of 12 hours. The SCBA shall then be transferred to a chamber with an air temperature of 160°F, ±2°F (71°C, ±1°C). The SCBA shall then be tested as specified in Section 6-1 at a chamber air temperature of 160°F, ±10°F (71°C, ±5°C). The air flow performance test specified in Section 6-1 shall commence within 3 minutes after removal from cold soak.

6-3 Vibration Tests.

6-3.1 SCBA shall be tested on a typical package tester similar to that shown in Figure 514.4-19 of MIL-STD-810E, *Environmental Test Methods,* within holding boxes as specified in 6-3.2.

6-3.2 Holding boxes for the vibration test shall be constructed with nominal $^3/_4$-in. (19-mm) plywood and shall be sized to encase the complete SCBA in one holding box and the SCBA components in a second holding box.

6-3.2.1 The tops of the holding boxes shall be permitted to be made of transparent material to allow observation during testing.

6-3.2.2 The SCBA holding box shall be constructed to encase the complete SCBA. SCBA regulators and hoses shall remain attached to the complete SCBA. The SCBA facepiece and those components that attach directly to the facepiece, excluding regulators, shall not be included in the SCBA holding box.

6-3.2.3 The travel distance between the widest part of the SCBA and the sideboards of the SCBA holding box shall be a total of 1.0 in., ±0.2 in., or 0.5 in., ±0.1 in., per side (25 mm, ±5 mm, or 13 mm, ±3 mm, per side). The travel distance between the highest point of the SCBA and the bottom of the SCBA holding box top shall be a total of 1.0 in., ±0.2 in. (25 mm, ±5 mm).

6-3.2.4 The total travel distance shall be measured with all movable components, excluding those components specified in 6-3.2.5, configured to minimize the size of the SCBA holding box. The highest point of the SCBA shall be measured with the SCBA oriented with the back plate resting on the bottom of the SCBA holding box as shown in Figure 6-3.2.4.

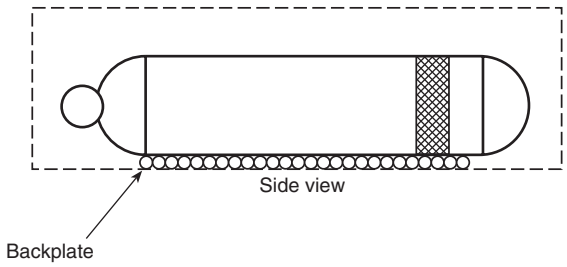


Figure 6-3.2.4 SCBA in holding box.

6-3.2.5 The second holding box for components shall be constructed to encase the facepiece and those components that attach directly to the facepiece, excluding the regulator and associated hoses.

6-3.2.6 The total travel distance between the widest part of the SCBA components and the sideboards of the component holding box shall be 1.0 in., ±0.2 in., or 0.5 in., ±0.1 in., per side (25 mm, ±5 mm, or 13 mm, ±3 mm, per side). The total travel distance between the highest point of the facepiece and the bottom of the component holding box top shall be 1.0 in., ±0.2 in. (25 mm, ±5 mm).

6-3.2.7 The total travel distance shall be measured with all movable components, as specified in 6-3.2.5, configured to minimize the size of the component-holding box. The highest point of the SCBA facepiece shall be measured with the facepiece oriented with the outer portion of the lens facing the top of the component-holding box.

6-3.3* The breathing gas cylinder of the SCBA shall be replaced by a surrogate cylinder.

6-3.3.1 The surrogate cylinder and cylinder valve shall be of identical design and construction as the breathing gas cylinder and cylinder valve of the SCBA to be tested.

6-3.3.2 The mass of the breathing gas of a fully pressurized breathing gas 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 6-3.3.2.

6-3.3.3 The surrogate cylinder and cylinder valve with the substitute mass shall have the same total mass, ±5 percent, as the fully pressurized breathing gas cylinder and cylinder valve.

6-3.4 The test items shall be placed unrestrained in the holding boxes specified in 6-3.2 and shall be tested to the level as specified in I-3.3.3.2 of Method 514.4, Vibration, of MIL-STD-810E, *Environmental Test Methods.*

6-3.5 The test shall be conducted with the test specimen situated in each of the two positions shown in Figure 6-3.5(a) and Figure 6-3.5(b). The total test duration shall be three hours, consisting of two 90-minute periods, one period for each position. *(See Figure 6-3.5(a) and Figure 6-3.5(b) on page 18.)*

6-3.6 After being subjected to the vibration test, the SCBA shall be reattached to the breathing gas cylinder originally provided with the SCBA and shall then be tested as specified in Section 6-1.

6-4 Fabric Flame Tests.

6-4.1 Ten specimens of each different fabric component of the SCBA shall be tested in accordance with Method 5903.1, Flame Resistance of Cloth, Vertical, of Federal Test Method Standard 191A, *Textile Test Methods.*

6-4.2 Test specimens shall be a minimum of 12 in. (305 mm) long and shall be tested in the width specified by the prescribed test method. Test specimens shall be cut from a standard production run of the fabric components used in the SCBA. If the fabric components are not available in the width specified in Method 5903.1, the width of the test specimen shall be the widest width as used on the SCBA, but shall be a minimum of 12 in. (305 mm) long.

6-4.3 Five test specimens shall be tested without any conditioning. The remaining five test specimens shall first 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 ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics,* prior to flame-resistance testing.

6-4.4 The char lengths and afterflame shall be recorded, and each shall be averaged to determine pass/fail. Specimens shall be observed for evidence of melting or ignition to determine pass/fail.

6-5 Fabric Heat Tests.

6-5.1 Ten specimens of each different fabric component of the SCBA shall be tested in a forced circulating air oven capable of achieving and maintaining an air stream temperature of 500°F, +10°/-0°F (260°C, +5°/-0°C).

6-5.2 Test specimens shall be 15 × 15 in., ±0.5 in. (381 × 381 mm, ±13 mm) and shall be cut from a standard production run of the fabric components used in the SCBA. If the fabric is not available in a 15-in. (381-mm) width, the width of the test specimen shall be the widest width as used on the SCBA, but shall be a minimum of 15 in. (381 mm) long.

6-5.3 Five test specimens shall be tested without any conditioning. The remaining five test specimens shall first 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 ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics,* prior to heat-resistance testing.

6-5.4 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 not less than 2 in. (51 mm) from any oven surface or another test specimen. Oven air flow shall be parallel to the plane of the material.

6-5.5 Test specimens shall be exposed to the circulating air flow for 5 min, +15/-0 sec. Oven recovery time after the door is closed shall not exceed 1 minute. Test specimen exposure time shall begin when the oven has recovered to an air temperature of 500°F, +10°/-0°F (260°C, +5°/-0°C).

