NFPA®

# 1953

## Standard on Protective Ensembles for Contaminated Water Diving

2021

NFPA®

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**Standard on**

# Protective Ensembles for Contaminated Water Diving

**2021 Edition**

This edition of NFPA 1953, *Standard on Protective Ensembles for Contaminated Water Diving*, was prepared by the Technical Committee on Special Operations Protective Clothing and Equipment and released by the Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on March 15, 2020, with an effective date of April 4, 2020, and supersedes all previous editions.

This edition of NFPA 1953 was approved as an American National Standard on April 4, 2020.

## Origin and Development of NFPA 1953

The Technical Committee on Special Operations Protective Clothing and Equipment began the process of creating the first edition of NFPA 1953 in 2008 with a request to the Standards Council. After some clarification, the committee received permission to begin work on a draft, which was completed and approved by the Standards Council in August 2012.

The technical committee developed NFPA 1953 with the goal of establishing protection requirements for protective clothing and equipment to reduce the safety risks and health risks associated with exposure of personnel to the hazards of contaminated water diving.

It is left to emergency services organizations to select the appropriate items for the protection of their emergency responders based on the expected and anticipated contaminated water incidents to which the organizations will or could be expected to respond.

The 2021 edition of NFPA 1953 added a definition for *facility* to match other documents in the standard and language in Chapter 4 to cover manufacturing in multiple facilities. There is also an updated Table 4.4.1 to make the recertification schedule easier to understand and apply. The committee also removed the abrasion resistance test and chemical permeation resistance test for dry suits (but not closure assemblies) and corresponding performance requirements. A corresponding resistance test was added to replace the removed one.

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*This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.*

NOTE: 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.

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

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NOTE: 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.

**Committee Scope:** This Committee shall have primary responsibility for documents on special operations protective clothing and protective equipment, except respiratory equipment, that provides hand, foot, torso, limb, head, and interface protection for fire fighters and other emergency services responders during incidents involving special operations functions including, but not limited to, structural collapse, trench rescue, confined space entry, urban search and rescue, high angle/mountain rescue, vehicular extraction, swift water or flooding rescue, contaminated water diving, and air operations.

This Committee shall also have primary responsibility for documents on station/work uniform garments that are not of themselves primary protective garments but can be combined with a primary protective garment to serve dual or multiple functions.

Additionally, this Committee shall have primary responsibility for documents on the selection, care, and maintenance of special operations protective clothing and equipment by fire and emergency services organizations and personnel.

## Contents

NFPA 1953

Standard on

# Protective Ensembles for Contaminated Water Diving

2021 Edition

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

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

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

## Chapter 1 Administration

### 1.1* Scope.

**1.1.1*** This standard shall specify the minimum design, performance, testing, and certification requirements for protective clothing and equipment items, including dry suit, dry suit gloves and dry suit footwear designed to provide limited protection from physical, environmental and certain chemical and biological hazards that are listed herein for emergency services personnel during contaminated water dive operations.

**1.1.2*** This standard shall specify requirements for protective clothing and protective equipment used during operations in contaminated water dive operations.

**1.1.3** This standard shall not specify requirements for protective clothing and protective equipment used during operations in surface water, swift water, tidal water, surf, and ice.

**1.1.4*** This standard shall not specify requirements for protective clothing and protective equipment for any other technical rescue operation, any fire-fighting operations, or any hazardous materials emergencies.

**1.1.5*** This standard shall specify requirements for any accessories or enhancements built into, attached to, or sold with contaminated water dive operations protective clothing and equipment by the protective clothing and equipment manufacturer for later attachment, and shall be tested with the protective clothing and equipment with the accessories and enhancements installed or attached, to assure the performance and functions of the contaminated water dive operations protective clothing and equipment.

**1.1.6** This standard shall not be construed as addressing all of the safety concerns associated with the use of compliant contaminated water dive operations protective clothing and equipment. It shall be the responsibility of the persons and organizations that use compliant contaminated water dive operations protective clothing and equipment to establish safety and health practices and to determine the applicability of regulatory limitations prior to use.

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

**1.1.8** Certification of contaminated water dive operations protective clothing and equipment to the requirements of this standard shall not preclude certification to additional appropriate standards where the protective clothing or equipment meets all the applicable requirements of each standard.

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

### 1.2 Purpose.

**1.2.1*** The purpose of this standard shall be to establish minimum levels of protection for emergency services personnel assigned to or involved in performing search and rescue activities in and below the surface of contaminated water.

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

**1.2.3*** This standard is not intended as a detailed manufacturing or purchase specification, but shall be permitted to be referenced in purchase specifications as minimum requirements.

### 1.3 Application.

**1.3.1** This standard shall apply to the design, manufacture, and certification of new contaminated water dive operations protective clothing and equipment.

**1.3.2** This standard shall not apply to any contaminated water dive operations protective clothing and equipment manufactured to the requirements of any other organization's standards.

**1.3.3** This standard shall not apply to the use of any contaminated water dive operations protective clothing and equipment, as such use requirements for fire departments are specified in NFPA 1500 and the use requirements specified by other emergency services organizations.

**1.3.4** This standard shall apply to protective clothing and protective equipment used during contaminated water dive operations.

**1.3.5** This standard shall not apply to protective clothing and protective equipment for operations in surface water, swift water, tidal water, surf, and ice.

**1.3.6** This standard shall not apply to protective clothing and protective equipment for any other technical rescue operation, any fire-fighting operations, or any hazardous materials emergencies.

**1.3.7** This standard shall not apply to protection from all biological agents or to protection from all hazardous chemicals.

**1.3.8*** This standard shall apply to any accessories or enhancements built into, attached to, or sold with the contaminated water dive operations protective clothing and equipment by the protective clothing and equipment manufacturer for later attachment, and shall be tested with the protective clothing and equipment with the accessories and enhancements installed or attached, to assure the performance and functions of the contaminated water dive operations protective clothing and equipment.

**1.4* Units.**

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

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

## Chapter 2 Referenced Publications

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

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

NFPA 1500™, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*, 2020 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, 2017 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incidents*, 2018 edition.

**2.3 Other Publications.**

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

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

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

ASTM B117, *Standard Practice of Using Salt Spray (Fog) Apparatus*, 2018.

ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*, 2016a.

ASTM D751, *Standard Test Methods for Coated Fabrics*, 2019.

ASTM D2061, *Standard Test Methods for Strength Tests for Zippers*, 2013.

ASTM D2062, *Standard Test Methods for Operability of Zippers*, 2014.

ASTM D2582, *Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting*, 2016.

ASTM D3884, *Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, 2017.

ASTM D3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*, 2015.

ASTM D4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, 2017.

ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)*, 2016.

ASTM D5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*, 2015.

ASTM E810, *Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry*, 2013.

ASTM F392/F392M, *Standard Practice for Conditioning Flexible Barrier Materials for Flex Durability*, 2015.

ASTM F739, *Standard Test Method for Permeation of Liquids and Gases Through Protective Clothing Materials Under Conditions of Continuous Contact*, 2012e1.

ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, 2018.

ASTM F1101, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*, 2017.

ASTM F1342/F1342M, *Standard Test Method for Protective Clothing Material Resistance to Puncture*, 2013.

ASTM F1671/F1671M, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood- Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System*, 2013.

ASTM F1790/F1790M, *Standard Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing with CPP Test Equipment*, 2015.

ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester*, 2019.

**2.3.3 CAN/CGSB Publications.** Canadian General Standards Board, Public Works and Government Services Canada, 11 Laurier Street, Phase III, Place du Portage, Gatineau, QC K1A 0S5, Canada.

CAN/CGSB-65.16, *Immersion Suit Systems*, 2005.

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

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

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*, 2015.

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

ISO 17011, *Conformity assessment — Requirements for accreditation bodies accrediting conformity assessment bodies*, 2017.

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

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, 2017.

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

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

ANSI/UL 1197, *Standard for Immersion Suits*, 2013.

**2.3.6 US Government Publications.** US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 46, Code of Federal Regulations, Part 164.018, "Retroreflective Material for Lifesaving Equipment."

**2.3.7 Other Publications.**

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

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

## Chapter 3 Definitions

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

**3.2 NFPA Official Definitions.**

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

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

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

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

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

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

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

**3.3 General Definitions.**

**3.3.1 Bootie.** A sock-like extension of the dry suit leg that covers the entire foot.

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

**3.3.3 Closure.** The component that allows the wearer to enter (don) and exit (doff) the dry diving suit.

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

**3.3.5 Compliant Product.** Product that is covered by this standard and has been certified as meeting all applicable requirements of this standard that pertain to the product.

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

**3.3.7 Composite.** The layer or layers of materials or components.

**3.3.8 Contaminated Water.** A body of water that potentially contains a chemical or biological substance that poses a chronic or acute health risk to exposed personnel.

**3.3.9 Diving Helmet.** Headgear that provides protection from contaminated water by sealing the diver's entire head from the water while incorporating the breathing system.

**3.3.10 Dry Suit.** A suit that provides exposure protection for contaminated water operations.

**3.3.10.1** ***Dry Suit Closure Assembly.*** The combination of the dry suit closure and the seam attaching the dry suit closure to the dry suit, excluding any protective flap or cover.

**3.3.10.2*** ***Dry Suit Footwear.*** The portion of the dry suit ensemble for contaminated water diving that is designed to provide protection to the foot, ankle, and lower leg.

**3.3.10.3** ***Dry Suit Overboot.*** A secondary boot worn over an integrated attached bootie.

**3.3.11 Exhaust Valve.** Device used to allow for removal air from the dry suit.

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

**3.3.13 Full-Face Diving Mask.** A type of diving mask that seals the whole of the diver's face from the water and contains a mouthpiece or diving valve that provides the diver with breathing gas allowing the diver see clearly underwater, providing the diver's face with some protection from cold and polluted water, increasing breathing security and providing a space for equipment that lets the diver communicate with the surface support team.

**3.3.14 Glove.** An item of protective clothing used with contaminated water dry suits that are designed to provide minimum protection to fingers, thumb, hand, and wrist.

**3.3.15 Hardware.** Nonfabric components of the protective clothing and equipment including, but not limited to, those made of metal or plastic.

**3.3.16 Inlet Valve.** Device used to allow for addition of air into the dry suit.

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

**3.3.18 Manufacturing Facility.** A facility that is involved in the production, assembly, final inspection, or labeling of the compliant end product.

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

**3.3.20* Moderate Contamination.** Contaminated water where increased levels of chemical and/or biological contamination are anticipated to be found: poses a moderate heath risk to the rescuer if not properly protected.

**3.3.21 Neck Seal.** A device used for preventing water from entering the dry suit at the neck.

**3.3.22 Penetration.** For a protective clothing material or item the process by which a substance moves through closures, seams, interstices, and pinholes or other imperfections on a non-molecular level.

**3.3.23* Permeation.** The process by which a chemical moves through a protective clothing material on a molecular level.

**3.3.24 Product.** See 3.3.5, Compliant Product.

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

**3.3.26 Reinforcement.** An area of added mechanical protection.

**3.3.27 Retroreflection/Retroreflective.** The reflection of light in which the reflected rays are preferentially returned in the direction close to the opposite of the direction of the incident rays, with this property being maintained over wide variations of the direction of the incident rays.

**3.3.28 Sample.** The equipment, equipment component, ensemble, element, item, component, or composite that is conditioned for testing. (*See also 3.3.31, Specimen.*)

**3.3.29 Seam.** Any permanent attachment of two or more materials, in a line formed by joining the separate material pieces.

**3.3.30* Severe Contamination.** Grossly contaminated water with highly concentrated chemical and/or biological contamination: poses an immediate and/or severe health risk to rescuers if not fully encapsulated.

**3.3.31 Specimen.** The conditioned equipment, equipment component, ensemble, element, product, item, composite, component, or opposite that is tested. Specimens are taken from samples. (*See also 3.3.28, Sample.*)

**3.3.32 Suit.** See 3.3.10, Dry Suit.

**3.3.33 Suit Material.** The primary protective principal material(s) used in the construction of contaminated water dry suits.

**3.3.34 Trim.** See 3.3.35, Visibility Markings.

**3.3.35 Visibility Markings.** Retroreflective enhancements that improve nighttime conspicuity and fluorescent enhancements that improve daytime conspicuity.

**3.3.36 Wrist Seal.** A device used for preventing water from entering the dry suit at the wrist.

## Chapter 4 Certification

### 4.1 General.

**4.1.1** The process of certifying contaminated water dive operations protective clothing and equipment as compliant with NFPA 1953 shall meet the requirements of Section 4.1, General, through Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

**4.1.2** All compliant contaminated water dive operations protective clothing and equipment that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

**4.1.3** All certification shall be performed by a certification organization that meets at least the requirements specified in Section 4.2, Certification Program, and that is accredited for personal protective equipment (PPE) in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services.* The accreditation shall be issued by an accreditation body operating in accordance with ISO 17011, *Conformity assessment — Requirements for accreditation bodies accrediting conformity assessment bodies.*

**4.1.4*** Manufacturers shall not claim compliance with portions or segments of the requirements of this standard and shall not use the NFPA name or the name or identification of this standard, NFPA 1953, in any statements about their respective item(s) unless the item(s) is certified as compliant to this standard.

**4.1.5** All compliant protective clothing and equipment shall be labeled.

**4.1.6** All compliant contaminated water dive protective clothing and equipment items shall be listed by the certification organization. This listing shall uniquely identify the certified product, for example, by style, model number, or part number.

**4.1.7** All compliant contaminated water dive protective clothing and equipment items shall also have a product label that meets the requirements specified in Section 5.1, Product Label Requirements.

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

**4.1.9** The certification organization shall not issue any new certifications to the 2015 edition of NFPA 1953 on or after the NFPA effective date for the 2021 edition.

**4.1.10** The certification organization shall not permit any manufacturer to continue to label any protective ensembles or ensemble elements that are certified as compliant with the 2015 edition of NFPA 1953 plus 12 months.

**4.1.11** The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2015 edition of NFPA 1953 from all protective ensembles and ensemble elements that are under the control of the manufacturer on the effective date of this standard plus 12 months.

### 4.2 Certification Program.

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

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

**4.2.3** The certification organization shall be accredited for PPE in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services.* The accreditation shall be issued by an accreditation body operating in accordance with ISO 17011, *Conformity assessment — Requirements for accreditation bodies accrediting conformity assessment bodies.*

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

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

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

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

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

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

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

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

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

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

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

**4.2.9*** The certification organization shall have a follow-up inspection program of the manufacturer's manufacturing facilities of the compliant product with at least two random, unannounced visits per 12-month period to verify the product's continued compliance. Where portions of the production processes are carried out by multiple facilities, the certification organization shall determine the appropriate follow-up program according to the facility or facilities that most closely meet the definition of *manufacturing facility (see 3.3.18)*.

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

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

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

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

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

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

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

**4.3 Inspection and Testing.**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**4.3.9** Testing to determine product compliance with the performance requirements specified in Chapter 7 shall be conducted by the certification organization in accordance with the specified testing requirements of Chapter 8.

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

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

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

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

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

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

**4.3.14** The certification organization shall test an ensemble element with the specific ensemble(s) with which it is to be certified.

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

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

**4.4 Annual Verification of Product Compliance.**

**4.4.1** All products that are labeled as being compliant with this standard shall undergo recertification on an annual basis. This recertification shall include the following:

(1) Inspection and evaluation to all design requirements as required by the standard on all manufacturer models and components

(2) Testing to all performance requirements as specified in Table 4.4.1 on all manufacturers' models and components within the following protocol:

  (a) Where a test method incorporates testing both before and after the laundering preconditioning specified in 8.1.3 and the test generates quantitative results, recertification testing shall be limited to the conditioning that yielded the worst-case test result during the initial certification for the model or component.

  (b) Where a test method incorporates testing both before and after the laundering preconditioning specified in 8.1.3 and the test generates nonquantitative results, recertifications shall be limited to a single conditioning procedure in any given year. Subsequent annual recertification shall cycle through the remaining conditioning procedure to ensure that all required conditionings are included over time.

  (c) Where a test method requires the testing of three specimens, a minimum of one specimen shall be tested for annual certification.

  (d) Where a test method requires the testing of five or more specimens, a minimum of two specimens shall be tested for annual certification.

**4.4.1.1** This recertification shall include inspection and evaluation to all design requirements and testing to all performance requirements as required by this standard on all manufacturers' models and components as required by 4.4.3.

**4.4.1.2** Any change that affects the product's performance under design or performance requirements of this standard shall constitute a different model.

**4.4.1.3** For the purpose of this standard, models shall include each unique pattern, style, or design of the product.

**4.4.2** Any change that affects the element's performance under the design or performance requirements of this standard shall constitute a different model.

**4.4.3** For the purpose of this standard, models shall include each unique pattern, style, or design of the individual element.

**4.4.4** Samples of manufacturer models and components for recertification shall be acquired as part of the follow-up program in accordance with 4.2.9 and shall be permitted to be used toward annual recertification.

**4.4.5** The manufacturer shall maintain all design, inspection, performance, 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.

**4.5 Manufacturers' Quality Assurance Program.**

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

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

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

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

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

**Table 4.4.1 Recertification Schedule**

| Product/Test | Initial Certification | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| **Wet suit** | | | | | |
| 7.1.1 Overall Donning Efficiency Test | X | | | | |
| 7.1.2 Breaking Strength Test | X | | X | | |
| 7.1.3 Puncture Propagation Tear Resistance Test | X | | | | |
| 7.1.4 Seam/Closure Breaking Strength Test | X | X | X | X | X |
| 7.1.5 Liquid Absorption Resistance Test | X | | | | |
| 7.1.6 Retroreflectivity Test | X | | | | |
| 7.1.7 Zipper Strength Test | X | | | | |
| 7.1.8 Resistance to Twist of Pull and Slider Test | X | | | | |
| 7.1.9 Opening and Closing of Zippers Test | X | | | | |
| 7.1.10 Corrosion Resistance Test | X | | | | |
| 7.1.11 Label Durability and Legibility Test | X | | | | |
| **Ice suit** | | | | | |
| 7.3.1 Overall Liquid Integrity One | X | | | | |
| 7.3.2 Air Retention Test | X | X | X | X | X |
| 7.3.3 Viral Penetration Resistance Test | X | | | | |
| 7.3.4 Overall Donning Efficiency Test | X | | | | |
| 7.3.5 Thermal Insulation Test | X | | X | | |
| 7.3.6 Breaking Strength Test | X | | X | | |
| 7.3.7 Puncture Propagation Tear Resistance Test | X | | X | | |
| 7.3.8 Seam/Closure Breaking Strength Test | X | X | X | X | X |
| 7.3.9 Liquid Absorption Resistance Test | X | | X | | |
| 7.3.10 Liquid Penetration Resistance Test | X | | | | |
| 7.3.11 Retroreflectivity Test | X | | | | |
| 7.3.12 Water Penetration and Air Evacuation Test | X | | | | |
| 7.3.13 Buoyancy Test | X | | | | |
| 7.3.14 Corrosion Resistance Test | X | | | | |
| 7.3.15 Label Durability and Legibility Test | X | | | | |
| 7.3.16 Zipper Point Breaking Strength Test | X | | | | |
| 7.3.17 Zipper Leak Resistance Test | X | X | X | X | X |
| 7.3.18 Opening and Closing of Zippers Test | X | | | | |
| 7.3.19 Zipper Opening and Closing Force Test | X | | | | |
| **Wet suit gloves** | | | | | |
| 7.5.1 Cut Resistance Test | X | | | X | |
| 7.5.2 Puncture Resistance Test | X | | X | | |

*(continues)*

**Table 4.4.1** *Continued*

| Product/Test | Initial Certification | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 7.5.3 Abrasion Resistance Test Two | X | | | X | |
| 7.5.4 Glove Hand Function Test | X | | | | |
| 7.5.5 Grip Test | X | | | | |
| 7.5.6 Glove Donning Test | X | | | | |
| 7.5.7 Corrosion Resistance Test | X | | | | |
| 7.5.8 Label Durability and Legibility Test | X | | | | |
| **Dry suit gloves** | | | | | |
| 7.6.1 Cut Resistance Test | X | | | X | |
| 7.6.2 Puncture Resistance Test | X | | X | | |
| 7.6.3 Abrasion Resistance Test Two | X | | | X | |
| 7.6.4 Glove Hand Function Test | X | | | | |
| 7.6.5 Grip Test | X | | | | |
| 7.6.6 Glove Donning Test | X | | | | |
| 7.6.7 Corrosion Resistance Test | X | | | | |
| 7.6.8 Liquid Penetration Resistance Test | X | | | | |
| 7.6.9 Viral Penetration Resistance Test | X | | | | |
| 7.6.10 Overall Liquid Integrity Test Two | X | | X | | |
| 7.6.11 Label Durability and Legibility Test | X | | | | |
| **PFD** | | | | | |
| 7.10.1 Buoyancy Test – SG3, SG20 of UL 1123 | X | | | | |
| 7.10.2 Label Durability and Legibility Test | X | | | | |
| 7.10.3 Corrosion Resistance Test | X | | | | |
| 6.11.1 Water Entry Test – SG3, SG16 of UL 1123 | X | | | | |
| 6.11.1 Flotation Stability Test – SG3, SG16 of UL 1123 | X | | | | |
| 6.11.1 Buoyancy Distribution Test – SG3, SG19 of UL 1123 | X | | | | |
| 6.11.1 Tensile Strength – SG3, SG24 of UL 1123 | X | | | | |
| 6.11.1 750 Pound Shoulder Tensile Test – SG3, SG10, SG24 of UL 1123 | X | | | | |
| 6.11.1 750 Pound Harness Strength Test (without accelerated weathering) – SG9 of UL 1123 | X | | | | |
| 6.11.1 Pamphlet Strength of Attachment Test – SG3, SG35 of UL 1123 | X | | | | |
| 6.11.1 Pull Toggle Security of Attachment – SG7A of UL 1123 | X | | | | |
| **Helmet** | | | | | |
| 7.4.1 Helmet Bucketing Test | X | | | | |

*(continues)*

**Table 4.4.1** *Continued*

| Product/Test | Initial Certification | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 7.4.2 Top Impact Resistance Test (Force) | X | | | | |
| 7.4.3 Physical Penetration Resistance Test | X | | | | |
| 7.4.4 Suspension System Retention Test | X | | | | |
| 7.4.5 Retention System Test | X | | | | |
| 7.4.6 Corrosion Resistance Test | X | X | X | X | X |
| 7.4.7 Retroreflectivity Test | X | | | | |
| 7.4.8 Label Durability and Legibility Test | X | X | X | X | X |
| 7.4.9 Floatability Test | X | | | | |
| 7.4.10 Impact Resistance Test – Acceleration | X | X | X | X | X |
| 7.4.11 Helmet Roll Off Test | X | | | | |
| 7.4.12 Helmet Water Absorption Test | X | | | | |
| **Dry suit** | | | | | |
| 7.2.1 Air Retention Test | X | X | X | X | X |
| 7.2.2 Overall Liquid Integrity Test One | X | | | | |
| 7.2.3 Overall Donning Efficiency Test | X | | | | |
| 7.2.4 Water Penetration and Air Evacuation Test | X | | | | |
| 7.2.5 Breaking Strength Test | X | | X | | |
| 7.2.6 Puncture Propagation Tear Resistance Test | X | | | | |
| 7.2.7 Cleaning Shrinkage Resistance Test | X | | X | | X |
| 7.2.8 Seam Closure Breaking Strength Test | X | X | X | X | X |
| 7.2.9 Liquid Absorption Resistance Test | X | 3 chem | 3 chem | 3 chem | 3 chem |
| 7.2.10 Liquid Penetration Resistance Test | X | 3 chem | 3 chem | 3 chem | 3 chem |
| 7.2.11 Viral Penetration Resistance Test | X | | | | |
| 7.2.12 Zipper Strength Test | X | | | | |
| 7.2.13 Resistance to Twist of Pull and Slider Test | X | | | | |
| 7.2.14 Opening and Closing of Zippers Test | X | | | | |
| 7.2.15 Zipper Point Breaking Strength Test | X | | | | |
| 7.2.16 Zipper Leak Resistance Test | X | | | | |
| 7.2.17 Zipper Opening and Closing Force Test | X | | | | |
| 7.2.18 Retroreflectivity Test | X | | | | |
| 7.2.21 Corrosion Resistance Test | X | | | | |
| 7.2.24 Label Durability and Legibility Test | X | | | | |
| **Wetsuit footwear** | | | | | |
| 7.8.1 Footwear Drainage Test | X | | | | |
| 7.8.2 Abrasion Resistance Test Two (Upper) | X | | | X | |
| 7.8.3 Cut Resistance Test | X | | | X | |

*(continues)*

**Table 4.4.1** *Continued*

| Product/Test | Initial Certification | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 7.8.4 Puncture Resistance Test (Upper) | X | | X | | |
| 7.8.5 Abrasion Resistance Test Two (Sole) | X | | | X | |
| 7.8.6 Puncture Resistance Test (Sole) | X | | X | | |
| 7.8.7 Slip Resistance Test | X | | | | |
| 7.8.8 Corrosion Resistance Test | | | | | |
| 7.8.9 Label Durability and Legibility Test | | | | | |
| **Ice suit footwear** | | | | | |
| 7.9.1 Abrasion Resistance Test Two (Upper) | X | | | X | |
| 7.9.2 Cut Resistance Test | X | | | X | |
| 7.9.3 Puncture Resistance Test (Upper) | X | | X | | |
| 7.9.4 Abrasion Resistance Test Two | X | | | X | |
| 7.9.5 Puncture Resistance Test (Sole) | X | | X | | |
| 7.9.6 Slip Resistance Test | X | | | | |
| 7.9.7 Liquid Penetration Resistance Test | X | | | | |
| 7.9.8 Viral Penetration Resistance Test | X | | | | |
| 7.9.9 Corrosion Resistance Test | X | | | | |
| 7.9.10 Label Durability and Legibility Test | X | | | | |
| 7.9.11 Thermal Insulation Test | X | | X | | |
| **Dry suit footwear** | | | | | |
| 7.8.1 Footwear Drainage Test | X | | | | |
| 7.8.2 Abrasion Resistance Test Two (Upper) | X | | | X | |
| 7.8.3 Cut Resistance Test | X | | | X | |
| 7.8.4 Puncture Resistance Test (Upper) | X | | X | | |
| 7.8.5 Abrasion Resistance Test Two (Sole) | X | | | X | |
| 7.8.6 Puncture Resistance Test (Sole) | X | | X | | |
| 7.8.7 Slip Resistance Test | X | | | | |
| 7.8.8 Corrosion Resistance Test | X | | | | |
| 7.8.9 Label Durability and Legibility Test | X | | | | |
| **Integrated boot material** | | | | | |
| Abrasion Resistance Test Two (Upper) | X | | | X | |
| Cut Resistance Test | X | | X | | |
| Puncture Resistance Test (Upper) | X | | X | | |
| Abrasion Resistance Test (Sole) | X | | | X | |
| Puncture Resistance Test (Sole) | X | | X | | |
| Slip Resistance Test | X | | | | |
| Corrosion Resistance Test | X | | | | |
| Label Durability and Legibility Test | X | | | | |

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

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

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

**4.6 Hazards Involving Compliant Product.**

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

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

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

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

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

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

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

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

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

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

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

(1) Notifying parties authorized and responsible for issuing a safety alert when, in the opinion of the certification organization, such a notification is necessary to inform the users
(2) Notifying parties authorized and responsible for issuing a product recall when, in the opinion of the certification organization, such a recall is necessary to protect the users
(3) Removing the mark of certification from the product

**4.6.12** Where a hazardous condition exists and it is not practical to implement 4.6.11(1), 4.6.11(2), or 4.6.11(3); or the responsible parties refuse to take corrective action, the certification organization shall notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard.

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

**4.7 Manufacturers' Investigation of Complaints and Returns.**

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

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

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

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

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

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

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

## Chapter 5 Labeling and Information

### 5.1 Product Label Requirements.

**5.1.1*** The protective dry suit shall have a product label or labels permanently and conspicuously located on each product when the product is properly assembled with all layers and components in place.

**5.1.1.1** The dry suit glove labels shall be permitted to be attached to, printed on, or inserted into each package containing one or more pairs of gloves.

**5.1.1.2** The dry suit footwear labels shall be permitted to be attached to, printed on, or inserted into each package containing one or more pairs of gloves.

**5.1.1.3** Where labels are attached to, printed on, or inserted into each package, the individual item shall include a label permanently and conspicuously attached to or printed on each item when properly assembled with all layers, components, and component parts in place. This label shall contain the manufacturer's name, a manufacturer's identification number, lot number, or serial number, the size or size range, the symbol of the certification organization, and the words "NFPA 1953, 2021 ED" on the label.

**5.1.1.4** All letters on labels shall be at least 2.5 mm (3⁄32 in.) high.

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

**5.1.3*** The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label. All letters shall be at least 2.5 mm (3⁄32 in.) high. The label, symbol, or identifying mark shall be at least 6 mm (¼ in.) in height and shall be placed in a conspicuous location.

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

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

**5.1.6** The following statement shall be printed legibly on the product label. The appropriate term for the item type (dry suit, dry suit glove, or dry suit footwear) shall be inserted in this compliance statement text where indicated. All letters shall be at least 2.5 mm (3⁄32 in.) in height.

**"THIS CONTAMINATED WATER DIVING OPERATIONS**

**PROTECTIVE [*insert appropriate item term here*]**

**MEETS THE REQUIREMENTS OF NFPA 1953, *STANDARD ON PROTECTIVE ENSEMBLES FOR CONTAMINATED WATER DIVING*,**

**2021 EDITION.**

**THIS ENSEMBLE PROVIDES PROTECTION AGAINST THE**

**SEVERE X**

**MODERATE __**

**LEVEL OF CONTAMINATION AS DEFINED IN NFPA 1953, 2021 EDITION.**

**DO NOT REMOVE THIS LABEL!"**

**5.1.7** The following compliance statement shall be printed legibly on the product label of the main dry suit. All letters shall be at least 2.5 mm (3⁄32 in.) in height.

**"FOR COMPLIANCE WITH NFPA 1953, 2021 EDITION, THE FOLLOWING**

**COMPONENTS MUST BE WORN IN CONJUNCTION WITH**

**THIS CONTAMINATED WATER DIVING OPERATIONS**

**PROTECTIVE ENSEMBLE: [*list all detachable components here*]."**

**5.1.8** In addition to 5.1.7, where a dry suit consists of multiple layers as described in 6.1.3, the inner suit(s) shall be labeled with the following statement. All letters shall be at least 13 mm (½ in.) in height. This label shall be attached to the outside of the inner suit(s) in a conspicuous position and shall be of a contrasting color to the color of the suit material to which it is attached.

**"AN OUTER GARMENT SHALL BE WORN AS PART**

**OF THIS ENSEMBLE TO MEET THE REQUIREMENTS**

**OF NFPA 1953, 2021 EDITION."**

**5.1.9** The following information shall also be printed legibly on the product label of the main dry suit, dry suit glove, and dry suit footwear. All letters shall be 1.6 mm (1⁄16 in.) in height.

**"THIS CONTAMINATED WATER DIVING OPERATIONS PROTECTIVE ENSEMBLE ALSO MEETS THE OPTIONAL CBRN PROTECTION REQUIREMENTS OF NFPA 1953, 2021 EDITION."**

**5.1.10** The following information shall also be printed legibly on the product label of the main dry suit. All letters shall be at least 1.6 mm (1/16 in.) high.

(1) Manufacturer's name, identification, or designation
(2) Manufacturer's address
(3) Country of manufacture
(4) Manufacturer's identification number, lot number, or serial number
(5) Month and year of manufacture (not coded)
(6) Model name, number, or design
(7) Size
(8) Materials of construction of the composite
(9) Cleaning precautions

**5.2 User Information.**

**5.2.1** The manufacturer shall provide user information including, but not limited to, warnings, information, and instructions with each item.

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

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

**5.2.4*** The item manufacturer shall provide instructions and information regarding at least the following with each item:

(1) Pre-use information, including the following:
   (a) Safety considerations
   (b) Limitations of use
   (c) Marking recommendations and restrictions
   (d) A statement that most performance properties of the item cannot be tested by the user in the field
   (e) Closure lubricants, if applicable
   (f) Warranty information
(2) Preparation for use, including the following:
   (a) Sizing/adjustment
   (b) Recommended storage practices
(3) Inspection, including inspection frequency and details
(4) Don/doff, including the following:
   (a) Donning and doffing procedures
   (b) Sizing and adjustment procedures
   (c) Interface issues
(5) Use, including proper use consistent with national/federal, state/provincial, and local jurisdiction laws/ordinances
(6) For contaminated water dive operations, use consistent with NFPA 1670
(7) For fire departments, use consistent with NFPA 1500
(8) Maintenance and cleaning, including the following:
   (a) Cleaning instructions and precautions with a statement advising users not to use suits that are not thoroughly cleaned and dried
   (b) Inspection details
   (c) Maintenance criteria and methods of repair where applicable
   (d) Decontamination procedures for both chemical and biological contamination
(9) Retirement and disposal, including criteria and considerations
(10) Technical data
   (a) All data required to show compliance with this standard
   (b) Any chemical test data voluntarily made available by the manufacturer in addition to the requirements of this standard

## Chapter 6 Design Requirements

**6.1 Contaminated Water Diving Operations Protective Dry Suit Design Requirements.**

**6.1.1** Protective dry suits shall have at least the applicable design requirements specified in this section when inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

**6.1.2*** Dry suits shall be permitted to be single-layer or multiple-layer suits.

**6.1.3** Where multiple layers are necessary to meet the requirements of this standard, the protective dry suit shall have a means for securing the layers together.

**6.1.4** Protective dry suits shall be designed to completely cover the wearer with the exception of those areas covered by attached gloves and a full-face mask or diving helmet.

**6.1.5*** Where provided, hoods for use with a full-face mask shall be an integral part of the suit body or attached by a separate mechanical means.

**6.1.5.1** The hood shall provide protection to at least the head and neck.

**6.1.5.2** The hood shall provide a means for sealing the mask to the hood in the area of the diver's head.

**6.1.6** Where permitted, the diving helmet interface shall be permitted to be an integral part of the suit body or attached by a separate mechanical means.

**6.1.7*** The wrist and neck seals shall provide a means to prevent contaminated water from entering the suit in the event the glove or hood is breached.

**6.1.8** Protective dry suits shall include footwear meeting the requirements specified in Section 6.3.

**6.1.9** Protective dry suits shall be designed to accommodate permanently attached or detachable gloves meeting the requirements specified in Section 6.2.

**6.1.10** All protective dry suit hardware finish shall be free of rough spots, burrs, or sharp edges.

**6.1.11** Protective dry suit metal components and closure systems shall not come in direct contact with the body.

**6.1.12** Protective dry suits shall be reinforced, at a minimum, at the buttocks, forearms, and knees.

**6.1.13** Where an inlet valve is included on the suit, the inlet valve shall be equipped with a male quick disconnect fitting.