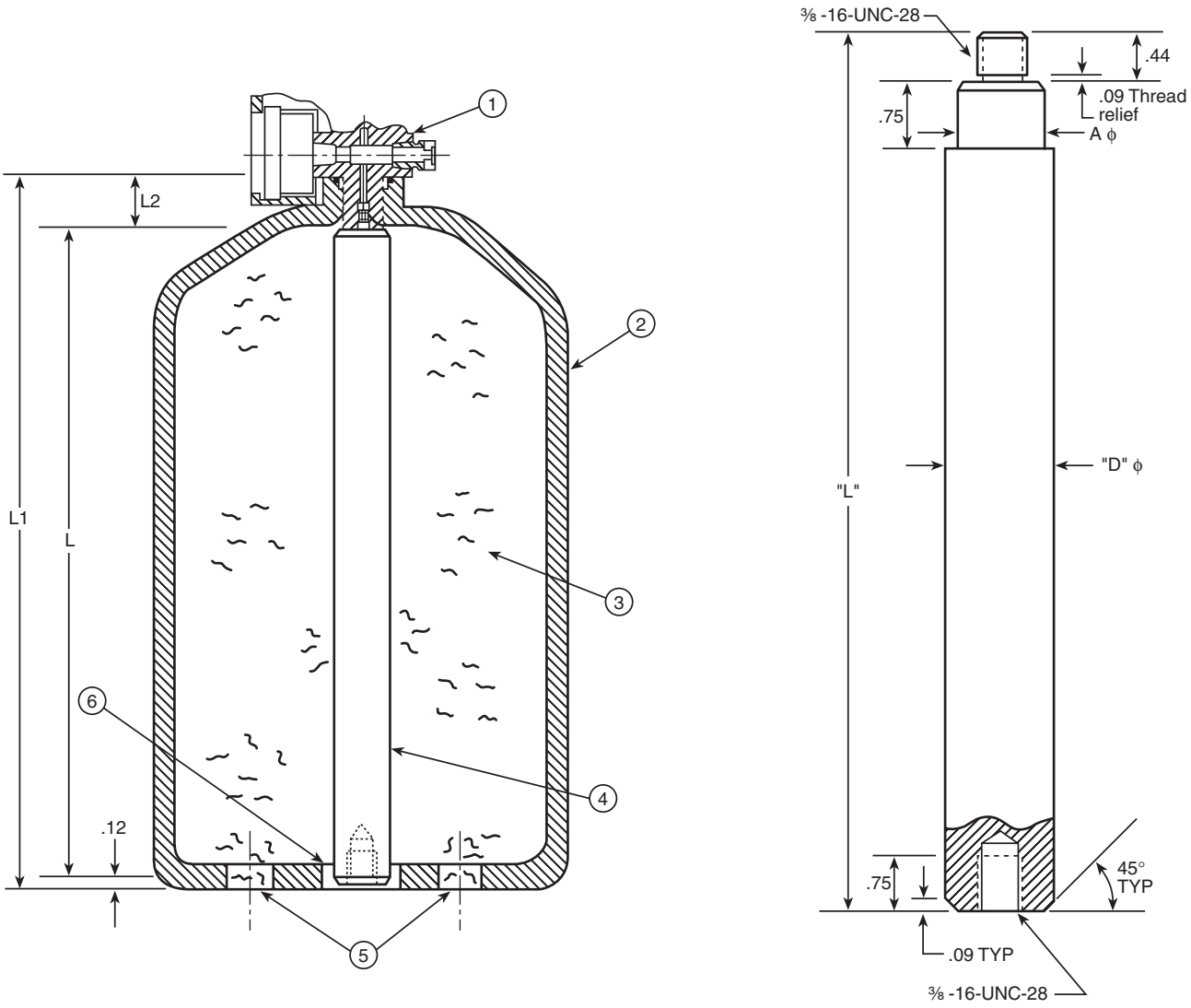
6-5.6 Specimens shall be observed for evidence of melting or ignition to determine pass/fail.

6-6 Thread Heat Test.

6-6.1 All thread utilized shall be tested in accordance with Method 1534, Melting Point of Synthetic Fibers, of Federal Test Method Standard 191A, *Textile Test Methods,* to a temperature of 500°F, +10°/-0°F (260°C, +5°/-0°C).

6-6.2 Specimens shall be observed for evidence of melting or ignition to determine pass/fail.

Item	Description	Quantity
1	Cylinder valve assembly w/gauge and guards, etc.	1
2	SCBA Air storage cylinder	1
3	Stepanfoam RI-9619 polyurethane foam system	A/R
4	Ballast rod — ASTM B16 brass, ½ hard	A/R
5	Fill/vent holes ¾ – ⅞ inch diameter	2
6	Ballast rod installation hole — diameter A/R	1



Complete surrogate cylinder **Ballast rod detail**

Figure 6-3.3.2 Surrogate cylinder.

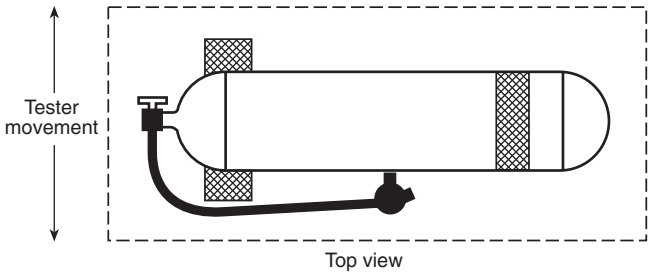


Figure 6-3.5(a) SCBA cylinder axis perpendicular to direction of tester movement.

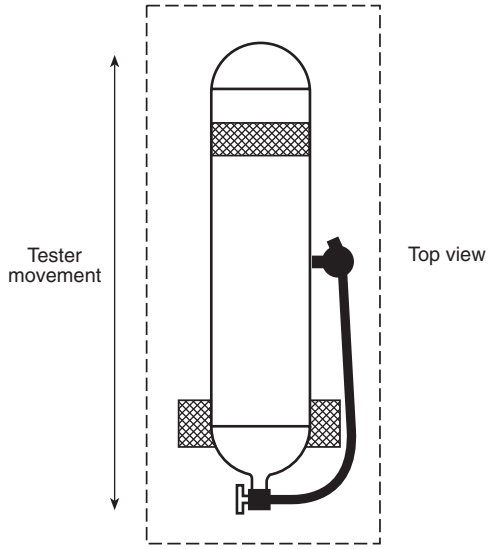


Figure 6-3.5(b) SCBA cylinder axis parallel to direction of tester movement.

6-7 Accelerated Corrosion Test.

6-7.1 An SCBA with a fully charged breathing gas cylinder, with the breathing gas cylinder valve fully closed, shall be tested in accordance with Method 509.3, Salt Fog, Section II, of MIL-STD-810E, *Environmental Test Methods*.

6-7.2 The SCBA shall be attached to a mannequin to simulate its typical wearing position on a fire fighter as specified by the manufacturer. The mannequin shall then be placed in a test chamber. The test chamber temperature shall be adjusted to 95°F, ±3°F (35°C, ±2°C). The SCBA shall be placed in the chamber for 2 hours prior to the introduction of the salt solution.

6-7.3 The SCBA shall be exposed to a 5 percent, ±1 percent, salt fog for a period of 48 hours.

6-7.4 The SCBA shall then be stored in an environment of 72°F, ±5°F (22°C, ±3°C) with 50 percent, ±5 percent relative humidity for a minimum of 48 hours.

6-7.5 The SCBA shall then be tested as specified in Section 6-1 to determine pass/fail. All controls or operating features of the SCBA shall operate per the SCBA manufacturer's instructions to determine pass/fail.

6-8 Particulate Test.

6-8.1 A fully charged SCBA shall be subjected to Method 510.3, Sand and Dust, Section II-3, Procedure 1, of MIL-STD-810E, *Environmental Test Methods*.

6-8.2 The facepiece of the SCBA being tested shall be secured to a test headform as specified in 6-1.1.

6-8.3 The test headform shall be joined to a mannequin with the remaining components of the SCBA attached to the mannequin to simulate its typical wearing position on a fire fighter, as specified by the manufacturer.

6-8.4 The test headform shall be connected, as specified in Section 6-1, to a Model 327-6 breathing machine or other respiration simulator producing a minute volume of 40 L, ±2 L at ambient conditions, as specified in 6-1.13, with a minimum tidal volume of 1.6 L per breath at a minimum respiration of 10 breaths per min.

6-8.5 The mannequin, including the test headform, shall be mounted upright and turned about its vertical axis 180 degrees midway through the test. The test duration shall be 1 hour, and the breathing machine shall be operating throughout the entire test. The test shall be permitted to be interrupted to change the SCBA breathing gas cylinder.