**6.1.13.1** Where included on the suit, the air inlet valve shall be mounted on the front chest area of the torso.

**6.1.14** Where the dry suit is equipped with an exhaust valve, it shall be equipped with an automatic adjustable exhaust valve with double-check protection as a minimum.

**6.1.14.1** Where the dry suit is equipped with an exhaust valve, it shall be mounted on the left arm to facilitate the venting of excess air in the dry suit.

**6.1.14.2** The exhaust valve shall have a diver-operated manual dump feature.

**6.1.15 Visibility Markings.** Where visibility markings are provided for protective dry suits, the markings shall meet the following criteria:

(1) They shall be Type 1 retroreflective material approved by the USCG in accordance with 46 CFR 164.018.
(2) They shall provide visibility of the wearer to include arms, and front and back of the upper torso.
(3) They shall have a minimum area of 0.04 $m^2$ (62 $in^2$).
(4) They shall have a retroreflective surface not less than 25 mm (1 in.) wide.
(5) They shall appear to be continuous for the length of the markings, with gaps between areas of retroreflectivity of not more than 6 mm (¼ in.).

**6.1.16*** Protective dry suits shall be able to fit a wide range of sizes and both genders. This shall be accomplished by providing multiple sizes and/or made-to-order sizes. At a minimum, those sizes shall fit the majority of divers within the following range:

(1) Chest circumferences 30 in. (762 mm) to 60 in. (1524 mm)
(2) Sleeve lengths 24 in. (607 mm) to 38 in. (965 mm)
(3) Waist circumferences 26 in. (660 mm) to 60 in. (1524 mm)
(4) Leg lengths 26 in. (660 mm) to 40 in. (1016 mm)

**6.2 Contaminated Water Diving Operations Protective Dry Suit Glove Design Requirements.**

**6.2.1** Protective dry suit gloves shall have at least the applicable design requirements specified in this section when inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

**6.2.2** Protective dry suit gloves shall consist of a composite that shall be permitted to be configured as a single layer, multiple layers, or multiple gloves that are designed to be worn together. Where the protective dry suit glove is made up of multiple layers or if multiple gloves are used, all layers of the glove or all gloves shall be individually graded per size.

**6.2.3** The protective dry suit gloves shall keep dry and isolate the diver's hands from the diving environment and contaminates.

**6.2.4** The protective dry suit glove shall be attached to the protective dry suit by a mechanical means which insures a dry water tight environment.

**6.2.5** The manufacturer shall provide gloves in not less than four separate and distinct sizes.

**6.2.6** All protective dry suit glove hardware finishes shall be free of rough spots, burrs, or sharp edges.

**6.3 Contaminated Water Diving Operations Protective Dry Suit Footwear Design Requirements.**

**6.3.1** Protective dry suit footwear shall have at least the applicable design requirements specified in this section when inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

**6.3.2** The protective dry suit footwear shall include an integrated attached bootie with a separate overboot or an integrated attached boot.

**6.3.3** Hardware used on protective dry suit footwear shall be free of rough spots, burrs, or sharp edges.

## Chapter 7 Performance Requirements

**7.1 Contaminated Water Diving Operations Protective Dry Suit Ensemble Performance Requirements.**

**7.1.1** Protective dry suits including dry suit gloves and hoods shall be tested for air penetration resistance as specified in Section 8.2, Air Retention Test, and shall not show any sign of leakage.

**7.1.2** Protective dry suit valves shall be tested for watertight integrity as specified in Section 8.3, Exhaust Valve Inward Leakage Test, and shall not show any sign of liquid leakage.

**7.1.3** The seal between the full-face mask and the dry suit hood shall be tested for air retention and watertight integrity as specified in Section 8.26, Hood to Full-Face Diving Mask Seal Test.

**7.1.4** The seal between the helmet and the dry suit shall be tested for air retention and watertight integrity as specified in Section 8.27, Diving Helmet Seal Test.

**7.1.5** Inlet valves shall be tested for retention as specified in Section 8.4, Inlet Valve Pull Test.

**7.1.5.1** The joint between the suit inlet valve and the dry suit shall withstand a pulling force of 500 N.

**7.1.5.2** The suit to valve bond shall not show visible signs of damage.

**7.1.5.3** The suit shall not leak.

**7.1.6** Protective dry suit materials, dry suit bootie materials, attached dry suit boot materials and dry suit hood materials shall be tested for bursting strength as specified in Section 8.5, Burst Strength Test, and shall have a bursting strength greater than 200 N (45 lbf).

**7.1.7** Protective dry suit materials, dry suit bootie materials, attached dry suit boot materials and dry suit hood materials shall be tested for puncture propagation tear resistance as specified in Section 8.6, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 49N (11 lbf).

**7.1.8** Protective dry suit seam assemblies, dry suit bootie seam assemblies, and dry suit hood seam assemblies shall be tested for seam strength as specified in Section 8.7, Seam Breaking Strength Test, and shall have a seam breaking strength of not less than 158N (35 lbf) for each seam type.

**7.1.9** Protective dry suit materials and seams, dry suit bootie material and seams, and dry suit hood materials and seams

shall be tested for liquid permeation resistance after flexing and abrading as specified in Section 8.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 $\mu g/cm^2$.

**7.1.10** Protective dry suit materials and seams, dry suit bootie materials and seams, and dry suit hood materials and seams shall be tested for biopenetration resistance as specified in Section 8.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

**7.1.11** Protective dry suit materials, dry suit bootie materials or attached dry suit boot materials, and dry suit hood materials shall be tested for cut resistance as specified in Section 8.11, Cut Resistance Test, and shall have a cut resistance distance of greater than 25 mm (1 in.).

**7.1.12** Protective dry suit zippers shall be tested for strength as specified in Section 8.13, Zipper Strength Test, and shall have a minimum strength of 222 N (50 lbf).

**7.1.13** Protective dry suit zippers shall be tested for resistance to twist as specified in Section 8.14, Resistance to Twist of Pull and Slider Test, and shall have a minimum force of 0.79 N-m (7 lbf-in.).

**7.1.14** Protective dry suit zippers shall be tested for operability as specified in Section 8.15, Opening and Closing of Zippers Test, and shall have a minimum force of 67 N (15 lbf).

**7.1.15** Protective dry suit zippers shall be tested for point breaking strength as specified in Section 8.16, Zipper Point Breaking Strength Test, and shall have a minimum strength of 440 N (90 lbf).

**7.1.16** Protective dry suit closure assemblies shall be tested for penetration resistance as specified in Section 8.28, Chemical Penetration Resistance Test, and shall show no penetration.

**7.1.17** Protective dry suit exhaust valves shall be tested for liquid penetration resistance as specified in Section 8.25, Chemical Degradation Resistance Test for Exhaust Valves, and shall show no penetration.

**7.1.18** Where protective dry suit visibility markings are specified, the visibility markings shall be tested for retroreflectivity as specified in Section 8.17, Retroreflectivity Test, and shall have a total coefficient of retroreflection (*Ra*) of not less than 100/lux/$m^2$ (100 cd/fc/$ft^2$).

**7.1.19** All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.18, Corrosion Resistance Test.

**7.1.19.1** Metals inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, shall show no more than light surface-type corrosion or oxidation.

**7.1.19.2** Ferrous metals shall show no corrosion of the base metal. All hardware, unless specifically excluded in the test method, shall remain functional.

**7.1.20** Protective dry suit product labels shall be tested for legibility as specified in Section 8.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

**7.1.21 Contaminated Water Diving Operations Protective Dry Suit Optional CBRN Protection Performance Requirements.**

**7.1.21.1** Protective dry suit materials, and seams, dry suit bootie materials and seams, and dry suit hood materials and seams shall be tested for CBRN permeation resistance as specified in Section 8.9, CBRN Permeation Resistance Test, and shall meet the following performance criteria:

(1) For permeation testing of the liquid chemical warfare agent sulfur mustard, distilled (HD, or bis [2-chloroethyl] sulfide, CAS 505-60-2), the average cumulative permeation in 1 hour shall not exceed 4.0 $\mu g/cm^2$.
(2) For permeation testing of the liquid chemical warfare agent Soman (GD, or o-Pinacolyl methylphosphonofluoridate, CAS 96-64-0), the average cumulative permeation in 1 hour shall not exceed 1.25 $\mu g/cm^2$.
(3) For permeation testing of the liquid toxic industrial chemical dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(4) For permeation testing of the chemical gas acrolein (allyl aldehyde, CAS 107-02-8), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(5) For permeation testing of the chemical gas acrylonitrile (VCN, cyanoethylene, CAS 107-13-1), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(6) For permeation testing of the chemical gas ammonia ($NH_3$, CAS 7664-41-7), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(7) For permeation testing of the chemical gas chlorine ($Cl_2$, CAS 7782-50-5), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.

**7.2 Contaminated Water Diving Operations Protective Dry Suit Glove Elements.**

**7.2.1** Protective dry suit glove materials shall be tested for resistance to cut as specified in Section 8.11, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

**7.2.2** Protective dry suit glove materials shall be tested for puncture resistance as specified in Section 8.20, Puncture Resistance Test, and shall not puncture under an applied force of 12 N (2.7 lbf).

**7.2.3** Protective dry suit glove materials shall be tested for abrasion resistance as specified in Section 8.21, Abrasion Resistance Test Two, and shall not wear through.

**7.2.4** Protective dry suit gloves shall be tested for hand function as specified in Section 8.22, using the Torque Test, and shall have an average percent of barehanded control not less than 80 percent.

**7.2.5** All dry suit protective glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.18, Corrosion Resistance Test, and shall not have metals that are inherently resistant to corrosion show more than light surface-type corrosion or oxidation, shall not have ferrous metals show corrosion of the base metal, and shall have all hardware items remain functional.

**7.2.6** Protective dry suit glove materials and seams shall be tested for permeation resistance after abrading as specified in

Section 8.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 μg/cm$^2$.

**7.2.7** Protective dry suit glove materials and seams shall be tested for biopenetration resistance as specified in Section 8.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

**7.2.8** Dry suit protective glove product labels shall be tested for legibility as specified in Section 8.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

**7.2.9 Contaminated Water Diving Operations Protective Dry Suit Glove Elements Optional CBRN Protection Performance Requirements.**

**7.2.9.1** Dry suit glove materials and seams shall be tested for permeation resistance as specified in Section 8.9, CBRN Permeation Resistance Test, and shall meet the following performance criteria:

(1) For permeation testing of the liquid chemical warfare agent sulfur mustard, distilled (HD, or bis [2-chloroethyl] sulfide, CAS 505-60-2), the average cumulative permeation in 1 hour shall not exceed 4.0 μg/cm$^2$.
(2) For permeation testing of the liquid chemical warfare agent Soman (GD, or o-Pinacolyl methylphosphonofluoridate, CAS 96-64-0), the average cumulative permeation in 1 hour shall not exceed 1.25 μg/cm$^2$.
(3) For permeation testing of the liquid toxic industrial chemical dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1), the average cumulative permeation in 1 hour shall not exceed 6.0 μg/cm$^2$.
(4) For permeation testing of the chemical gas acrolein (allyl aldehyde, CAS 107-02-8), the average cumulative permeation in 1 hour shall not exceed 6.0 μg/cm$^2$.
(5) For permeation testing of the chemical gas acrylonitrile (VCN, cyanoethylene, CAS 107-13-1), the average cumulative permeation in 1 hour shall not exceed 6.0 μg/cm$^2$.
(6) For permeation testing of the chemical gas ammonia ($NH_3$, CAS 7664-41-7), the average cumulative permeation in 1 hour shall not exceed 6.0 μg/cm$^2$.
(7) For permeation testing of the chemical gas chlorine ($Cl_2$, CAS 7782-50-5), the average cumulative permeation in 1 hour shall not exceed 6.0 μg/cm$^2$.

**7.3 Contaminated Water Diving Operations Protective Dry Suit Footwear Elements.**

**7.3.1 Attached Footwear.**

**7.3.1.1** Dry suit attached integrated boot uppers shall be tested for abrasion resistance as specified in Section 8.21, Abrasion Resistance Test Two, and shall not wear through.

**7.3.1.2** Dry suit attached integrated boot uppers shall be tested for cut resistance as specified in Section 8.11, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

**7.3.1.3** Dry suit attached integrated boot uppers shall be tested for puncture resistance as specified in Section 8.20, Puncture Resistance Test, and shall not puncture under an applied force of 45 N (10 lbf).

**7.3.1.4** Dry suit attached integrated boot soles shall be tested for abrasion resistance as specified in Section 8.29, Abrasion Resistance Test Four, and the relative volume loss shall not be greater than 250 mm$^3$ (0.015 in.$^3$).

**7.3.1.5** Dry suit attached integrated boot soles shall be tested for penetration (physical) resistance as specified in Section 8.20, Puncture Resistance Test, and shall not have a puncture force of less than 90 N (20 lbf).

**7.3.1.6** Dry suit attached integrated boot soles shall be tested for slip resistance as specified in Section 8.23, Slip Resistance Test, and shall have coefficient friction of 0.40 or greater.

**7.3.1.7** Protective dry suit attached integrated boot materials and seams shall be tested for permeation resistance after flexing and abrading as specified in Section 8.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 μg/cm$^2$.

**7.3.1.8** Protective dry suit attached integrated boot metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.18, Corrosion Resistance Test, and shall not have metals that are inherently resistant to corrosion show more than light surface-type corrosion or oxidation, shall not have ferrous metals show corrosion of the base metal, and shall have all hardware items remain functional.

**7.3.1.9** Protective dry suit footwear materials and seams shall be tested for biopenetration resistance as specified in Section 8.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

**7.3.1.10** Dry suit attached integrated boot product labels shall be tested for legibility as specified in Section 8.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

**7.3.2 Attached Integrated Bootie with Overboot.**

**7.3.2.1** Dry suit protective overboot shall be tested for drainage as specified in Section 8.24, Footwear Drainage Test, and shall retain less than 100 g (0.22 lb) of water.

**7.3.2.2** Dry suit protective overboot uppers shall be tested for abrasion resistance as specified in Section 8.21, Abrasion Resistance Test Two, and shall not wear through.

**7.3.2.3** Dry suit protective overboot uppers shall be tested for cut resistance as specified in Section 8.11, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

**7.3.2.4** Dry suit protective overboot uppers shall be tested for puncture resistance as specified in Section 8.20, Puncture Resistance Test, and shall not puncture under an applied force of 45 N (10 lbf).

**7.3.2.5** Dry suit protective overboot soles shall be tested for abrasion resistance as specified in Section 8.29, Abrasion Resistance Test Four, and the relative volume loss shall not be greater than 250 mm$^3$ (0.015 inches$^3$).

**7.3.2.6** Dry suit protective overboot soles shall be tested for penetration (physical) resistance as specified in Section 8.20, Puncture Resistance Test, and shall not have a puncture force of less than 90 N (20 lbf).

**7.3.2.7** Dry suit protective overboot soles shall be tested for slip resistance as specified in Section 8.23, Slip Resistance Test, and shall have coefficient friction of 0.40 or greater.

**7.3.2.8** Dry suit protective overboot metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.18, Corrosion Resistance Test, and shall not have metals that are inherently resistant to corrosion show more than light surface-type corrosion or oxidation, shall not have ferrous metals show corrosion of the base metal, and shall have all hardware items remain functional.

**7.3.2.9** Where the bootie material is different from the suit material, the bootie material and seams shall be tested for permeation resistance after flexing and abrading as specified in Section 8.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 $\mu g/cm^2$.

**7.3.2.10** Where the bootie material is different from the suit material, it shall be tested for biopenetration resistance as specified in Section 8.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

**7.3.2.11** Dry suit protective footwear product labels shall be tested for legibility as specified in Section 8.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

**7.3.2.12 Contaminated Water Diving Operations Protective Dry Suit Footwear Elements Optional CBRN Protection Performance Requirements.**

**7.3.2.12.1** Protective dry suit attached integrated bootie materials, bootie material seams, bootie material soles, attached integrated boot materials, attached integrated boot material seams, and attached integrated boot material soles shall be tested for permeation resistance as specified in 8.8.10 and shall meet the following performance criteria:

(1) For permeation testing of the liquid chemical warfare agent sulfur mustard, distilled (HD, or bis [2-chloroethyl] sulfide, CAS 505-60-2), the average cumulative permeation in 1 hour shall not exceed 4.0 $\mu g/cm^2$.
(2) For permeation testing of the liquid chemical warfare agent Soman (GD, or o-Pinacolyl methylphosphonofluoridate, CAS 96-64-0), the average cumulative permeation in 1 hour shall not exceed 1.25 $\mu g/cm^2$.
(3) For permeation testing of the liquid toxic industrial chemical dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(4) For permeation testing of the chemical gas acrolein (allyl aldehyde, CAS 107-02-8), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(5) For permeation testing of the chemical gas acrylonitrile (VCN, cyanoethylene, CAS 107-13-1), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(6) For permeation testing of the chemical gas ammonia ($NH_3$, CAS 7664-41-7), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.
(7) For permeation testing of the chemical gas chlorine ($Cl_2$, CAS 7782-50-5), the average cumulative permeation in 1 hour shall not exceed 6.0 $\mu g/cm^2$.

## Chapter 8 Test Methods

### 8.1 Sample Preparation Procedures.

#### 8.1.1 Application.

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

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

#### 8.1.2 Room Temperature Conditioning Procedure.

**8.1.2.1** Samples shall be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and a relative humidity of 65 percent, ±5 percent, for at least 24 hours.

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

#### 8.1.3 Washing and Drying Procedure.

**8.1.3.1** Samples shall be subjected to 10 cycles of washing. Samples shall be complete suit ensembles, including dry suit gloves and hoods. Valves shall be removed, gloves uninstalled, and zippers opened.