6-8.6 The test conditions as outlined per Method 510.3, Sand and Dust, of MIL-STD-810E, *Environmental Test Methods*, Section I-3d, shall be the following:

(a) Air velocity: 1750 ft/min, ±250 ft/min (533.4 m/min, ±76.2 m/min)

(b) Temperature: 72°F, ±5°F (22°C, ±3°C)

(c) Test item configuration and orientation: mannequin upright and rotated 180 degrees midway through the test

(d) Dust composition: refer to Section I-3.2d (1)

(e) Dust concentration: refer to Section I-3.2e (1)

(f) Test duration: 1.0 hour.

6-8.7 After the completion of the above test, the SCBA shall be removed from the test compartment. It shall be lightly shaken or brushed free of dust and then shall be tested as specified in Section 6-1 to determine pass/fail.

6-9 Facepiece Lens Abrasion Test.

6-9.1 The test apparatus shall be constructed in accordance with Figure 6-9.1.

6-9.2 Seven samples shall be chosen from a minimum of three facepiece lenses. Four samples shall be taken from the left viewing area, and three samples shall be taken from the right viewing area. One of the four samples taken from the left viewing area shall be the set-up sample.

6-9.2.1 The left test samples shall include all of the following criteria:

(a) The sample shall be a square measuring 2 × 2 in. (51 × 51 mm).

(b) 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 sample.

(c) At least $1^1/_2$ in. (38 mm) of the 2 × 2-in. (51 × 51-mm) square shall be taken from the left side of the center line of the lens.

(d) The 2 × 2-in. (51 × 51-mm) square shall be cut at approximately eye level.

6-9.2.2 The right test samples shall include all of the following criteria:

(a) The sample shall be a square measuring 2 × 2 in. (51 × 51 mm).

(b) 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 sample.

(c) At least $1^1/_2$ in. (38 mm) of the 2 × 2-in. (51 × 51-mm) square shall be taken from the right side of the center line of the lens.

(d) The 2 × 2-in. (51 × 51-mm) square shall be cut at approximately eye level.

6-9.3 Each of the samples shall be cleaned in the following manner:

(a) The sample shall be rinsed with clean tap water.

(b) The sample shall be washed with a solution of nonionic/low-phosphate detergent and water using a clean, soft gauze pad.

(c) The sample shall be rinsed with deionized water.

(d) The sample shall be blown dry with clean compressed air or nitrogen.

6-9.4 The haze of the sample 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:

(a) The haze shall be measured in the middle of the sample $\pm^1/_{16}$ in. (±1.6 mm).

(b) The sample shall be repositioned to achieve the maximum haze value within the area defined in (a).

(c) The haze meter shall have a specified aperture of $^7/_8$ in. (22.4 mm).

(d) The haze meter shall have a visual display showing 0.1 percent resolution.

(e) 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.*

6-9.5 The set-up sample shall be placed cover side up in the test apparatus sample holder. The sample holder shall be configured with a flat surface under the lens or with an inner radius support.

6-9.6 The pad holder shall consist of a cylinder $^3/_8$ in. (9.6 mm) high and 1 in. (25.4 mm) 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.

6-9.7 The pad shall be a Blue Streak M306M wool felt polishing pad $^{15}/_{16}$ in. (23.8 mm) in diameter.

6-9.8 The abrasive disc shall be made from 3M Part Number 7415, Wood Finishing Pad. A disc $^{15}/_{16}$ in. (23.8 mm) in diameter shall be cut from the abrasive sheet. The marked side of the disc shall be placed against the pad. Care shall be exercised to maintain this orientation for each abrasive disc throughout the testing.

6-9.9 The pad holder, pad, and abrasive disc shall be installed on the stroking arm. The stroking arm shall be leveled to ±3 degrees by adjusting the threaded pin. The pin shall be secured to prevent rotation of the pad holder. The axis of curvature of the pad holder shall be coincident with the axis of curvature of the lens.

6-9.10 The stroking arm shall be counterbalanced with the pad holder, pad, and abrasive disc in place.

6-9.11 The set-up sample shall be replaced with one of the six samples to be tested.

6-9.12 The 2.2-lb, ±0.18 lb (1000-g, ±5 g) test weight shall be installed on the pin above the test sample.

6-9.13 The test shall be run for 200 cycles, ±1 cycle. One cycle shall consist of a complete revolution of the eccentric wheel.

6-9.14 The length of stroke shall be $^9/_{16}$ in. (14.4 mm), producing a pattern $1^1/_2$ in. (38.1 mm) long. The frequency of the stroke shall be 60 cycles, ±1 cycle per min. The center of the stroke shall be within $\pm^1/_{16}$ in. (±1.6 mm) of the center of the sample.

6-9.15 The sample shall be removed and cleaned following the procedure specified in 6-9.3. The abrasive disc shall be discarded.

6-9.16 The haze of the sample shall be measured following the procedure specified in 6-9.4.

6-9.17 The delta haze shall be calculated by subtracting the initial haze from the final haze.

6-9.18 The testing steps specified in 6-9.3 through 6-9.17 shall be repeated five times with a new sample and abrasive disc.

6-9.19 The six delta haze values shall be averaged. The resultant value shall be compared to the value specified in 5-9.1 to determine pass/fail.

6-10 Communication Test.

6-10.1 The method for measuring word intelligibility shall be as specified in ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems,* as modified by the following requirements.

6-10.2 Testing shall be conducted in a chamber that absorbs a minimum of 90 percent of all sound from 500–5000 Hz.

6-10.3 Five listening subjects and five talkers consisting of four males and one female shall be available for testing. The subjects participating as listeners 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.* Talkers and listeners shall be selected and trained according to Section 7 of ANSI S3.2.

6-10.4 The five talkers shall not have facial hair, any unusual facial characteristics, or any other condition that could cause interference with the seal of the facepiece. The talkers shall perform and pass a qualitative facepiece-to-face fit check per the SCBA manufacturer's instructions. If the talker is qualified to wear several sizes of facepieces, then the talker shall choose the facepiece that is most comfortable.

6-10.5 The five talkers shall be trained in the donning and usage of the SCBA per manufacturer's instructions.

6-10.6 The five talkers shall have no obvious speech defect or strong regional accent. Distance between the talker and listener(s) shall be 5 ft, +1/−0 ft (1.5 m, +30.5/−0 cm), and they shall be facing each other.

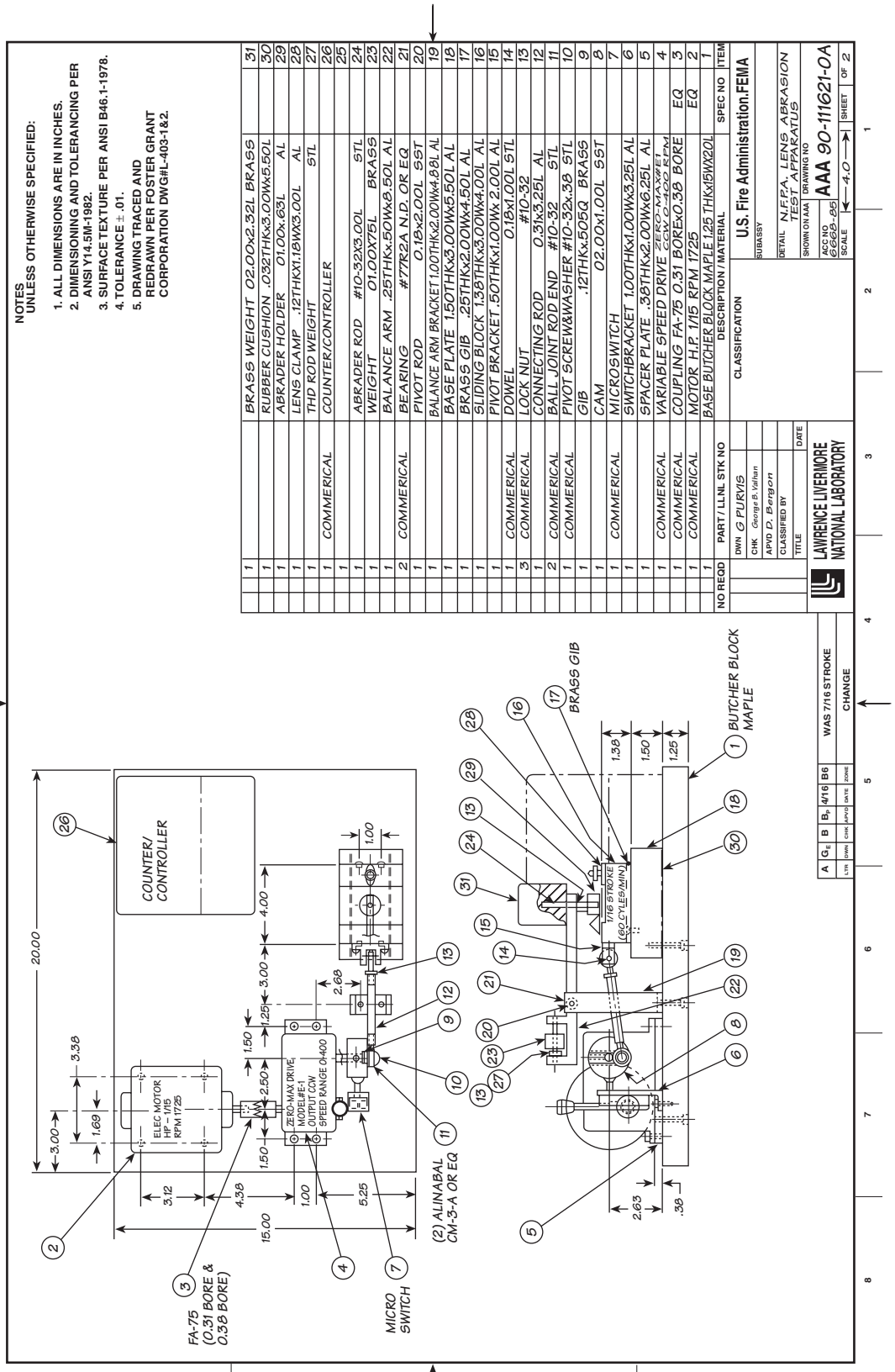


Figure 6-9.1 Lens abrasion tester.

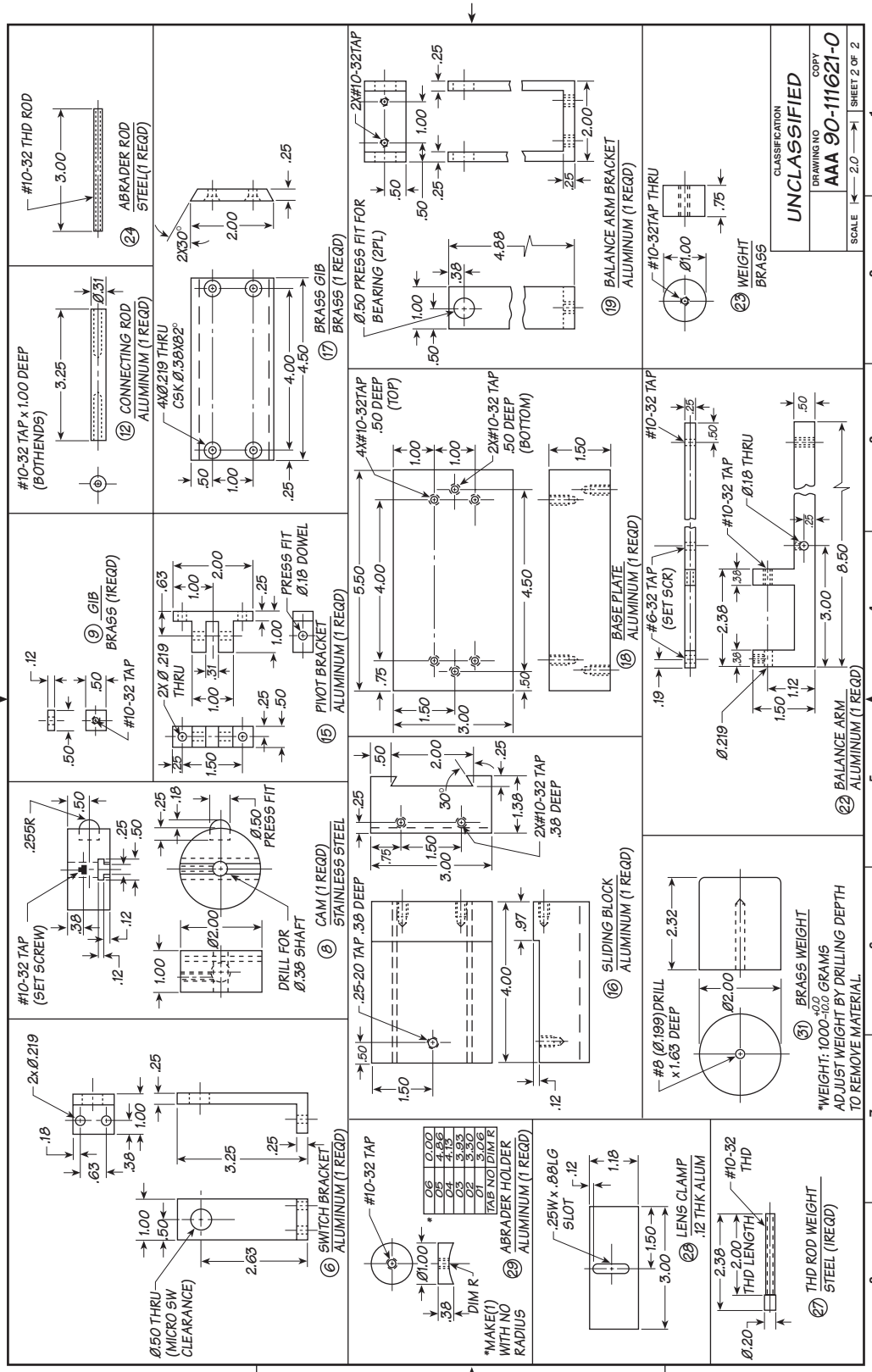


Figure 6-9.1 Lens abrasion tester. ***(continued)***.

6-10.7 The test material shall be the reading of one complete list of phonetically balanced words as contained in Table 1 of ANSI S3.2, *Method for Measuring the Intelligibility of Speech over Communication Systems*. The words shall be spoken singularly in the following carrier sentence: "Would you write (list word) now?" The rate shall be approximately one test word every six seconds. The talkers shall be trained to talk at 65–75 dBA without an SCBA facepiece, measured at the listener's ear, placing no unusual stress on any word. Training shall include the use of background noise as defined in 6-10.9. The talkers shall not vary their voice level after the facepiece is donned from that used without the facepiece. The listeners shall write each word as they hear it.