**8.1.3.2** A front-loading washer/extractor shall be used.

**8.1.3.3** The wash load shall not exceed two-thirds of the rated capacity of the washer.

**8.1.3.4** The wash cycle procedure in Table 8.1.3.4 shall be followed.

**8.1.3.5** Samples shall be completely dried and valves and gloves reinstalled after the last washing cycle by air drying prior to conducting the testing.

#### 8.1.4 Flexural Fatigue Procedure.

**8.1.4.1** Samples shall be subjected to flexural fatigue in accordance with ASTM F392/392M, *Standard Practice for Conditioning Flexible Barrier Materials for Flex Durability*, with the following modifications:

(1) In lieu of Flexing Conditions A, B, C, D, or E, test specimens shall have a flex period of 100 cycles at 45 cycles per minute. A cycle shall be a full flex and twisting action.
(2) Anisotropic materials shall be tested in both machine and transverse directions.

**Table 8.1.3.4 Wash Cycle Procedure**

| Operation | Time (min) | Temperature ±3°C | Temperature ±5°F | Water Level |
|---|---|---|---|---|
| Water Only | 10 | 49 | 120 | Low |
| Drain | 1 | | | |
| Carry-over | 5 | 49 | 120 | Low |
| Drain | 1 | | | |
| Rinse | 2 | 38 | 100 | High |
| Drain | 1 | | | |
| Rinse | 2 | 38 | 100 | High |
| Drain | 1 | | | |
| Extract | | | | |

**8.1.4.2** The preconditioning shall be performed according to the sequence specified in the test methods of this chapter.

**8.1.5 Abrasion Procedure.** Samples shall be abraded in accordance with ASTM D4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, under the following conditions:

(1) A 2.3 kg (5 lb) tension weight shall be used.
(2) A 1.6 kg (3½ lb) head weight shall be used.
(3) The abradant shall be silicone carbide, ultrafine 600 grit.
(4) The specimen shall be configured as shown in Figure 8.1.5.
(5) The specimen shall be abraded for 25 continuous cycles.

**8.1.6 Wet Conditioning Procedure for Whole Gloves.**

**8.1.6.1** Test subjects shall be selected such that their hand dimensions are as close as possible to those specified in accordance with manufacturing glove-sizing guidelines.

**8.1.6.2** The test subject shall don the test specimen gloves.

**8.1.6.3** The test subject shall immerse the donned specimens into two containers of water at a temperature of 21°C, ±3°C (70°F, ±5°F) to within 25 mm (0.9 in.) of the end of the glove.

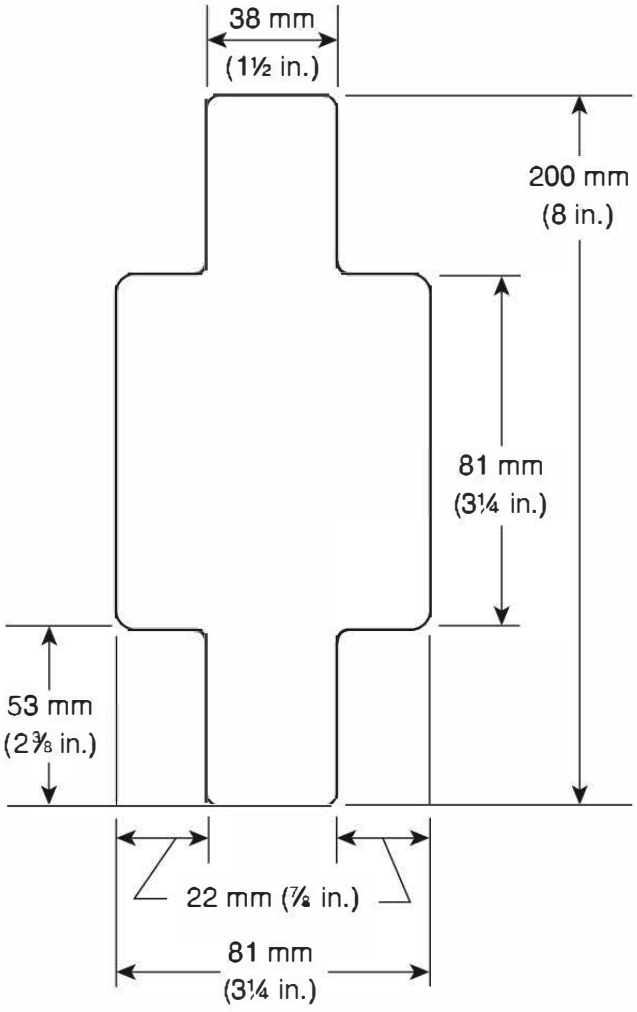


**FIGURE 8.1.5 Specimen Configuration.**

**8.1.6.4** The glove specimens shall be tested within 1 minute.

**8.1.7 Conditioning Procedure for Dry Suit Closure Assemblies.** Sample suit closure assemblies shall be exercised for a total of five openings and five closings while being lubricated and maintained according to manufacturer's instructions.

**8.2 Air Retention Test.**

**8.2.1 Application.** This test method shall apply to complete protective dry suits.

**8.2.2 Samples.**

**8.2.2.1** Samples shall be complete protective suits ensembles including hood, gloves, and footwear and assembled with all layers that are required for the suit to be compliant.

**8.2.2.2** Samples shall be conditioned as specified in 8.1.2 and 8.1.3.

**8.2.3 Specimens.** A minimum of three specimens shall be tested.

**8.2.4 Procedure.** Air retention performance testing shall be performed in accordance with ANSI/UL 1197, *Standard for Immersion Suits*, with the following modifications:

(1) The suit ensemble shall be submerged in water.
(2) The suit ensemble shall be pressurized to 6.9 kPa (1 psi).
(3) The suit ensemble shall be inspected for leaks while submerged in water.

**8.2.5 Report.** Any air leakage for each specimen shall be recorded and reported.

**8.2.6 Interpretation.** Pass or fail determination shall be based on evidence of air leakage.

**8.3 Exhaust Valve Inward Leakage Test.**

**8.3.1 Application.** This application shall apply to exhaust valves.

**8.3.2 Sample Preparation.**

**8.3.2.1** Samples shall be exhaust valve–mounted in a piece of dry suit material.

**8.3.2.2** Samples shall be conditioned as specified in 8.1.2.

**8.3.3 Specimens.**

**8.3.3.1** The exhaust valve shall be installed into a sufficiently sized piece of dry suit material that can be adequately sealed into the test cell described in 8.3.4.

**8.3.3.2** A minimum of three specimens shall be tested.

**8.3.4 Test Apparatus.**

**8.3.4.1** The exhaust valve shall be exposed to chemicals using the penetration test cell specified in ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, with the following modifications:

(1) The test cell shall be permitted to have its liquid cavity diameter and the overall test cell diameter increased to permit the placement of the mounted exhaust valve sample inside the sample, such that there is a minimum clearance of 12 mm (0.5 in.) from the mounted exhaust valve to the sides of the test cell.
(2) The Plexiglas® shield shall be omitted from the test cell.

**8.3.5 Procedure.**

**8.3.5.1** The specimen shall be placed and sealed in the test cell described in 8.25.4.1, such that the normal exterior side of the exhaust valve is oriented towards the liquid reservoir.

**8.3.5.2** The specimen shall be evaluated at a test temperature using Procedure D of ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, using deionized water as the test liquid and the following pressure/time sequence for a total 5-minute exposure:

(1) 3 minutes ambient pressure
(2) 1 minute at 0.69 kPa (0.1 psi)
(3) 1 minute at ambient pressure

**8.3.5.3** Liquid failures shall be confirmed by the use of blotting patter at the conclusion of the exposure period.

**8.3.6 Report.**

**8.3.6.1** The pass or fail results for each specimen tested shall be recorded and reported.

**8.3.6.2** The identification of the locations where penetration occurs, if discernible, shall be recorded and reported.

**8.3.7 Interpretation.** Observed liquid penetration at the end of the test for any specimen shall constitute failure of this test.

**8.4 Inlet Valve Pull Test.**

**8.4.1 Application.** The juncture of the suit and inlet valve shall be tested for strength.

**8.4.2 Sample Preparation.** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.4.3 Specimens.** A minimum of three specimens shall be tested.

**8.4.4 Procedure.**

**8.4.4.1** The dry suit and inlet valve shall be fitted to a mannequin.

**8.4.4.2** The joint between the suit inlet valve and the dry suit shall be submitted to a pulling force of 500 N, ±5 N, for a test period of 10 sec, ±1 sec.

**8.4.4.3** The force shall be applied through the valve inflation hose if supplied by the manufacturer or the valve nipple and perpendicular to the initial orientation of the suit material.

**8.4.4.4** The suit and the inlet valve shall be visually inspected and tested for leakage in accordance with Section 8.2, Air Retention Test.

**8.4.5 Report.** The result of the air retention test and any observations from the visual inspection shall be reported.

**8.4.6 Interpretation.** Any leakage or signs of damage shall constitute failure.

**8.5 Burst Strength Test.**

**8.5.1 Application.**

**8.5.1.1** This test shall apply to protective dry suit materials, protective dry suit attached integrated bootie or attached integrated boot materials, and protective dry suit hood materials.

**8.5.1.2** Where the suit, bootie, or hood material is constructed of several separable layers, then all layers shall be assembled in the order in which they appear in the suit, bootie, or hood, and shall be tested as a composite.

**8.5.2 Sample Preparation.**

**8.5.2.1** Samples shall be at least 305 mm (12 in.) squares of material.

**8.5.2.2** One set of samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2. A second set of samples shall be conditioned as specified in 8.1.5 followed by the conditioning specified in 8.1.2.

**8.5.3 Specimens.**

**8.5.3.1** Specimens shall be the size specified in ASTM D751, *Standard Test Methods for Coated Fabrics*.

**8.5.3.2** At least 10 specimens shall be tested following the laundering conditioning.

**8.5.3.3** At least 10 specimens shall be tested following the abrasion conditioning.

**8.5.4 Procedure.** Specimens shall be tested in accordance with Section 18.2, Tensile Testing Machine with Ring Clamp, in ASTM D751, *Standard Test Methods for Coated Fabrics*, using the tension testing machine with ring clamp.

**8.5.5 Report.**

**8.5.5.1** The burst strength of each specimen shall be recorded and reported to the nearest 1 N (0.25 lbf).

**8.5.5.2** The average burst strength of all specimens shall be calculated, recorded, and reported for each condition.

**8.5.6 Interpretation.** The average burst strength for each condition shall be used to determine the pass or fail performance.

**8.6 Puncture Propagation Tear Resistance Test.**

**8.6.1 Application.** This test shall apply to protective dry suit materials, protective dry suit attached integrated boot materials, protective attached integrated dry suit bootie materials, and protective dry suit hood materials.

**8.6.2 Samples.**

**8.6.2.1** Samples shall be at least 0.5 m (0.5 yd) squares of material.

**8.6.2.2** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.6.3 Specimens.**

**8.6.3.1** Specimens shall be the size specified in ASTM D2582, *Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting*.

**8.6.3.2** A minimum of five specimens in each of the warp direction, machine or course, and the filling direction, cross machine or wales, shall be tested.

**8.6.3.3** Where the material is isotropic, 10 specimens shall be tested.

**8.6.4 Procedure.** Specimens shall be tested in accordance with ASTM D2582, *Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting*.

**8.6.5 Report.**

**8.6.5.1** The puncture propagation tear resistance for each specimen shall be recorded and reported to the nearest 1 N (0.1 lb) of force.

**8.6.5.2** An average puncture propagation tear resistance shall be calculated for warp and filling directions. The average puncture propagation tear resistance calculations shall be recorded and reported.

**8.6.6 Interpretation.**

**8.6.6.1** Pass or fail performance shall be based on the average puncture propagation tear resistance in the warp and filling directions.

**8.6.6.2** Failure in any one direction constitutes failure for the material.

**8.7 Seam Breaking Strength Test.**

**8.7.1 Application.** This test method shall apply to protective dry suit seam assemblies, dry suit hood seam assemblies, and dry suit bootie seam assemblies.

**8.7.2 Samples.**

**8.7.2.1** Samples shall be full suits or 305 mm (12 in.) or greater lengths of seam with at least 150 mm (6 in.) of material on either side of the seam centerline.

**8.7.2.2** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.7.3 Specimens.**

**8.7.3.1** Specimens shall be cut from the finished suit or shall be permitted to be prepared by the joining of two pieces of the suit fabric using the same thread, seam type, and stitch type as used in the finished garment.

**8.7.3.2** Specimens shall be the size specified in ASTM D751, *Standard Test Methods for Coated Fabrics*.

**8.7.3.3** At least five seam specimens shall be tested for each seam type.

**8.7.4 Procedure.** All seam assemblies shall be tested in accordance with ASTM D751, *Standard Test Methods for Coated Fabrics*. The test machine shall be operated at a rate of 305 mm/min (12 in./min).

**8.7.5 Report.**

**8.7.5.1** The seam breaking strength for each seam specimen shall be recorded and reported.

**8.7.5.2** The average seam breaking strength for each seam type shall also be calculated, recorded, and reported.

**8.7.5.3** The type of seams tested shall be reported as to whether the specimens were cut from the finished suit or prepared from fabric samples.

**8.7.6 Interpretation.** The average seam breaking strength for each seam type shall be used to determine pass or fail performance.

**8.8 Chemical Permeation Resistance Test.**

**8.8.1 Application.**

**8.8.1.1** This test method shall apply to dry suit materials and seams, dry suit hood materials and seams, dry suit glove materials and seams, dry suit attached integrated bootie materials and seams (if different from suit materials and seams), and dry suit attached integrated boot materials and seams (if different from suit materials and seams).

**8.8.1.2** Modifications to this test method for testing dry suit, hood, and attached integrated bootie materials shall be as specified in 8.8.7.

**8.8.1.3** Modifications to this test method for testing dry suit, hood, attached integrated boot, and attached integrated bootie seams shall be as specified in 8.8.8.

**8.8.1.4** Modifications to this test method for testing glove materials and seams shall be as specified in 8.8.9.

**8.8.1.5** Modifications to this test method for testing attached integrated boot materials shall be as specified in 8.8.10.

**8.8.2 Sample Preparation.**

**8.8.2.1** Samples shall be the chemical protection layer of the size specified in the modifications.

**8.8.2.2** Samples shall be conditioned as specified in 8.1.2, after the conditioning specified in the modifications.

**8.8.3 Specimens.**

**8.8.3.1** Specimens shall be the size specified in ASTM F739, *Standard Test Method for Permeation of Liquids and Gases Through Protective Clothing Materials Under Conditions of Continuous Contact*.

**8.8.3.2** At least three specimens of each material shall be tested per chemical.

**8.8.4 Procedure.**

**8.8.4.1** Except as noted in 8.8.4.1(1) through 8.8.4.1(5), specimens shall be tested for permeation resistance in accordance with ASTM F739, *Standard Test Method for Permeation of Liquids and Gases Through Protective Clothing Materials Under Conditions of Continuous Contact*, with the following modifications:

(1) The test cells shall be selected or designed to accommodate the introduction of liquid chemicals in a safe manner.
(2) The test cells shall be maintained in a vertical orientation such that the material has full contact with the test liquid.
(3) Testing shall be performed at a temperature of 32°C ± 1°C (90°F ± 2°F).
(4) The collection medium shall be permitted to be either deionized water or dry air.
(5) Analytical methods used for detecting permeation shall be sensitive to concentrations of at least one order of magnitude lower than the required end points.

**8.8.4.2*** The following liquid chemicals at a concentration of 5 percent (w/v) shall be tested for the dry suit ensembles and elements:

(1) Acetonitrile
(2) Diethylamine
(3) Dimethylformamide
(4) Ethyl acetate

(5) Hexane
(6) Methanol
(7) Sodium hydroxide
(8) Sulfuric acid
(9) Tetrahydrofuran
(10) Toluene

**8.8.4.3** Where chemicals are not miscible or soluble in water, the solution shall be allowed to naturally separate during the test exposure.

**8.8.4.4** The chemical exposure period shall be 10 minutes, +1 minute/–0 minute.

**8.8.5 Report.**

**8.8.5.1** The cumulative permeation over the test duration shall be calculated, recorded, and reported in $\mu g/cm^2$ for each specimen for each challenge chemical.

**8.8.5.1.1** If no challenge chemical is detected at the end of the test period, the cumulative permeation shall be recorded and reported as less than the minimum detectable mass per unit area for the specific chemical being tested.

**8.8.5.2** The average cumulative permeation shall be calculated and reported by averaging the results from all specimens for each challenge chemical.

**8.8.5.2.1** For the calculation of average cumulative permeation, if the result of one or more of the specimens tested is less than the minimum detectable cumulative permeation, the minimum detectable cumulative permeation shall be used as the result for those specimens.

**8.8.5.2.2** For the calculation of average cumulative permeation, if the results of all the specimens tested are less than the minimum detectable cumulative permeation, the average cumulative permeation shall be reported as the minimum detectable cumulative permeation.

**8.8.5.3** Any observations of degradation or other abnormalities shall be reported at the conclusion of the testing of each specimen.

**8.8.6 Interpretation.** The average cumulative permeation for each challenge chemical shall be used to determine pass or fail performance.

**8.8.7 Specific Requirements for Testing Dry Suit, Dry Suit Hood, and Dry Suit Attached Integrated Bootie Materials.**

**8.8.7.1** Samples for conditioning shall be at least 380 mm (15 in.) square and shall consist of all layers as configured in the suit, hood, or attached integrated bootie.

**8.8.7.2** Composite samples prepared as specified in 8.8.7.1 shall be tested after being subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.3.
(2) Specimens shall then be conditioned as specified in 8.1.2.