6-10.8 The talkers shall conduct two tests in the chamber having an ambient noise field as specified in 6-10.9, using a different word list for each of the following conditions:

(a) With no SCBA

(b) With SCBA worn and operated per the SCBA manufacturer's instructions

6-10.9 The test chamber shall be filled with broadband "pink" noise with a tolerance of 6 dB per octave band from 400–4000 Hz. The forward axis of the loudspeaker shall be oriented away from the listener group. The distance between the loudspeaker and the listeners shall be as great as possible so as to create a quasiuniform sound field over the listening group. More than one loudspeaker shall be permitted to be used to achieve the desired sound field. The gain of the power amplifier shall be adjusted to achieve an A-weighted sound level of 60 dB, ±2 dB at each listener's head position, without listeners present.

6-10.10 Each listener's response form shall be scored as to the number of correct responses out of the 50 words recited. Talkers' speech shall be recorded or monitored closely during the tests to determine if the talkers conform to the word list specified for that test. Listeners' scores shall be based on the words actually spoken by the talkers. Listeners' scores shall not be reduced because of speaking mistakes of the talkers or spelling errors that are phonetically correct.

6-10.11 All of the listeners' scores without the SCBA used by the talker shall be averaged. All of the listeners' scores with the SCBA used by the talker shall be averaged. The average score of the five listeners for the talker using the SCBA shall be divided by the average score of the five listeners for the talker without using the SCBA, and the result shall be called the "score value". This procedure shall be performed for each of the five talkers.

6-10.12 The average of the score values obtained in 6-10.11 shall be calculated.

6-10.12.1 If the average of the score values > 72 percent, this average score value shall be used to determine pass/fail as specified in Section 5-10.

6-10.12.2 If the average of the score values < 72 percent, the sample standard deviation (*s.d.*) of the score values shall be calculated in the following manner

$$s.d. = \sqrt{\frac{\Sigma x^2 - \left(\frac{\Sigma x}{N}\right)^2}{N-1}}$$

where:

x = score values

N = sample size (5)

6-10.12.3 If the calculated sample standard deviation of the test score values > 10.0, the test shall be invalidated, and the procedures of 6-10.7 through 6-10.12.6 shall be repeated.

6-10.12.4 If the calculated sample standard deviation of the test score values < 10.0, a test statistic T value shall be calculated to determine if the average of the score values obtained is or is not equivalent to 72 percent; it shall be calculated in the following manner:

$$T = \frac{(\mu - \bar{X})\sqrt{N}}{s.d.}$$

where:

$\bar{X}$ = average of the score values

N = sample size (5)

μ = 72 percent

$\overline{s.d.}$ = sample standard deviation

6-10.12.5 For T values ≤ 2.13, the score value shall be considered to be equivalent to a score value of 72 percent and shall be used to determine pass/fail as specified in Section 5-10.

6-10.12.6 For T values > 2.13, the score value shall be as calculated in 6-10.12. This calculated score value shall be used to determine pass/fail as specified in Section 5-10.

6-11* Heat and Flame Test.

6-11.1 A test mannequin meeting the requirements specified in Figure 6-11.1 shall be provided.

6-11.2* The test mannequin shall have a protective covering. The protective covering shall be designed and constructed as follows.

6-11.2.1 The assembled protective covering composite consisting of an outer shell, moisture barrier, and thermal liner shall have an average Thermal Protective Performance (TPP) of not less than 35.0 when tested in accordance with Section 5-2, Thermal Protective Performance Test, of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*.

6-11.2.2 The outer shell shall be 40 percent PBI®/60 percent Kevlar® ripstop weave, weighing approximately 7.5 oz/yd² (255 g/m²), with a water-repellent finish. Color shall be natural and undyed.

6-11.2.3 The thermal liner shall be constructed of a 3.0-oz/yd² (102-g/m²) ripstop pajama check Nomex® III facecloth quilt-stitched to 100-percent Nomex® III batting of approximately 6.0 oz/yd² (204 g/m²).

6-11.2.4 The moisture barrier shall be constructed of approximately 2.25-oz/yd² (76-g/m²) polyester/cotton fabric that is coated with approximately 6.5 oz/yd² (221 g/m²) of flame-resistant neoprene.

6-11.2.5 The moisture barrier shall be completely sewn to the thermal liner at its perimeter with the neoprene side facing outward from the thermal liner. All edges shall be sewn together and bound with nonwicking moisture barrier material. The liner/moisture barrier shall be no more than 3 in. (76 mm) from the coat hem.

6-11.2.6 The moisture barrier and thermal liner shall be completely detachable from the outer shell.

NOTES
Unless otherwise specified:
1. All dimensions are in inches.
2. Dimensioning and tolerancing per ANSI Y14.5M–1982.
3. Surface texture per ANSI B46.1–1978.
4 ⚠ 4 x 0.197 +.010 −.002 THRU ITEM 11, MATCH DRILL FROM ITEMS 13 & 14 FOR ITEM 32.

NO REQD	PART/UNL STK NO	DESCRIPTION/MATERIAL	SPEC NO.	ITEM
A/R		TUBE, 5/5TL, 1/4 O.D.		36
1		CLAMP, AEROSEAL, O 1/2		35
1	SWAGELOK-400-6	UNION, 1/4 TUBE CRES		33
12		SCR, #8-32 UNC-2A RD HD X 3/8 LG CRES		32
1		CLAMP, AEROSEAL, O 1/2 CRES		31
A/R		TUBE, PVC REINFORCED 1/4 I.D.	9330-51405	30
5	SWAGELOK-600-1-2	MALE CONNECTOR, 3/8 TUBE X 1/8 NPT CRES		29
A/R		TUBE, 0.375 X .035 W. CRES	4710-14193	28
1	ARO CORP	SNUBBER		27
12		SCR, 1/4-20 UNC-2A SOC HD X 1.00 LG STL		26
4		STANDOFF, #6-32 THD, X 1.00 LG ALUM	5975-53447	25
4		NUT, HEX, #10-32 UNF-2B STD STL		24
4		SCR, #10-32 UNF-2A SOC HD X 1.50 LG STL		23
4		SCR, #10-32 UNF-2A FLT HD X 1.00 LG STL		22
1	ARO CORP MODEL K21355120A	VALVE		21
1	ARO CORP 0418-1003-080	CYLINDER, AIR, 1 1/8 BORE		20
4		SCR, #6-32 UNC-2A RD HD X 11/2 LG STL		19
4	MARLIN CORP. 1032-6	CONNECTOR, T.C., 6 JACK, 2 HOLE, TYPE K	5935-58196	18
		NUT, HEX, 1/4-20 UNC-2B STD STL		17
12		SCR, 1/4-20 UNC-2A FLT HD X .75 LG STL		16
4		SCR, 1/4-20 UNC-2A SOC HD X .50 LG STL		15
4	90-101459	BRACKET		14
2	90-101473 ⚠	TIE STRAP		13
1	90-101456	HEAD		12
1	90-10146 OR 90-101458	TORSO I OR TORSO II		11
1	89-113884	COLLAR-MOUNT		10
1	89-113883	SHAFT END		9
1	89-111724	MOUNT PLATE, MANNEQUIN		8
4	89-113882	GUIDE VERTICAL		7
1	89-113881	T.C. PANEL		6
1	89-113880	VALVE PLATE		5
2	89-113878	FRAME BAR		4
1	89-113877	MOUNT-AIR CYL.		3
1	89-113876	BASE MOUNT		2
1	89-113879	LIFT PLATE		1

DWN G PURVIS
CHK George B. Vallhan
APVD D. Bergon
CLASSIFIED BY:
TITLE

LAWRENCE LIVERMORE NATIONAL LABORATORY

MAJOR UNIT U.S. Fire Administration FEMA
SUBASSY. NFPA HEAT & FLAME TEST APPARATUS
DETAIL MANNEQUIN ASSY
SHOWN ON AAA | DRAWING NO
3265-30 | AAA 90-101453-0A
SCALE 8.00 | SHEET | OF

Figure 6-11.1 Test mannequin.

6-11.2.7 The protective covering shall be stitched with Kevlar® thread using a minimum of 6–8 stitches per inch (25.4 mm). All major seams shall be double stitched and felled locked with all inside seams to be finished with Kevlar® thread. All stress points shall be reinforced. No metal shall pass from the outside of the protective covering through the moisture barrier and liner to cause the transfer of heat to the mannequin when the protective covering is completely assembled. The protective covering, including the front closure, shall be constructed in a manner that provides secure and complete moisture and thermal protection. If nonpositive fasteners, such as snaps or hook-and-pile tape, are utilized in garment closures, a positive locking fastener, such as hooks and dees or zippers, shall also be utilized. Pockets and fluorescent retroreflective trim shall not be installed.

6-11.2.8 The collar shall be made of four-piece construction consisting of outer shell material on both the back, or outside, and next to the mannequin neck. The two inner layers shall consist of a thermal liner and moisture barrier. No throat strap shall be attached.

6-11.2.9 Sleeve outside seams shall be felled, while inside seams shall be lock stitched.

6-11.2.10 All protective covers shall measure 35 in. (889 mm) long when measured from the center of the back collar seam to the hem. The protective cover size shall be 44-in. (118-mm) chest × 34-in. (864-mm) sleeve.

6-11.2.11 The complete protective covering shall be discarded and shall not be used after three flame exposures of the flame and heat test.

6-11.3 A test headform meeting the requirements specified in 6-1.1 shall be used on the test mannequin.

6-11.4 The test headform shall be attached to the Model 327-6 Breathing Machine as specified in Figures 6-1.12(a), (b), and (c), with the modification that a 0.75-in. (19-mm) ID. breathing hose, not longer than 25 ft (7.6 m), shall be attached to the tee in the breathing machine and the throat tube of the test mannequin headform.

6-11.5 The test headform shall be covered with an undyed aramid hood for protection of the headform during testing. The protective hood shall meet the requirements of Sections 4-5 and 5-5 of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*.

6-11.6 The protective hood, when placed on the test headform, shall not affect the seal of the facepiece to the headform. 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.

6-11.7 The SCBA shall be mounted on the test mannequin to simulate the correct wearing position on a fire fighter as specified by the SCBA manufacturer's instructions.

6-11.8 The facepiece shall be mounted and tested on the test headform as specified in 6-1.1.

6-11.9 The heat and flame test apparatus shall be as specified in Figure 6-11.9.

6-11.10 The test oven shall be a horizontal forced circulating air oven with an internal velocity of 200 linear ft (61 m) per min. The test oven shall have minimum dimensions of 36 depth × 36 width × 48 in. height (914 depth × 914 width × 1.22 m height).

6-11.11 The test oven shall be calibrated using a 30-gauge exposed bead type J iron/constantan wire reference thermocouple that has been calibrated to set the 32.0°F (0.0°C) reference point with an ice bath containing ice and deionized or distilled water. Boiling water shall be used to set the 212°F (100°C) reference value. The reference temperatures shall be corrected to standard temperatures using a barometric pressure correction.

6-11.12 For calibration prior to the heat and flame test, the calibration mannequin, as specified in Figure 6-11.12, shall be exposed to direct flame contact for 10 sec using the heat and flame test apparatus. All peak temperature readings shall be within a temperature range of 1500°F to 2102°F (815°C to 1150°C). The average mean of all peak temperature readings shall be no higher than 1742°F (950°C).

6-11.13 The test oven recovery time, after the door is closed, shall not exceed 1.0 min.

6-11.14 The air flow performance test shall be conducted as specified in 6-1.12 through 6-1.15 herein, with modifications to the ventilation rate specified in 6-11.15 and with test temperatures specified in 6-11.12 and 6-11.15 herein. The air flow performance test shall continue through the drop test as specified in 6-11.19.

6-11.14.1 The variation in pressure extremes caused by the flame and heat test mannequin configuration shall be determined in the following manner. The air flow performance test as specified in Section 6-1 shall be carried out at a ventilation rate of 103 L/min, ±3 L/min, and 40 L/min, ±2 L/min. A second air flow performance test shall be carried out using the configuration specified in 6-11.4 at the same ventilation rates. The difference in pressure between the two tests shall be calculated by subtracting the values obtained using the configuration defined in 6-11.4 from the values obtained using the configuration specified in Section 6-1.

6-11.15 The ventilation rate shall be set at 40 L/min, ±2 L/min, with a respiratory frequency of 12, ±1 breaths/min, at ambient conditions as specified in 6-1.13. The SCBA mounted on the test mannequin shall be placed in the test oven that has been preheated to 203°F, ±4°F (95°C, ±2°C). After the door is closed and the oven temperature recovers to 203°F (95°C), the test exposure time of 15 min shall begin.

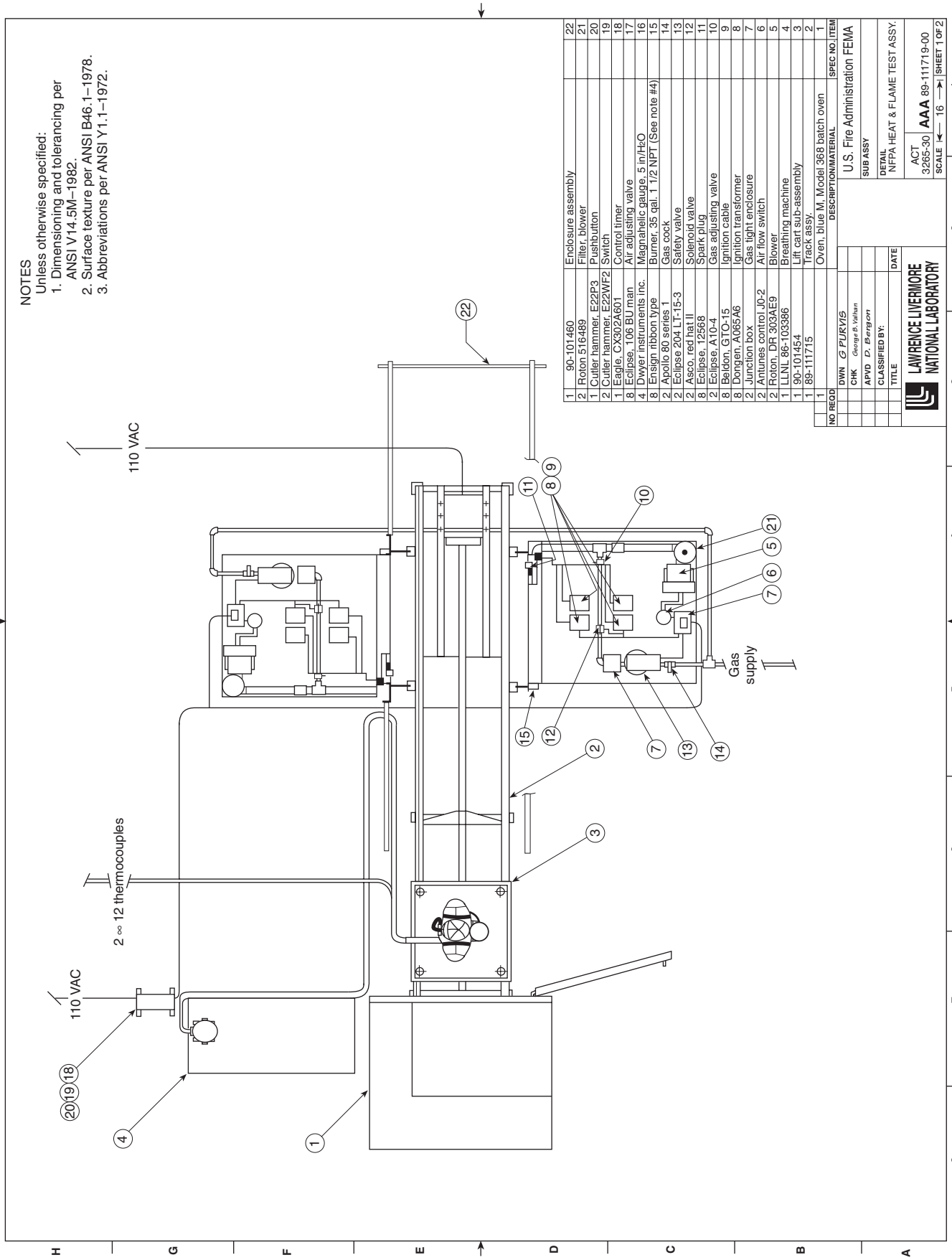
6-11.16 At the completion of the 15-min exposure, the ventilation rate shall be increased to 103, ±3 L/min, as specified in 6-1.12. The oven door shall be opened and the SCBA mounted on the test mannequin shall be moved out of the oven and into the center of the burner array.