**8.8.7.3** Composite samples conditioned as specified in 8.8.7.2 shall be trimmed to a sample size of 300 mm × 280 mm (12 in. × 11 in.).

**8.8.7.3.1** Trimmed composite samples shall be subject to flexing conditioning as specified in 8.1.4, with the 280 mm (11 in.) direction parallel with the compression action of the machine.

**8.8.7.3.2** Trimmed composite samples shall be mounted such that the outer layer is visible with all layers in their normal "as worn" orientation.

**8.8.7.4** Following flexing, samples of the barrier layer shall be removed from the flexed, trimmed composite samples and cut to the dimensions specified in 8.8.7.3, with the long dimension of the sample parallel to the 280 mm (11 in.) dimension.

**8.8.7.5** The layers in the flexed, trimmed composite sample adjacent to the barrier layer shall be retained for use as the abradants.

**8.8.7.6** The barrier layer samples prepared as specified in 8.8.7.4 and the other samples retained as specified in 8.8.7.5 shall be subjected to abrasion as specified in 8.1.5.

**8.8.7.7** Following abrading, the permeation test specimen shall be taken from the center of the abraded sample so that the center of the permeation test and the center of the abraded sample coincide.

**8.8.7.8** Specimens shall be oriented in the permeation test cell with the exterior surfaces facing the challenge chemical.

**8.8.7.9** Specimens shall be tested for permeation resistance as specified in 8.8.2 through 8.8.6.

**8.8.8 Specific Requirements for Testing Dry Suit, Dry Suit Hood, and Dry Suit Attached Integrated Bootie Seams.**

**8.8.8.1** Samples for conditioning shall be at least 380 mm (15 in.) square and shall consist of all layers of the composite sample arranged in the order used in the construction of the suit, hood, or bootie. The multilayer composite shall be stitched around the entire periphery.

**8.8.8.2** Composite samples prepared as described in 8.8.8.1 shall be tested after being subjected twice to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.3.
(2) Specimens shall then be conditioned as specified in 8.1.2.

**8.8.8.3** Composite samples conditioned as specified in 8.8.8.2 shall be trimmed to a sample size of 300 mm × 280 mm (12 in. × 11 in.), with the seam parallel to the 300 mm (12 in.) direction.

**8.8.8.3.1** Trimmed composite samples shall be subject to flexing conditioning as specified in 8.1.4, with the 280 mm (11 in.) direction parallel with the compression action of the machine.

**8.8.8.3.2** Trimmed composite samples shall be mounted such that the outer layer is visible, with all layers in their normal "as worn" orientation.

**8.8.8.4** Specimens for permeation testing shall be cut from the flexed, trimmed composite sample such that the seam bisects the specimen.

**8.8.8.5** Specimens shall be oriented in the permeation test cell with the exterior surfaces facing the challenge chemical.

**8.8.8.6** Specimens shall be tested for permeation resistance as specified in 8.8.2 through 8.8.6.

**8.8.9 Specific Requirements for Testing Dry Suit Glove Materials and Seams.**

**8.8.9.1** This test shall apply to all types of glove configurations.

**8.8.9.2** Samples for conditioning shall be whole gloves.

**8.8.9.3** Glove samples shall be subjected to the following sequence two times prior to permeation testing:

(1) Specimens shall first be subjected to the procedure specified in 8.1.3.
(2) Specimens shall then be conditioned as specified in 8.1.2.

**8.8.9.4** Specimens for permeation resistance testing shall be taken from the flexed glove. Where the outer layer includes seams, specimens shall include seams that bisect the specimens.

**8.8.9.5** Specimens shall be tested for permeation resistance as specified in 8.8.2 through 8.8.6.

**8.8.10 Specific Requirements for Testing Dry Suit Attached Integrated Boot Materials.**

**8.8.10.1** This test shall not apply to footwear configurations that include attached integrated booties that are subjected to the procedures in 8.8.7.

**8.8.10.2** Samples for conditioning shall be whole attached integrated boot items.

**8.8.10.3** Footwear samples shall first be conditioned as specified in 8.1.2.

**8.8.10.4** Samples shall be taken in areas from the footwear upper at the footwear quarter and vamp areas and cut to the dimensions specified in 8.8.7.3.

**8.8.10.5** Cut samples shall then be conditioned by abrading as specified in 8.1.5 using silicon carbide, ultrafine, 600 grit sandpaper as the abradant in lieu of other specified layers.

**8.8.10.6** Following abrading, the permeation test specimen shall be taken from the center of the abraded sample so that the center of the permeation test and the center of the abraded sample coincide.

**8.8.10.7** Specimens shall be tested for permeation resistance as specified in 8.8.2 through 8.8.6.

**8.9 CBRN Permeation Resistance Test.**

**8.9.1 Application.**

**8.9.1.1** This method shall only define the modifications to Section 8.8, Chemical Permeation Test, and the additional information required to perform the optional CBRN permeation resistance tests.

**8.9.1.2** This method shall apply to dry suit materials and seams, dry suit hood materials and seams, dry suit glove materials and seams, dry suit bootie materials and seams (if different from suit material and seams), or dry suit attached integrated boot materials and seams (if different from suit material and seams), and closure assemblies. Specific requirements for testing each are given in 8.8.1.

**8.9.2 Conditioning of Samples and Specimens.**

**8.9.2.1** The conditioning described in 8.1.2 shall be replaced by the following: Specimens shall be conditioned at a temperature of 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent, for at least 24 hours prior to testing.

**8.9.3 Apparatus.**

**8.9.3.1** A controlled environmental chamber shall be used to maintain the test cell, air flow control system, and reagent chemicals within ±1.0°C (±2.0°F) of the test temperature and ±5 percent of the test relative humidity. The controlled environment chamber shall be sized so that it can be used for conditioning test materials, test cells when not in use, challenge chemicals, and other test apparatus prior to testing, as well as holding the test cells horizontally during use while connected to the air delivery system with manifold and to the effluent sampling mechanism.

**8.9.3.2** The test cell shall be a two-chambered cell for contacting the specimen with the challenge chemical on the specimen's normal outside surface and for flowing a collection medium on the specimen's normal inside surface, consisting of parts shown in Figure 8.9.3.2(a) and individual part detail shown in Figure 8.9.3.2(b) through Figure 8.9.3.2(f).

**8.9.3.3** An air delivery system and manifold shall be used to provide oil-free, conditioned air to the test cell/fixtures at a rate of 2 standard liters per minute (SLPM) per test cell/fixture with a temperature precision of ±0.2°C (±32.36°F) and a relative humidity precision of ±5 percent. The manifold shall be designed to deliver 0.3 L/min for the challenge side of the test cell and 1 L/min for the collection side of the test cell and maintain at the test temperature. All parts of the air delivery system and manifold shall be chemically inert and nonabsorptive to the challenge chemical.

**8.9.3.4** An analytical system shall be used to evaluate the amount of challenge chemical in the effluent air streams from the collection side of the test cell and shall be selected to provide the ability to measure the challenge chemical at 0.1 $\mu g/cm^2$ over the test exposure period. The analytical system shall be permitted to include a bubbler tube, solid sorbent, or real-time chemical analyzer. Effluent sampling shall be permitted to be taken discretely or cumulatively; however, the selected analytical system shall be able to determine the entire challenge chemical permeating through the specimen in 60 minutes.

**8.9.3.5** A vacuum pump capable of creating vacuum of at least 127 mm (5 in.) water column shall be used for testing the integrity of the assembled test cell.

**8.9.3.6** A manometer or pressure gage capable of measuring pressures or vacuums to 254 mm (10 in.) water column with an accuracy of 5 percent of scale shall be used for testing the integrity of the assembled test cell.

**8.9.4 Supplies.**

**8.9.4.1** Syringe needles capable of delivering 1 µL droplets ± 1 percent of the challenge chemical shall be used for dispensing liquid challenge chemical onto the surface of the specimen in the test cell.

**8.9.4.2** Replacement O-rings shall be available for use in the permeation test cell.

**8.9.4.2.1** If unknown, the compatibility of the O-ring material with the challenge chemical shall be verified before use.

**8.9.4.2.2** If an O-ring shows any signs of chemical degradation in the form of softening, hardening, swelling, deterioration, or loss of shape or function, an O-ring of different material shall be used that does not show chemical degradation.

**8.9.4.3** An inert impermeable surrogate material shall be used as a negative control during validation tests.

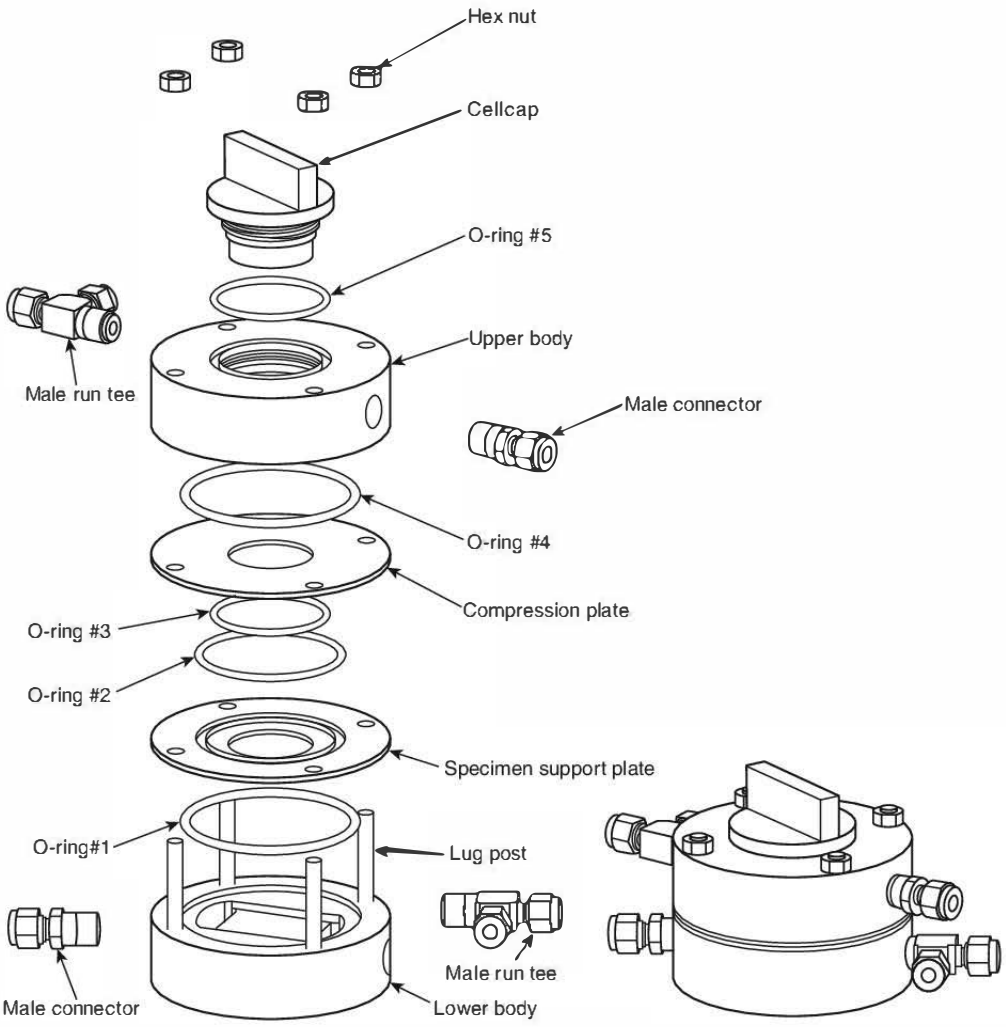


**FIGURE 8.9.3.2(a) Diffusion Test Cell Assembly (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)**

**8.9.5 Chemicals.**

**8.9.5.1** The following challenge chemicals shall be tested as liquids:

(1) Liquid chemical warfare agents
   (a) Sulfur mustard, distilled (HD, or bis [2- chloroethyl] sulfide, CAS 505-60-2)
   (b) Soman (GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-64-0)
(2) Liquid toxic industrial chemical
   (a) Dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1)

**8.9.5.2 Process for Determining the Mass of Liquid Chemical Challenge Applied.**

**8.9.5.2.1** Prior to assembling the test cell and conducting the test, the mass of the applied challenge chemical shall be determined using the procedure specified in 8.9.5.2.2 to 8.9.5.2.4.

**8.9.5.2.2** The challenge chemical shall be applied to an inert impermeable surrogate specimen in the pattern described in 8.9.7.4.

**8.9.5.2.3** After application, the inert impermeable surrogate specimen shall be visually inspected to verify that the liquid chemical challenge was correctly applied.

**8.9.5.2.4** The inert impermeable surrogate specimen with the applied liquid chemical challenge shall be placed in a closed large vial containing a known volume of solvent compatible with the analysis procedure in 8.9.5.2.5 to 8.9.5.2.8.

**8.9.5.2.5** The large vial with solvent and impermeable surrogate specimen with the applied liquid challenge chemical shall be agitated for at least 1 hour to ensure complete extraction of the challenge chemical.

**8.9.5.2.6** After agitation, the solvent vial shall be removed and submitted for analysis of the liquid challenge chemical, using a procedure capable of detecting 1.0 mg of the liquid challenge chemical.

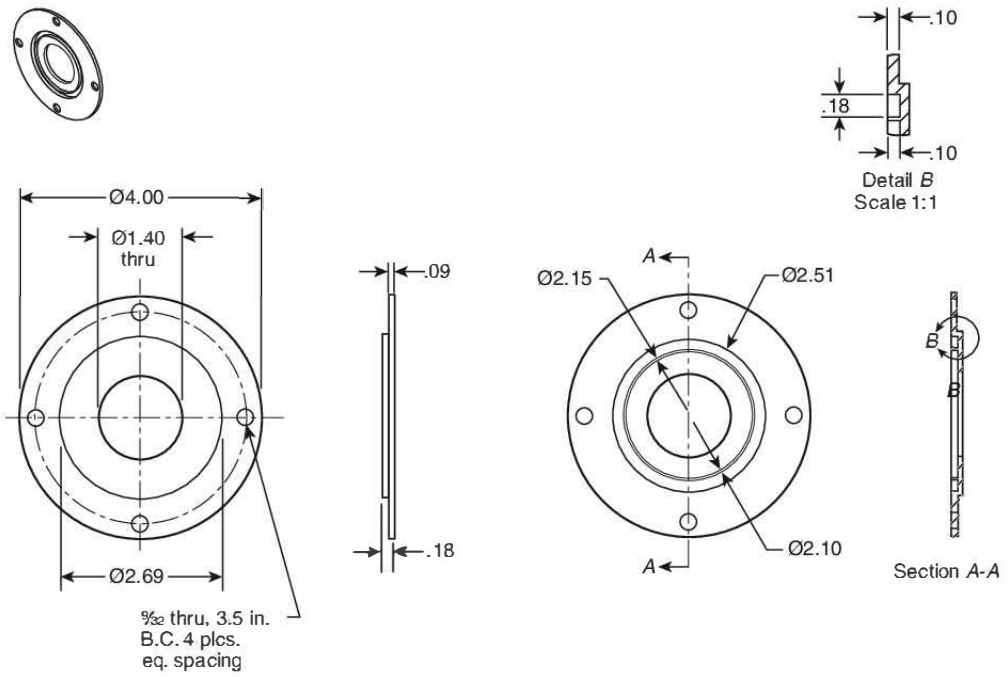


**FIGURE 8.9.3.2(b) Sample Support Plate (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)**

**8.9.5.2.7** Using the mass of the liquid challenge chemical detected in the extraction procedure and the exposed area of the test specimen defined by the test cell, the exposure concentration shall be 10 g/m$^2$ (+1.0/–0.0 g/m$^2$).

**8.9.5.2.8** The number of 1 µL liquid droplets shall be adjusted to conform to the 10 g/m$^2$ (+1.0/–0.0 g/m$^2$) concentration requirement.

**8.9.5.3** The following challenge chemicals shall be tested as gases or vapors in dry air or nitrogen:

(1) Ammonia ($NH_3$, CAS 7664-41-7)
(2) Chlorine ($Cl_2$, CAS 7782-50-5)
(3) Acrolein (allyl aldehyde, CAS 107-02-8)
(4) Acrylonitrile (VCN, cyanoethylene, CAS 107-13-1)

**8.9.6 Procedures.**

**8.9.6.1 Preconditioning.**

**8.9.6.1.1** The challenge chemicals, test specimen, test equipment, and test cell assembly shall be placed in the environmental chamber for a minimum of 24 hours at 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent, prior to testing.

**8.9.6.2 Test Cell Assembly.**

**8.9.6.2.1** The test cell shall be assembled in the environmental chamber at 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent.

**8.9.6.2.2** O-Ring #1 shall be placed on the lower body (collection side) of the test cell.

**8.9.6.2.3** The sample support plate shall be placed on the lower body (collection side) of the test cell.

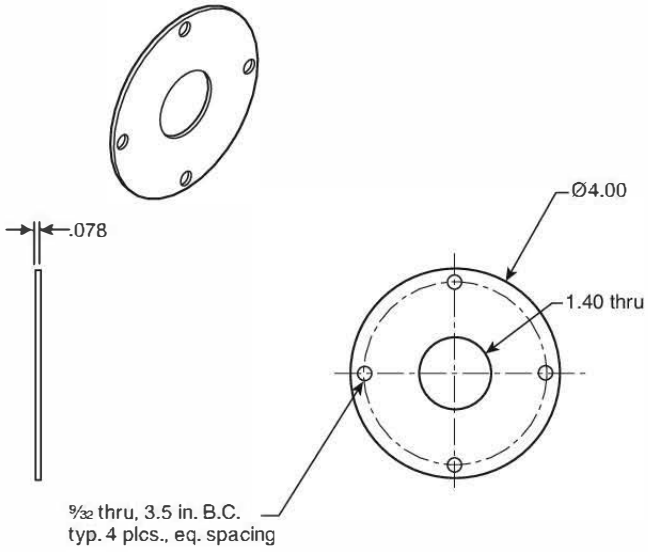


**FIGURE 8.9.3.2(c) Compression Plate (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)**

**8.9.6.2.4** O-ring #2 (outer) and O-ring #3 (inner) shall be placed in the respective grooves on the sample support plate.

**8.9.6.2.5** The specimen shall be removed from the conditioning location in the environmental chamber and shall be placed on top of the sample support plate.

**8.9.6.2.6** With the upper body (challenge side) of the test cell upside down, O-ring #4 shall be placed in the upper body of the test cell on the specimen side and the compression plate shall be positioned over O-ring #4.

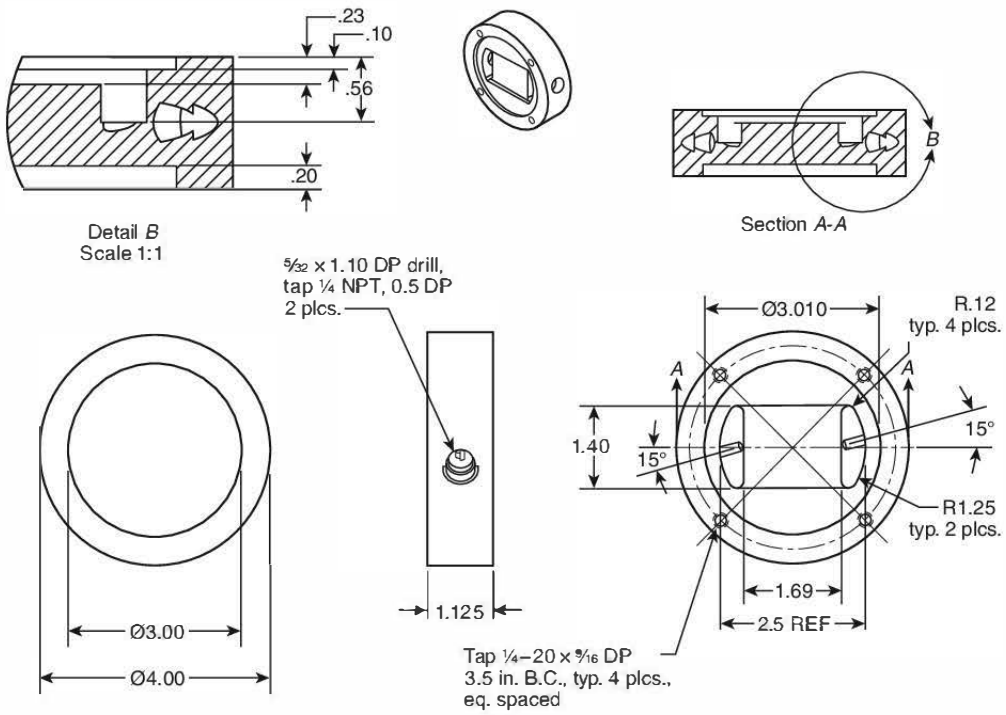


**FIGURE 8.9.3.2(d) Lower Body (Collection Side) (Copyright ©2006 W.L. Gore &Associates, Inc. Used by permission.)**

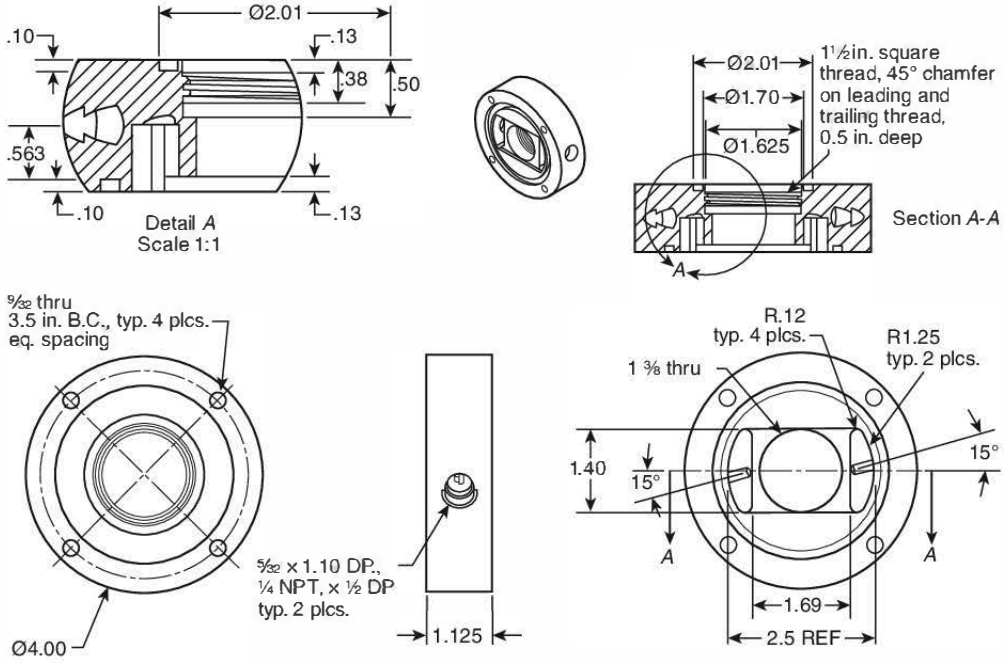


**FIGURE 8.9.3.2(e) Upper Body (Challenge Side) (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)**

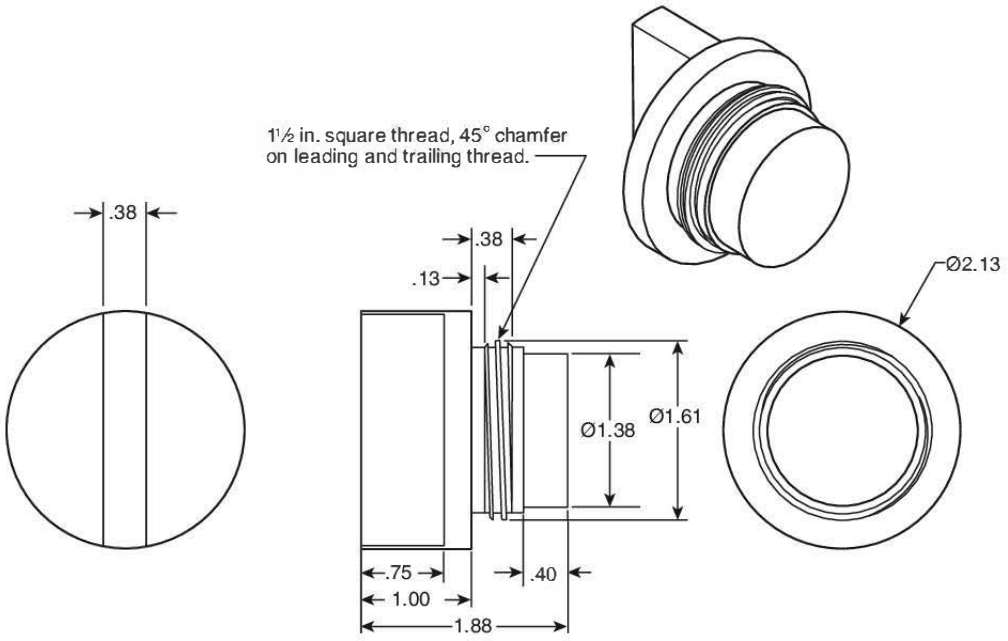


**FIGURE 8.9.3.2(f) Top Cap (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)**

**8.9.6.2.7** The upper body (challenge side) of the test cell with O-ring #4 and the compression plate shall be inverted, aligned with the lug posts, and joined with the lower body (collection-side) of the test cell.

**8.9.6.2.8** Using the four cell sealing lugs, the cell halves shall be clamped together and 51.8 cm-kg (45 in.-lb) of torque shall be applied to each lug to ensure a proper cell seal.

**8.9.6.2.9** O-ring #5 shall be inserted into the groove around the agent challenge port in the upper body of the test cell, and the cell top cap shall be screwed into place.

**8.9.6.2.10** The integrity of the test cell assembly shall be verified using the procedure in 8.9.6.3.

**8.9.6.2.11** Each test cell shall be labeled with the challenge chemical to be used in it.

**8.9.6.3 Verification of Test Cell Integrity.**

**8.9.6.3.1** Test cell integrity shall be performed in the environmental chamber at 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent.

**8.9.6.3.2** Valves on the outlet ports of the upper and lower body of the test cell shall be closed.

**8.9.6.3.3** Both the upper and lower body inlet ports of the test cell shall be connected to a manometer.

**8.9.6.3.4** Both inlet ports shall be connected to a vacuum and the test cell upper body and test cell lower body shall be depressurized to 75 mm (3 in.) water column pressure.

**8.9.6.3.5** If the test cell pressure drops below 50 mm (2 in.) of water column within 2 minutes, the test cell shall be reassembled according to the steps in 8.7.7.2 of NFPA 1994.

**8.9.6.3.6** Only test cells that have passed this integrity test shall be used for testing.

**8.9.6.4 Determination of Procedure for Applying Liquid Challenge Chemicals.**

**8.9.6.4.1** The liquid chemical challenge concentration shall be 10 g/m$^2$ (+1.0/–0.0 g/m$^2$).

**8.9.6.4.2** The number of 1 µL droplets shall be permitted to vary, depending on the density of the liquid chemical challenge. Eight droplets shall be applied evenly spaced around the perimeter and the remaining droplets placed in the center. If more than one droplet is required in the center, the droplets shall be spaced 8.1 mm (⅓ in.) apart. For seams, the droplets in the center shall be spaced along the seam juncture.

**8.9.6.4.3** A mechanical or automated device shall be permitted for uniformly dispensing the droplets onto the surface of the specimen.

**8.9.6.4.4** When testing any liquid chemical, a quality control trial shall be conducted to verify that the application process delivers 10 g/m$^2$ (+1.0/–0.0 g/m$^2$) using the procedures in 8.12.5.2.

**8.9.6.5 Procedure for Liquid Chemical Challenge.**

**8.9.6.5.1** The test cell shall be mounted horizontally and connected to the air delivery system in the environmental chamber at 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent. All connections shall be secured.

**8.9.6.5.2** The calibrated analytical detection system shall be assembled and initiated according to its instructions.

**8.9.6.5.3** If bubblers are used, each bubbler shall be filled with the proper collection solvent using a calibrated pipette or equivalent device; the collection solvent shall incorporate an internal standard so adjustments can be made for solvent evaporation/water condensation during sampling.

**8.9.6.5.4** If solid sorbent tubes are to be used, each sorbent tube shall be cleaned by heating and purging; the absence of any residual chemical shall be verified by the appropriate analysis technique.

**8.9.6.5.5** The air delivery shall be flowing filtered air at a temperature of 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent, to the collection side of the test cell at least 15 minutes prior to the application of the challenge chemical.

**8.9.6.5.6** With the cell top cap removed, 1 µL droplets shall be placed through the agent challenge port of the test cell on the specimen's outer surface within 20 seconds, according to the procedure determined in 8.9.6.4.

**8.9.6.5.7** After placing the liquid challenge chemical on the specimen in the test cell, the cell top cap shall be sealed within 5 seconds.

**8.9.6.5.7.1** For testing of Class 2 ensemble materials, the filtered air at a temperature of 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent shall be flowed only to the collection side of the test cell at a rate of 1.0 L/min ± 0.1 L/min. No air shall be flowed across the challenge side of the test cell.

**8.9.6.5.7.2** For testing of Class 3 ensemble materials, the filtered air at a temperature of 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent shall be flowed to the challenge side of the test cell at a rate of 0.3 L/min ± 0.03 L/min and to the collection sides of the test cell at a rate of 1.0 L/min ± 0.1 L/min.

**8.9.6.5.8** The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes +1.0 /–0 minutes.

**8.9.6.5.9** The collection media for the challenge chemical shall be analyzed using an appropriate analytical procedure.

**8.9.6.5.10** At least one test shall be conducted with a specimen, but without the challenge chemical, as a negative control.

**8.9.6.5.11** At least one test shall be conducted with an inert impermeable surrogate specimen as a negative control.

**8.9.6.5.12** The results from tests accompanied by unsuccessful negative controls shall not be used and the test shall be repeated.

**8.9.6.6 Procedure for Gas or Vapor Challenge Chemicals.**

**8.9.6.6.1** The test cell shall be mounted horizontally and connected to the air delivery system in the environmental chamber at 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent. All connections shall be secured.

**8.9.6.6.2** The air delivery shall be connected and flowing 1 L/min of filtered air at a temperature of 32°C ± 1°C (90°F ± 2°F) and at a relative humidity of 80 percent ± 5 percent to the collection side of the test cell at least 15 minutes prior to the initiation of any gas or vapor challenge chemical.

**8.9.6.6.3** The calibrated analytical detection system shall be assembled and initiated according to its instructions.

**8.9.6.6.4** The initiation of the test shall occur when the gas or vapor challenge chemical is introduced into the challenge side of the test cell.

**8.9.6.6.4.1** The supply of the gas or vapor challenge chemical shall be sufficient to maintain the gas or vapor challenge chemical concentration during the exposure period of 60 minutes +1.0/–0.0 minutes.

**8.9.6.6.4.2** The gas or vapor challenge chemical shall be at a temperature of 32°C ± 1°C (90°F ± 2°F).

**8.9.6.6.4.3** For testing of Class 2 ensemble materials, the concentration of the gas or vapor challenge chemical shall be 350 ppm +35/–0 ppm.

**8.9.6.6.4.4** For testing of Class 3 ensemble materials, the concentration of the gas or vapor challenge chemical shall be 40 ppm +10/–0 ppm.

**8.9.6.6.5** The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes +1.0/–0 minutes.

**8.9.6.7** The collection media for the challenge chemical shall be analyzed using an appropriate analytical procedure.

**8.9.6.8** At least one test shall be conducted with the specimen, but without the challenge chemical, as a negative control.

**8.9.6.9** At least one test shall be conducted with an inert surrogate specimen as a negative control.

**8.9.6.10** The results from tests accompanied by unsuccessful negative controls shall not be used, and the test shall be repeated.

**8.9.7 Test Conclusion, Test Cell Cleaned, and Specimen Disposal.**

**8.9.7.1** At the conclusion of the test, the test cell shall be purged and the air delivery and analytical system shall be shut down.

**8.9.7.2** Each cell shall be disassembled one at a time.

**8.9.7.3** The tested specimen shall be inspected for degradation or other obvious abnormalities; these observations shall be recorded with the test results.

**8.9.7.4** Disposal of tested specimens and other supplies shall be handled according to local, state, federal or other applicable regulations.

**8.9.7.5** Each component of the test cell shall be rinsed with acetone or other appropriate solvent to remove residual chemicals.

**8.9.7.6** The cell shall be allowed to air dry in a clean area for 24 hours before reuse.

**8.9.8 Report.**

**8.9.8.1** The cumulative permeation in 1 hour shall be calculated, recorded, and reported in $\mu g/cm^2$ for each specimen for each challenge chemical.

**8.9.8.1.1** If no challenge chemical is detected at the end of the 60-minute test period, then the cumulative permeation shall be recorded and reported as less than the minimum detectable mass per unit area for the specific chemical being tested.

**8.9.8.1.2** The average cumulative permeation shall be calculated and reported by averaging the results from all specimens for each challenge chemical.

**8.9.8.1.3** For the calculation of average cumulative permeation, if the results of one or more of the specimens tested is less than the minimum detectable cumulative permeation, then the minimum detectable cumulative permeation shall be used as the result for those specimens.

**8.9.8.1.4** For the calculation of average cumulative permeation, if the results of all the specimens tested are less than the minimum detectable cumulative permeation, then the average cumulative permeation shall be reported as the minimum detectable cumulative permeation.

**8.9.8.2** Any observations of degradation or other abnormalities shall be reported at the conclusion of the testing of each specimen.

**8.9.9 Interpretation.** The average cumulative permeation for each challenge chemical shall be used to determine pass or fail performance.

**8.10 Viral Penetration Resistance Test.**

**8.10.1 Application.**

**8.10.1.1** This test method shall apply to dry suit materials and seams, dry suit hood materials and seams, glove materials and seams, dry suit attached integrated boot materials and seams, glove materials and seams, dry suit bootie materials and seams, and dry suit hood materials and seams.

**8.10.1.2** Modifications to this test method for testing glove materials shall be as specified in 8.10.8.

**8.10.1.3** Modifications to this test method for testing attached integrated boots shall be as specified in 8.10.9.

**8.10.2 Samples.** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.10.2.1** Samples shall be 1 m (1 yd) square of material for suit and suit seams, hood and hood seams, bootie and bootie seams, and whole elements for gloves and attached integrated boots.

**8.10.3 Specimens.**

**8.10.3.1** Specimens shall be as specified in 8.10.7, 8.10.8, or 8.10.9.

**8.10.3.2** Specimens shall consist of three 75 mm (3 in.) squares for each material type unless otherwise specified.

**8.10.3.3** A minimum of three specimens shall be tested for each material type.

**8.10.4 Procedure.**

**8.10.4.1** Biopenetration resistance testing shall be conducted in accordance with ASTM F1671/1671M, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System.*

**8.10.4.2** The normal outer surface of the material as oriented in the clothing item shall be exposed to the liquid.

**8.10.5 Report.** The pass or fail result for each specimen shall be recorded and reported.

**8.10.6 Interpretation.** One or more failures of any specimen against any liquid shall constitute failure of the material.