6-11.17 The SCBA shall then be exposed to direct flame contact for 10 sec +0.25/-0.0 sec. This exposure shall begin within 20 sec of removal of the SCBA from the test oven.

6-11.17.1 The SCBA shall be observed for any afterflame, and the afterflame duration shall be recorded to determine pass/fail as specified in 5-11.2.

6-11.18 Within 20 sec after completing the direct flame exposure, the SCBA mounted on the test mannequin shall be raised 6 in., +0.25/-0.0 in. (152 mm, +6.3/-0.0 mm) and dropped freely.

6-11.18.1 The SCBA shall be observed to determine pass/fail as specified in 5-11.3.



ITEM	SPEC NO.	DESCRIPTION/MATERIAL	NO REQD
22		Enclosure assembly	1
21		Filter, blower	2
20		Pushbutton	1
19		Switch	2
18		Control timer	1
17		Air adjusting valve	8
16		Magnahelic gauge, 5 in/H2O	4
15		Burner, 35 gal. 1 1/2 NPT (See note #4)	8
14		Gas cock	2
13		Safety valve	2
12		Solenoid valve	2
11		Spark plug	8
10		Gas adjusting valve	2
9		Ignition cable	8
8		Ignition transformer	8
7		Gas tight enclosure	2
6		Air flow switch	2
5		Blower	2
4		Breathing machine	1
3		Lift cart sub-assembly	1
2		Track assy	1
1		Oven, blue M, Model 368 batch oven	1
1	90-101460	Enclosure assembly	
2	Roton 516489	Filter, blower	
1	Cutler hammer, E22P3	Pushbutton	
2	Cutler hammer, E22WF2	Switch	
1	Eagle, CX302A601	Control timer	
8	Eclipse, 106 BU man	Air adjusting valve	
4	Dwyer instruments inc.	Magnahelic gauge, 5 in/H2O	
8	Ensign ribbon type	Burner, 35 gal. 1 1/2 NPT (See note #4)	
2	Apollo 80 series 1	Gas cock	
2	Eclipse 204 LT-15-3	Safety valve	
2	Asco, red hat II	Solenoid valve	
8	Eclipse, 12568	Spark plug	
2	Eclipse, A10-4	Gas adjusting valve	
8	Beldon, GTO-15	Ignition cable	
8	Dongen, A065A6	Ignition transformer	
2	Junction box	Gas tight enclosure	
2	Antunes control J0-2	Air flow switch	
2	Roton, DR 303AE9	Blower	
1	LLNL 86-103386	Breathing machine	
1	90-101454	Lift cart sub-assembly	
1	89-111715	Track assy	

Figure 6-11.9 Heat and flame test apparatus.

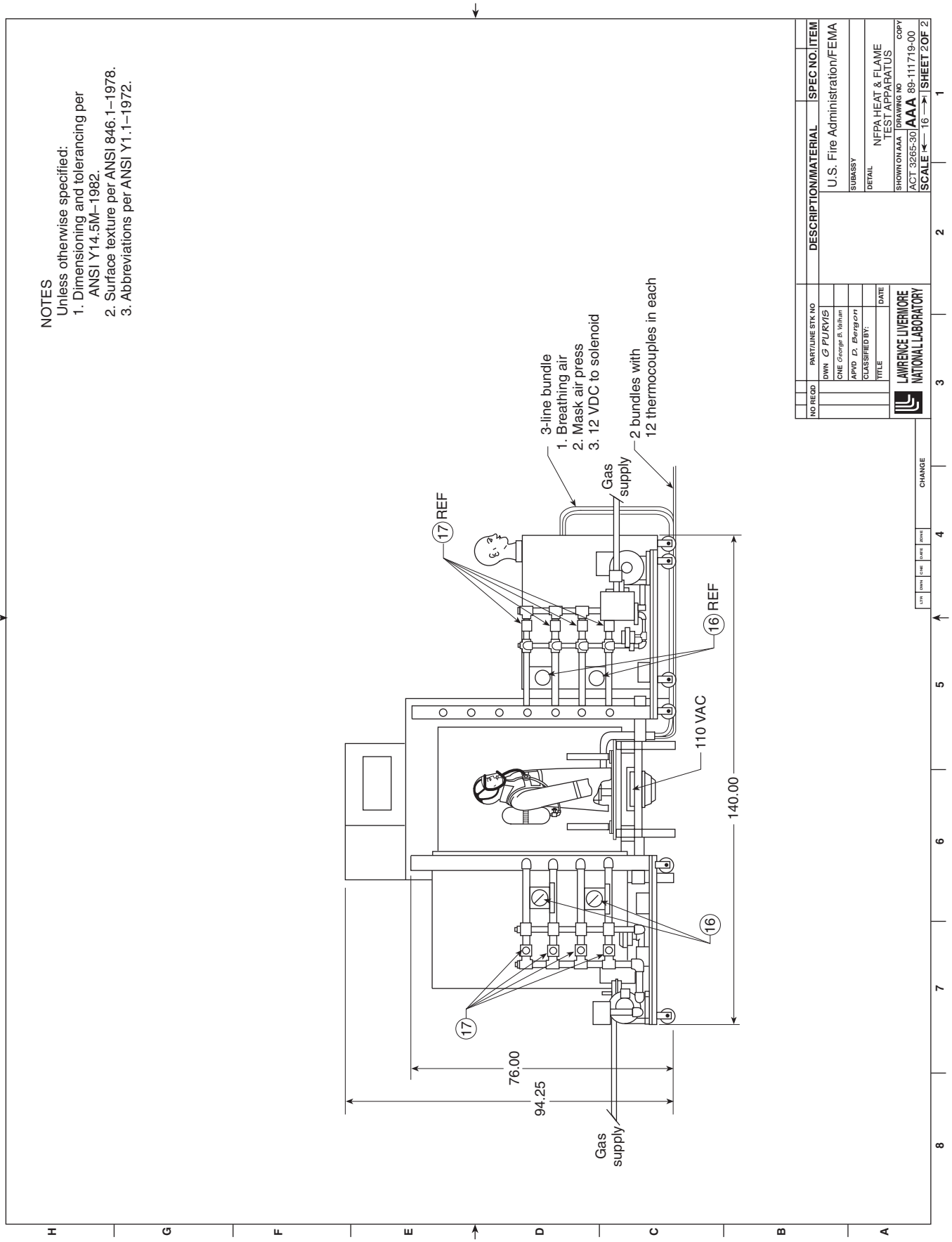


Figure 6-11.9 Heat and flame test apparatus. ***(continued)***.