**8.10.7 Specific Requirements for Testing Suit, Hood, and Attached Integrated Bootie Materials.** Specimens shall consist of the barrier layer that is intended to prevent the penetration of liquids.

**8.10.8 Specific Requirements for Testing Glove Materials.**

**8.10.8.1** Specimens shall be representative of the glove moisture barrier and moisture barrier seams. Three specimens shall be tested.

**8.10.8.2** Samples for conditioning shall be in the form of a 200 mm × 200 mm (8 in. × 8 in.) pouch. The pouch shall be made of two glove body composite swatches. The two glove body composites shall be permitted to be of the same materials and construction. The two glove body composites shall be permitted to be representative of either the palm or the back of the glove. The two composite swatches shall be 200 mm × 200 mm (8 in. × 8 in.), and shall be constructed to simulate the actual layers of the glove, arranged in proper composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

**8.10.8.2.1** Where the moisture barrier material is continuous throughout the glove body, the moisture barrier layers shall contain a seam. The seam shall run within 25 mm (1 in.) of the center and shall extend across the entire width of the specimen.

**8.10.8.3** The glove moisture barrier layers shall be removed from the multilayer composite samples after all preconditioning has been completed and shall become the glove barrier test specimen.

**8.10.8.4** Specimens for testing shall be the barrier layer only.

**8.10.9 Specific Requirements for Testing Footwear Materials.** Three specimens shall be representative of the moisture barrier, and three specimens shall be representative of each type of moisture barrier seam. Only that separable layer of the footwear item intended to prevent the penetration of liquids shall be tested. Attached integrated boot shall be subjected only to the conditioning specified in 8.1.2 prior to testing.

**8.11 Cut Resistance Test.**

**8.11.1 Application.**

**8.11.1.1** This test method shall apply to dry suit, hood, and bootie materials, gloves, and footwear.

**8.11.1.2** Modifications to this test method for evaluation of dry suit bootie materials shall be as specified in 8.11.8.

**8.11.1.3** Modifications to this test method for evaluation of glove materials shall be as specified in 8.11.7.

**8.11.1.4** Modifications to this test method for evaluation of attached integrated boots shall be as specified in 8.11.8.

**8.11.2 Samples.** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.11.3 Specimens.** Specimens shall be the size specified in ASTM F1790/F1790M, *Standard Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing with CPP Test Equipment,* consisting of all layers.

**8.11.4 Procedure.** Specimens shall be evaluated in accordance with ASTM F1790/F1790M, *Standard Test Method for Meas-*

*uring Cut Resistance of Materials Used in Protective Clothing with CPP Test Equipment*, with the modification that specimens shall be tested to a specific load with the measurement of blade travel distance.

**8.11.5 Report.**

**8.11.5.1** The blade travel distance shall be recorded and reported to the nearest 1 mm (1/32 in.) for each sample specimen.

**8.11.5.2** The average blade travel distance in mm shall be recorded and reported for all specimens tested.

**8.11.6 Interpretation.** The average blade travel distance shall be used to determine pass or fail performance.

**8.11.7 Specific Requirements for Testing Glove Materials.**

**8.11.7.1** Specimens shall be taken from the back and palm of the glove and shall not include seams.

**8.11.7.2** Samples shall be in the form of a complete glove.

**8.11.7.3** After conditioning, the glove and necessary stitching shall be cut to form specimens for testing.

**8.11.7.4** Cut resistance testing shall be performed under a load of 200 g (0.44 lb).

**8.11.8 Specific Requirements for Testing Attached Integrated Boots Upper Materials.**

**8.11.8.1** Samples shall be attached integrated boots uppers or representative materials.

**8.11.8.2** Specimens shall consist of each composite of footwear upper that provide uniform thickness and shall not include seams.

**8.11.8.3** Cut resistance testing shall be performed under a load of 800 g (1.76 lb).

**8.12 Abrasion Resistance Test One.**

**8.12.1 Application.**

**8.12.1.1** This test method shall apply to dry suit, dry suit bootie, and dry suit hood materials.

**8.12.2 Samples.**

**8.12.2.1** Samples for conditioning shall be at least 1 m (1 yd.) square of material.

**8.12.2.2** Samples shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

**8.12.3 Specimens.**

**8.12.3.1** Specimens shall be the size specified in ASTM D3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*.

**8.12.3.2** A minimum of ten specimens in each of the warp direction, machine or course, and the filling direction, cross machine or wales, shall be tested.

**8.12.3.3** If the material is isotropic, then 20 specimens shall be tested.

**8.12.4 Procedure.**

**8.12.4.1** Five specimens in each direction, or ten specimens if the material is isotropic, shall be subjected to abrasion in accordance with ASTM D3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*, under the following conditions:

(1) A 0.23 kg (0.5 lb) head weight shall be used.
(2) A 1.35 kg (3.0 lb) back weight shall be used.
(3) The specimen shall be abraded for 500 continuous cycles.

**8.12.4.2** After being abraded as specified in 8.1.5, both abraded and non-abraded specimens shall be tested in accordance with ASTM D5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*.

**8.12.5 Report.**

**8.12.5.1** The breaking strength of each specimen shall be recorded and reported to the nearest 0.2 N (0.1 lbf).

**8.12.5.2** An average breaking strength before and after abrasion shall be individually calculated and reported for the warp and filling directions.

**8.12.5.3** For isotropic materials, a single average breaking strength after abrasion shall be calculated.

**8.12.5.4** The percentage change in breaking strength between the non-abraded and abraded specimens shall be calculated in each material direction as specified in the following equation:

**[8.12.5.4]**

$$\text{Percent change in breaking strength} = \frac{\text{breaking strength}_{\text{non-abraded}} - \text{breaking strength}_{\text{abraded}}}{\text{breaking strength}_{\text{non-abraded}}} \times 100$$

**8.12.6 Interpretation.**

**8.12.6.1** Pass or fail performance shall be based on the percent change in average breaking strength after abrasion in the warp and filling directions.

**8.12.6.2** Failure in any one direction constitutes failure for the material.

**8.13 Zipper Strength Test.**

**8.13.1 Application.** This test method shall apply to all protective suit zippers.

**8.13.2 Samples.** Samples shall be conditioned as specified in 8.1.2.

**8.13.3 Specimens.** A minimum of three specimens shall be tested.

**8.13.4 Procedure.** Zippers shall be tested in accordance with ASTM D2061, *Standard Test Methods for Strength Tests for Zippers*, and the following procedures shall be used:

(1) Strength of Chains and Elements, Sections 9–16, Chain Crosswise Strength
(2) Where separating zippers are used, Holding Strengths of Separable Units, Sections 25–32, Separating Unit, Crosswise
(3) Where non-separating zippers are used, Holding Strengths and Stops, Sections 17–24, Bottom Stop Holding, Crosswise

**8.13.5 Report.**

**8.13.5.1** The crosswise strength of each specimen shall be recorded and reported.

**8.13.5.2** The average crosswise strength of all specimens shall be calculated, recorded, and reported.

**8.13.6 Interpretation.**

**8.13.6.1** The average crosswise strength shall be used to determine pass or fail performance.

**8.13.6.2** Where an individual result from any test set varies more than ±10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

**8.14 Resistance to Twist of Pull and Slider Test.**

**8.14.1 Application.** This test method shall apply to all protective suit zippers.

**8.14.2 Samples.** Samples shall be conditioned as specified in 8.1.2.

**8.14.3 Specimens.** A minimum of three specimens shall be tested.

**8.14.4 Procedure.** Zippers shall be tested in accordance with Sections 52-61, Resistance to Twist of Pull and Slider Test, of ASTM D2061, *Standard Test Methods for Strength Tests for Zippers.*

**8.14.5 Report.** The average force shall be calculated, recorded, and reported.

**8.14.6 Interpretation.**

**8.14.6.1** The average resistance to twist strength shall be used to determine pass or fail performance.

**8.14.6.2** Where an individual result from any test set varies more than ±10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

**8.15 Opening and Closing of Zippers Test.**

**8.15.1 Application.** This test method shall apply to all protective suit zippers.

**8.15.2 Samples.** Samples shall be conditioned as specified in 8.1.2.

**8.15.3 Specimens.** A minimum of three specimens shall be tested.

**8.15.4 Procedure.** Zippers shall be tested in accordance with Sections 14-17, Opening and Closing of Zippers Test, of ASTM D2062, *Standard Test Methods for Operability of Zippers.*

**8.15.5 Report.**

**8.15.5.1** The operability force of each specimen shall be calculated, recorded, and reported.

**8.15.5.2** The average operability force of all specimens shall be calculated, recorded, and reported.

**8.15.6 Interpretation.**

**8.15.6.1** The average operability force shall be used to determine pass or fail performance.

**8.15.6.2** Where an individual result from any test set varies more than ±10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

**8.16 Zipper Point Breaking Strength Test.**

**8.16.1 Application.** This test method shall apply to all protective suit zippers.

**8.16.2 Samples.**

**8.16.2.1** Dry suit zipper samples shall be conditioned as specified in 8.1.2.

**8.16.2.2** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.16.3 Specimens.** A minimum of three specimens shall be tested.

**8.16.4** Procedure Zippers shall be tested as specified in Section 6.3.6.2, Point Breaking Strength Test, of CAN/CGSB-65.16, *Immersion Suit Systems.*

**8.16.5 Report.**

**8.16.5.1** The point breaking strength of each specimen shall be recorded and reported.

**8.16.5.2** The average point breaking strength of all specimens shall be calculated, recorded, and reported.

**8.16.6 Interpretation.**

**8.16.6.1** The average point breaking strength shall be used to determine pass or fail performance.

**8.16.6.2** Where an individual result from any test set varies more than ±10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

**8.17 Retroreflectivity Test.**

**8.17.1 Application.**

**8.17.1.1** This test method shall apply to visibility markings used on dry suits and hoods.

**8.17.1.2** Visibility markings shall be tested for each procedure specified in 8.17.4.

**8.17.2 Samples.**

**8.17.2.1** Samples for the conditioning shall include 305 mm (12 in.) long sections of visibility markings.

**8.17.2.2** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.17.3 Specimens.**

**8.17.3.1** A minimum of three of each visibility marking specimens shall be tested.

**8.17.3.2** Each visibility marking test specimen shall be 100 mm × 100 mm (4 in. × 4 in.) of the finished visibility marking product.

**8.17.3.3** Where retroreflective and nonretroreflective surface areas are combined to form visibility markings, the specimen shall consist of the retroreflective and nonretroreflective portions of the finished visibility marking product.

**8.17.4 Procedures for Measurement of Coefficient of Retroreflection.**

**8.17.4.1** The coefficient of retroreflection *(Ra)* shall be measured in accordance with ASTM E810, *Standard Test Method for*

*Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry*, with the following modifications:

(1) Test distance = 15.2 m (50 ft).
(2) Observation angle = 0.2 degree.
(3) Entrance angle = +5.0 degrees.
(4) The receiver shall be provided with an entrance aperture of 25 mm (1 in.), ±5 percent, in diameter, which is equivalent to 0.1 degree angular aperture.
(5) The exit aperture of the source shall be circular and 26 mm (1 in.), ±5 percent, in diameter, which corresponds to 0.1 degree angular aperture.
(6) Retroreflector reference angle = 90 degrees.
(7) Datum mark shall be placed as specified by the visibility markings manufacturer.

**8.17.4.2** The $R_a$ shall be calculated by the following equation:

**[8.17.4.2]**

$$R_a = \frac{R_i}{A_s}$$

where:
$R_i$ = the coefficient of luminous intensity measured as specified in 8.16.4.1
$A_s$ = only the retroreflective surface area of the visibility marking test specimen's surface area

**8.17.4.3** $A_s$ shall be calculated by subtracting the nonretroreflective surface area from the test specimen's total surface area.

**8.18 Corrosion Resistance Test.**

**8.18.1 Application.**

**8.18.1.1** This test method shall apply to all hardware items.

**8.18.2 Samples.** Samples shall be conditioned as specified in 8.1.2.

**8.18.3 Specimens.** A total of three specimen of each hardware type shall be tested.

**8.18.4 Procedure.**

**8.18.4.1** Specimens shall be tested in accordance with ASTM B117, *Standard Practice of Using Salt Spray (Fog) Apparatus*. Hardware items shall be exposed to a 5 percent, ±1 percent, saline solution for a period of 48 hours.

**8.18.4.2** Immediately following the storage specified in 8.18.4.1 and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

**8.18.4.3** Specimens shall then be examined visually with the unaided eye to determine the presence of corrosion.

**8.18.4.4** The functionality of each specimen shall be evaluated.

**8.18.5 Report.** The presence of corrosion and the functionality of each specimen shall be recorded and reported.

**8.18.6 Interpretation.** One or more hardware specimens failing this test shall constitute failing performance for the hardware type.

**8.18.7 Specific Requirements for Testing Suit, Glove, and Footwear Hardware.**

**8.18.7.1** Samples shall be whole hardware items.

**8.18.7.2** A total of three specimens of each hardware type shall be tested.

**8.19 Label Durability and Legibility Test.**

**8.19.1 Application.**

**8.19.1.1** This test method shall apply to labels on dry suits, hoods, gloves, and footwear.

**8.19.1.2** Modifications to this test method for testing suit, and hood labels shall be as specified in 8.19.7.

**8.19.1.3** Modifications to this test method for testing glove labels shall be as specified in 8.19.8.

**8.19.1.4** Modifications to this test method for testing footwear labels shall be as specified in 8.19.9.

**8.19.2 Samples.** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.19.3 Specimens.**

**8.19.3.1** A minimum of three specimens of each type of label for each element shall be tested in each test.

**8.19.3.2** Where labels have an area of "write-in" information, two additional specimens shall be tested that include those areas with sample information written in.

**8.19.4 Procedures.**

**8.19.4.1 Laundering Durability Test.**

**8.19.4.1.1** Specimens shall be subjected to 10 cycles of laundering and drying using Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai of AATCC 135, *Dimensional Changes of Fabrics After Home Laundering*.

**8.19.4.1.2** A 1.8 kg, ±0.1 kg (4.0 lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

**8.19.4.1.3** Specimens shall be examined for legibility to the unaided eye by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 305 mm (12 in.) in a well illuminated area.

**8.19.4.2 Abrasion Durability Test.**

**8.19.4.2.1** Specimens shall be subjected to abrasion in accordance with ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)*, with the following modifications:

(1) The standard abrasive fabric and the felt-backing fabric shall be soaked for 24 hours or agitated in distilled water so that they are thoroughly wet.
(2) The standard abrasive fabric shall be rewetted after each set of cycles by applying 20 ml (0.68 oz) of distilled water from a squeeze bottle by squirting on the center of the abrasive composite pad.
(3) Specimens shall be subjected to 200 cycles, 3200 revolutions, of the test apparatus.

**8.19.4.2.2** Specimens shall be examined for legibility to the unaided eye by a person with 20/20 vision, or vision corrected

to 20/20, at a nominal distance of 305 mm (12 in.) in a well illuminated area.

**8.19.5 Report.** The legibility of each specimen shall be recorded and reported as acceptable or unacceptable.

**8.19.6 Interpretation.** One or more label specimens failing this test shall constitute failing performance.

**8.19.7 Specific Requirements for Testing Dry Suit and Hood Labels.**

**8.19.7.1** For testing label legibility after laundering, specimens shall include individual labels sewn onto a 1 m (1 yd) square of ballast material no closer than 50 mm (2 in.) apart in parallel strips. For labeling that is stamped or sealed onto test material, the label and test material will be tested together.

**8.19.7.2** The ballast material shall be as specified in AATCC 135, *Dimensional Changes of Fabrics After Home Laundering*.

**8.19.7.3** For testing label legibility after abrasion, specimens shall be individual labels.

**8.19.7.4** Specimens shall be tested separately for legibility after laundering and abrasion as specified in 8.19.4.1 and 8.19.4.2, respectively.

**8.19.8 Specific Requirements for Testing Protective Glove Labels.**

**8.19.8.1** For testing label legibility after laundering, specimens shall include gloves with labels attached.

**8.19.8.2** For testing label legibility after abrasion, specimens shall be individual labels.

**8.19.8.3** Specimens shall be tested separately for legibility after laundering and abrasion as specified in 8.19.4.1 and 8.19.4.2, respectively.

**8.19.9 Specific Requirements for Testing Protective Attached Integrated Boot Labels.**

**8.19.9.1** For testing label legibility after laundering, specimens shall include protective attached integrated boot with labels attached.

**8.19.9.2** For testing label legibility after abrasion, specimens shall be individual labels.

**8.19.9.3** Specimens shall be tested separately for legibility after laundering and abrasion as specified in 8.19.4.1 and 8.19.4.2, respectively.

**8.20 Puncture Resistance Test.**

**8.20.1 Application.**

**8.20.1.1** This test method shall apply to glove and footwear materials.

**8.20.1.2** Modifications to this test method for testing glove materials shall be as specified in 8.20.7.

**8.20.1.3** Modifications to this test method for testing protective footwear upper material, including overboot uppers, shall be as specified in 8.20.8.

**8.20.1.4** Modifications to this test method for testing footwear soles shall be as specified in 8.20.9.

**8.20.2 Samples.** Samples shall be conditioned as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

**8.20.3 Specimens.**

**8.20.3.1** Specimens shall be at least 150 mm (6 in.) square.

**8.20.3.2** At least three specimens shall be tested.

**8.20.4 Procedure.** Specimens shall be tested in accordance with ASTM F1342/1342M, *Standard Test Method for Protective Clothing Material Resistance to Puncture*.