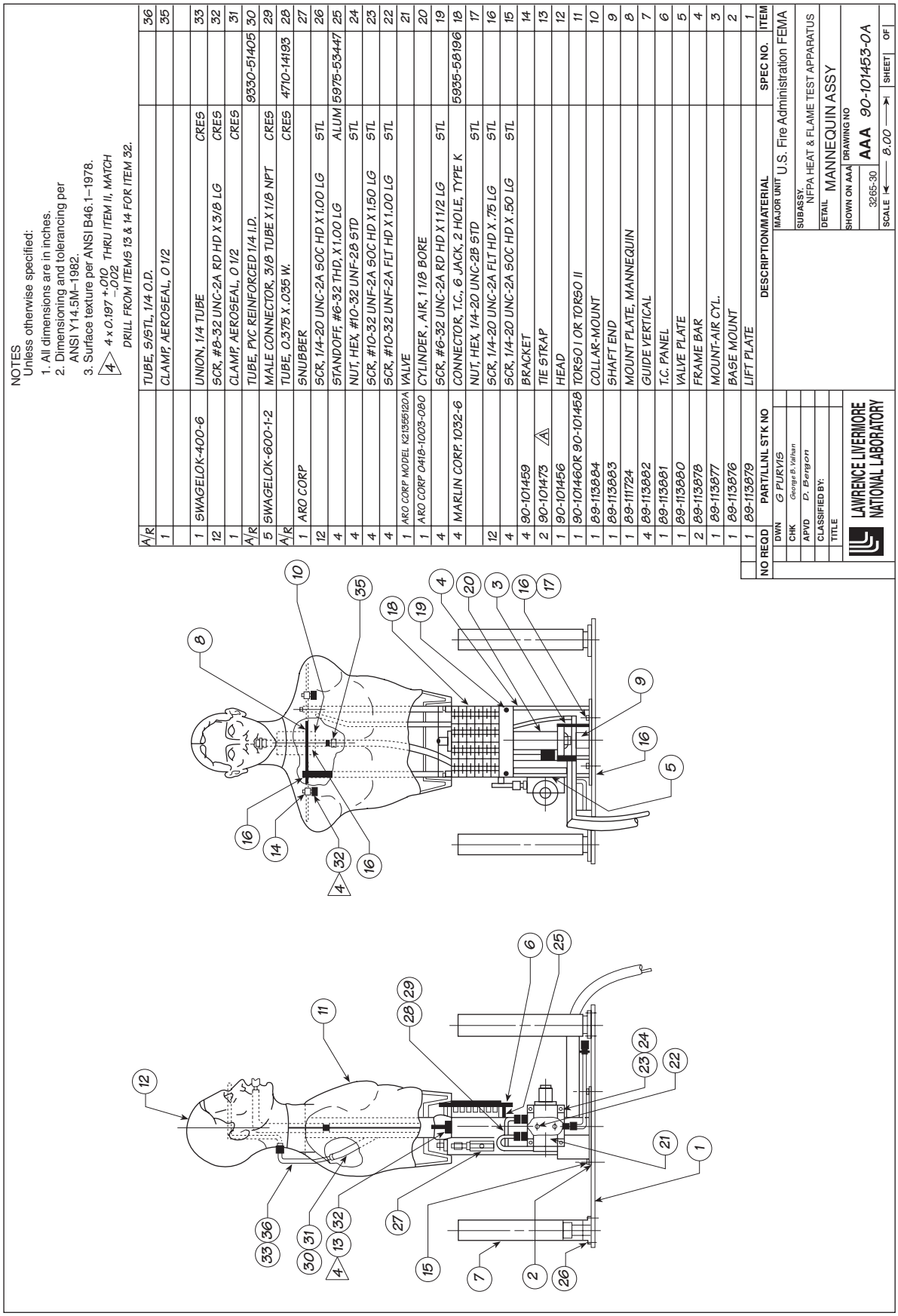


Figure 6-11.12 Calibration mannequin.

6-11.19 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 6-11.14 to determine pass/fail as specified in 5-11.1. 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.

6-11.20 The SCBA facepiece shall be removed from the test headform and, without touching the lens, shall be donned by a test subject with visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses. The test shall be conducted using a standard 20-ft (6.1-m) eye chart with normal lighting range of 100–150 ft-candles at the chart and with the test subject positioned at a distance of 20 ft (6.1 m) from the chart. 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/fail as specified in 5-11.4.

6-11.20.1 The nominal center of the lens shall be the area bounded by a line 2 in. (51 mm) above, 2 in. (51 mm) below, 2 in. (51 mm) left, and 2 in. (51 mm) right of the intersection of the basic and midsagittal planes.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix B.

7-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* 1997 edition.

NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting,* 1997 edition.

7-1.2 ANSI Publications. American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

ANSI/AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics,* 1989.

ANSI/CGA G-7.1, *Commodity Specification for Air,* 1989.

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

ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations,* 1988.

ANSI Z34.1, *American National Standard for Third-Party Certification Programs for Products, Processes, and Services,* 1993.

7-1.3 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics,* 1988

7-1.4 GSA Publication. General Services Administration, Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Plant, Washington, DC 20407.

Federal Test Method Standard 191A, *Textile Test Methods,* 20 July 1978.

7-1.5 ISO Publications. ISO Central Secretariat; 1, Rue de Varembé; Case postale 56; CH 1211 GENÉVE 20; Switzerland.

ISO 9001, *Quality Systems — Model for Quality Assurance in Design, Development, Production, Installation, and Servicing,* 1994.

ISO 9002, *Quality Systems — Model for Quality Assurance in Production, Installation, and Servicing,* 1994.

7-1.6 Navy Publication. Navy Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

MIL-STD-810E, *Environmental Test Methods,* 14 July 1989.

7-1.7 U.S. Government Publication. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Title 42, *Code of Federal Regulations,* Part 84 (42 *CFR* 84), *Respiratory Protective Devices, Tests for Permissibility,* 8 June 1995.

Appendix A Explanatory Material

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

A-1-1.1 The use of self-contained breathing apparatus (SCBA) by fire fighters is always assumed to be in atmospheres immediately dangerous to life or health (IDLH). There is no way to predetermine hazardous conditions, concentrations of toxic materials, or percentages of oxygen in air in a fire environment, during overhaul (salvage) operations, or under other emergency conditions involving spills or releases of hazardous materials. Thus, SCBA are required at all times during any fire-fighting, hazardous materials, or overhaul operations. General use criteria are contained in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.*

A-1-2.1 The following is a brief description of selected performance requirements of this standard:

(a) *Air Flow Performance Test.* This test increases the current NIOSH breathing machine requirement of 40 L/min to 100 L/min. The 100 L/min ventilation rate was derived from a review of several studies indicating that a ventilation rate of 100 standard liters per minute encompasses the 98th percentile of all fire fighters studied.

(b) *Environmental Temperature Resistance Tests.* This series of tests exposes SCBA to various temperature extremes and temperature cycles to which SCBA might be exposed during storage conditions and certain environmental changes.

(c) *Particulate Resistance Test.* This test exposes SCBA to a specified concentration of particulate to provide a reasonable level of assurance that SCBA are designed to properly function when exposed to the dust conditions commonly present during fire-fighting operations.

(d) *Facepiece Lens Abrasion Resistance Test.* This test is designed to provide a reasonable level of assurance that the SCBA facepiece lens is not easily scratched during fire-fighting operations, thereby resulting in reduced visibility for the fire fighter.

(e) *Communications Test.* This test is designed to assure that the SCBA facepiece does not significantly reduce a fire fighter's normal voice communication.