**8.20.5 Report.**

**8.20.5.1** The puncture force shall be recorded and reported for each specimen to the nearest 0.4 N (0.1 lb) of force.

**8.20.5.2** The average puncture force shall be recorded and reported for all specimens tested.

**8.20.6 Interpretation.** The average puncture force shall be used to determine pass or fail performance.

**8.20.7 Specific Requirements for Testing Glove Materials.**

**8.20.7.1** Samples shall be in the form of complete gloves.

**8.20.7.2** After conditioning, the pouch and necessary stitching shall be cut to form specimens for testing.

**8.20.7.3** Specimens shall consist of each composite of the palm and palm side of the fingers with layers arranged in the proper order. Where the specimen composites of the palm and palm side of the fingers are identical, only one representative composite shall be required to be tested.

**8.20.8 Specific Requirements for Testing Protective Footwear Upper Materials.**

**8.20.8.1** Samples shall be footwear uppers or representative materials.

**8.20.8.2** Specimens shall be taken from the thinnest portion of the footwear upper. The footwear upper shall include the toe, vamp, quarter, shaft, collar, and throat, but shall not include the sole.

**8.20.9 Specific Requirements for Testing Protective Footwear Soles.**

**8.20.9.1** Specimens shall consist of each composite of the footwear item sole, including the heel, used in the actual suit footwear configuration, with layers arranged in proper order.

**8.20.9.2** Specimens shall be taken from the thinnest portion of the footwear sole.

**8.21 Abrasion Resistance Test Two.**

**8.21.1 Application.**

**8.21.1.1** This test method shall apply to glove palm composites and footwear materials.

**8.21.1.2** Modifications to this test method for testing glove composite shall be as specified in 8.21.7.

**8.21.1.3** Modifications to this test method for testing footwear upper materials, including overboot uppers, shall be as specified in 8.21.8.

**8.21.1.4** Modifications to this test method for testing footwear soles shall be as specified in 8.21.9.

**8.21.2 Samples.**

**8.21.2.1** Samples shall be as specified in 8.21.7, 8.21.8, or 8.21.9.

**8.21.2.2** Samples shall be conditioned as specified in 8.1.2.

**8.21.3 Specimens.**

**8.21.3.1** Specimens shall be as specified in 8.21.7, 8.21.8, or 8.21.9.

**8.21.3.2** Specimens shall be the size specified in ASTM D3884, *Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method).*

**8.21.3.3** At least five specimens of each different dry suit protective gloves, dry suit footwear uppers, and dry suit footwear soles shall be tested.

**8.21.4 Procedure.**

**8.21.4.1** Specimens shall be tested in accordance with ASTM D3884, *Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, using a Calibrase H-18 wheel using a total of 2500 cycles.

**8.21.4.2** At the end of each abrasion exposure, the specimen shall be examined for wear-through of the outermost separable layer.

**8.21.5 Report.** The wear-through determination shall be recorded and reported for each specimen tested.

**8.21.6 Interpretation.** Any specimen showing wear-through shall constitute failure of this test.

**8.21.7 Requirements for Testing Protective Glove Composites.**

**8.21.7.1** Specimens shall be taken from the palm area of the gloves and shall not include seams. Samples and specimens shall be permitted to be materials representative of those used in the construction of the glove. Specimens shall consist of the outer separable layer of the glove composite.

**8.21.7.2** A load of 500 g (1.1 lb) on each wheel shall be used in abrasion testing of gloves.

**8.21.8 Requirements for Testing Protective Footwear Upper Materials.**

**8.21.8.1** Specimens shall be taken from the footwear upper area and shall not include seams. Samples and specimens shall be permitted to be materials representative of those used in the construction of the footwear upper. Specimens shall consist of the outer separable layer of the boot composite.

**8.21.8.2** The footwear upper shall include the toe, vamp, quarter, shaft, collar, and throat, but shall not include the sole.

**8.21.8.3** A load of 1000 g (2.2 lb) on each wheel shall be used in abrasion testing offootwear.

**8.21.9 Requirements for Testing Protective Footwear Soles.**

**8.21.9.1** Samples and specimens shall be permitted to be materials representative of those used in the construction of the footwear upper. Specimens shall consist of the outer separable layer of the boot composite.

**8.21.9.2** Specimens shall consist of each composite of the footwear item sole, including the heel, used in the actual suit footwear configuration, with layers arranged in the proper order.

**8.21.9.3** A load of 1000 g (2.2 lb) on each wheel shall be used in abrasion testing of footwear.

**8.21.9.4** A total of 5000 cycles shall be used to evaluate abrasion resistance.

**8.22 Torque Test.**

**8.22.1 Application.** This test method shall apply to gloves.

**8.22.2 Samples.**

**8.22.2.1** Samples for conditioning shall be whole gloves.

**8.22.2.2** Sample glove pairs shall be preconditioned as specified in 8.1.3.

**8.22.3 Specimens.**

**8.22.3.1** A minimum of three glove specimens each for size small and size large shall be used for testing.

**8.22.3.2** Right-hand specimen gloves shall be used for right-hand dominant test subjects while left-hand specimen gloves shall be used for left-hand dominant test subjects.

**8.22.3.3** Each specimen glove shall be tested in new, as distributed, condition.

**8.22.3.4** Specimen gloves shall be tested for each material and construction combination.

**8.22.3.5** Specimen gloves shall be tested after being conditioned for wet conditions as specified in Section 8.1.

**8.22.4 Apparatus.**

**8.22.4.1** Torque testing shall be evaluated with the use of an acrylic cylinder with diameter 1⅝ in. securely centered on a calibrated digital torque meter capable of measuring up to 88.5 lb-in (10.00 N-m).

**8.22.5 Procedure.**

**8.22.5.1** Test subjects with the proper hand size shall be selected for testing size small and large gloves.

**8.22.5.2** While standing, each test subject shall grasp the cylinder so that the elbow is against the side of the body and the arm bend creates a right angle.

**8.22.5.3** For right-hand dominant test subjects, the direction mode on the torque device shall be set to "open" or counter-clockwise and set to "close" or clockwise for left-hand dominant test subjects.

**8.22.5.4** Each test subject shall make five successive attempts to twist the cylinder in the appropriate direction exerting as much force as possible. The range of motion of the subject's arm shall indicate the end of the twisting cycle. The average max force over the five attempts shall be the bare-handed control value.

**8.22.5.5** Wet conditioned specimen gloves shall be tested on a wet acrylic cylinder. Gloves shall be subjected to wet conditioning as specified in Section 8.1. The pipe shall be wet conditioned between attempts by wiping with a damp rag.

**8.22.5.6** Each test subject shall test a minimum of three sample gloves using the method specified in 8.22.5.1 through 8.22.5.4. Test subjects shall attempt one trial with each glove. A trial shall consist of five successive attempts. The average maximum twisting force over the five attempts shall be the twisting

force with the glove. The average twisting force shall be calculated, recorded, and reported for each glove.

**8.22.5.7** The average max twisting force with gloves over the three trials for each size shall be calculated, recorded, and reported. The average twisting force shall be compared with the barehanded control value.

**8.22.5.8** The percentage of bare-handed control value shall be calculated as follows:

**[8.22.5.8]**

$$\frac{TF_g}{CV_b} \times 100$$

where:
$TF_g$ = average twisting force with glove
$CV_b$ = bare-handed control value

**8.22.6 Report.** The percentage of bare-handed control value shall be recorded and reported for each specimen glove size.

**8.22.7 Interpretation.**

**8.22.7.1** The percentage of bare-handed control value for size small and size large shall be used to determine pass or fail performance.

**8.22.7.2** Failure of either size shall constitute failure of the test.

**8.23 Slip Resistance.**

**8.23.1 Application.** This test method shall apply to footwear.

**8.23.2 Samples.**

**8.23.2.1** Samples shall be the whole footwear in men's size 9D, medium width.

**8.23.2.2** Samples shall be conditioned as specified in ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester.*

**8.23.3 Specimens.**

**8.23.3.1** Specimens shall be the whole footwear in men's size 9D, medium width.

**8.23.3.2** At least three specimens shall be tested.

**8.23.4 Procedure.** Slip resistance shall be performed in accordance with ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester.* in the following configurations. References to any other flooring and/or contaminate within ASTM F2913 shall not apply.

**8.23.4.1** Footwear shall be tested both in the forepart and heel positions.

**8.23.4.2** Footwear shall be tested in the wet condition. The wet condition shall be achieved using distilled or de-ionized water. The water shall be applied to thoroughly wet the testing surface and to the bottom of the footwear and make a pool at least as wide and long as the test portion of the footwear in the area of initial contact.

**8.23.4.3** Footwear shall be tested on a quarry tile surface that meets the specifications of ASTM F2913 and shall be calibrated in accordance with ASTM F2913. The calibration frequency of every 10 tests specified in ASTM F2913 shall be equivalent to 50 test runs.

**8.23.5 Report.**

**8.23.5.1** The coefficient of friction of each specimen shall be reported.

**8.23.5.2** The average coefficient of friction of all specimens for each configuration shall be calculated, recorded, and reported.

**8.23.6 Interpretation.** The average coefficient of friction for each configuration shall be used to determine pass/fail performance.

**8.24 Footwear Drainage Test.**

**8.24.1 Application.** This test method shall apply to protective dry suit overboot.

**8.24.2 Samples.**

**8.24.2.1** Samples shall be whole protective dry suit overboot.

**8.24.2.2** Samples shall be conditioned as specified in 8.1.2.

**8.24.3 Specimens.** At least three complete protective dry suit overboot shall be tested.

**8.24.4 Procedure.**

**8.24.4.1** Individual dry suit overboot specimens shall be weighed to the nearest gram.

**8.24.4.2** Specimens shall be fully submerged in an upright position in a tank of water for a period of 5 minutes.

**8.24.4.3** Water in tank shall be tap water maintained at 21°C, ±3°C (70°F, ±5°F).

**8.24.4.4** Specimens shall be removed from the water completely and allowed to drain in the upright position for a period of 60 seconds.

**8.24.4.5** Within 30 seconds following draining, the individual dry suit overboot specimens shall be weighed to the nearest gram. The weights of each specimen shall be recorded.

**8.24.5 Report.**

**8.24.5.1** The weights of the individual wet dry suit overboot specimens before submersion shall be recorded and reported.

**8.24.5.2** The weights of the individual dry suit overboot specimens after submersion shall be recorded and reported.

**8.24.5.3** The difference between the before-submersion weight and the after-submersion weight of the individual dry suit footwear specimens shall be recorded and reported.

**8.24.6 Interpretation.**

**8.24.6.1** For the dry suit overboot specimens, the difference between dry and wet weights shall be used to determine pass or fail performance.

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

**8.25 Chemical Degradation Resistance Test for Exhaust Valves.**

**8.25.1 Application.** This test method shall apply to dry suit exhaust valves.

**8.25.2 Sample Preparation.**

**8.25.2.1** Samples shall be a complete exhaust valve mounted in a section of dry suit material sufficient to meet the specimen requirements specified in 8.25.4.1. The same means of mounting applied in the construction of the dry suit in Section 6.1 shall be applied in the preparation of the sample.

**8.25.2.2** Samples shall be conditioned as specified in 8.1.2 after the conditioning specified in the modifications.

**8.25.3 Specimens.** At least three specimens shall be tested.

**8.25.4 Apparatus.**

**8.25.4.1** Exhaust valves shall be exposed to chemicals using the penetration test cell specified in ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, with the following modifications:

(1) The test cell shall be permitted to have its liquid cavity diameter and the overall test cell diameter increased to permit for the placement of the mounted exhaust valve sample inside the sample such that there is a minimum clearance of 12 mm (0.5 in.) from the mounted exhaust valve to the sides of the test cell.
(2) The Plexiglas® shield shall be omitted from the test cell.

**8.25.5 Procedures.**

**8.25.5.1** The specimen shall be placed and sealed in the test cell described in 8.25.4.1 such that the normal exterior side of the exhaust valve is oriented towards the liquid reservoir.

**8.25.5.2** The specimen shall be exposed to the chemicals listed in 8.25.5.3, 8.25.5.4, and 8.25.5.5, as appropriate for the representation of contamination made by the manufacturer, with the following modifications:

(1) All tests shall be conducted at 25°C, ±3°C (77°F, ±5°F).
(2) The test cell shall be permitted to be modified to accommodate the shape of the test specimens without affecting other parts of the test procedure.

**8.25.5.3** Exhaust valves shall be exposed to the following liquid chemicals at a concentration of 5 percent (w/v):

(1) Acetonitrile
(2) Diethylamine
(3) Dimethylformamide
(4) Ethyl acetate
(5) Methanol
(6) Sodium hydroxide
(7) Sulfuric acid
(8) Tetrahydrofuran

**8.25.5.4** Where chemicals are not miscible or soluble in water, the solution shall be allowed to naturally separate during the test exposure.

**8.25.5.5** Exhaust valve specimens shall be exposed to the following liquids without dilution:

(1) IRM 901, specified in ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*
(2) Diesel/heating oil (ISO Liquid F), specified in ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*
(3) High octane (ISO Liquid C), specified in ISO 1817

**8.25.5.6** Dry suits being represented for severe contamination shall be exposed for 1 hour, +1 minute/–0 minute.

**8.25.5.7** Dry suits being represented for moderate contamination shall be exposed for 10 minutes, +30 seconds/–0 seconds.

**8.25.5.8** Following exposure to the chemicals, specimens shall be evaluated for inward leakage as specified in Section 8.3, by draining the chemical and refilling the test cell with water as specified in 8.3.3.

**8.25.6 Report.**

**8.25.6.1** The pass or fail results for each chemical tested shall be recorded and reported.

**8.25.6.2** The identification of the locations where penetration occurs, if discernible, shall be recorded and reported.

**8.25.7 Interpretation.** Observed liquid penetration at the end of the test for any specimen shall constitute failure of this test.

**8.26 Hood to Full-Face Diving Mask Seal Test.**

**8.26.1 Application.** This test method shall apply to seal between dry suit hood and a full-face diving mask for use in moderate contamination.

**8.26.2 Specimens.**

**8.26.2.1** Specimens shall be a dry suit or a waterproof bag, with the hood seal, constructed of the same material used for the dry suit, the dry suit hood, and the full-face diving mask.

**8.26.2.2** The specimen shall have a two-way air valve installed by the manufacturer to allow for inflating. The mask shall have a blanking plug installed where the regulator would normally be located.

**8.26.2.3** Specimens shall be conditioned as specified in 8.1.2 and 8.1.3.

**8.26.2.4** A minimum of three hood specimens shall be tested with each manufacturer's mask supplied for compliance.

**8.26.3 Procedure.** The test shall be performed in accordance with the following procedure:

(1) The hood shall be mounted on a head form and installed on the waterproof bag in accordance with the manufacturer's recommendations. Due to the rigidness of many head forms, modifications to the head form shall be permitted to allow for a more representative seal between the hood and the mask.
(2) The mask shall be placed on the hooded head form with a minimum of 20 mm overlap between hood and mask skirt in accordance with the manufacturer's recommendations.
(3) The complete specimen shall be placed in water in a position that submerges the entire mask. The specimen shall then be pressurized to 0.3 psi and shall maintain the pressure for 10 minutes.
(4) At the conclusion of the 10-minute submergence, the specimen shall be removed from the water and the exterior of the complete specimen shall be towel dried.

(5) The mask shall be carefully removed and the interior of the mask and the facial area of the hooded head form shall be examined for moisture.

**8.26.3.1** This procedure shall be performed on all three specimens.

**8.26.3.2** This procedure shall be repeated with the mask of each manufacturer to ensure compliance.

**8.26.4 Report.** Any moisture leakage for each specimen shall be recorded and reported, and all modifications made to the head form shall be recorded and reported.

**8.26.5 Interpretation.** Pass or fail determination shall be based on evidence of moisture leakage.

**8.27 Diving Hehnet Seal Test.**

**8.27.1 Application.** This test method shall apply to the mechanical attachment seal between the dry suit and the diving helmet for use in severe contamination.

**8.27.2 Specimens.**

**8.27.2.1** Specimens shall be the dry suit or a waterproof bag constructed of the same material used for the dry suit and the mechanical attachment between the suit and helmet. The specimen shall have a two-way air valve installed by the manufacturer. The mechanical attachment shall be attached to the specimen in the same manner as it would be on the suit.

**8.27.2.2** Samples shall be conditioned as specified in 8.1.2 and 8.1.3.

**8.27.2.3** A minimum of three specimens shall be tested with each mechanical attachment supplied for compliance.

**8.27.3 Procedure.** Testing the mechanical connections between the diving helmet and the bag shall be performed in accordance with the following procedure:

(1) The mechanical attachment used to attach the diving helmet and specimen shall be installed in accordance with the manufacturer's recommendations.
(2) A plate, or the like, shall be installed onto the mechanical attachment to seal the specimen.
(3) The complete specimen shall be placed in water for 10 minutes in a position that submerges the entire mechanical attachment. The specimen shall then be pressurized to 0.3 psi and shall maintain the pressure for 10 minutes.
(4) At the conclusion of the 10-minute submergence, the specimen shall be removed from the water, and the exterior of the complete specimen shall be towel dried.
(5) The mechanical attachment shall be removed from the specimen and the interior of the specimen shall be examined for moisture.

**8.27.3.1** This procedure shall be performed on all three specimens.

**8.27.3.2** This procedure shall be repeated with specimens from each of the manufacturers to ensure compliance.

**8.27.4 Report.** Any moisture leakage for each specimen shall be recorded and reported.

**8.27.5 Interpretation.** Pass or fail determination shall be based on evidence of moisture leakage.

**8.28 Chemical Penetration Resistance Test.**

**8.28.1 Application.** This test method shall apply to dry suit closure assemblies.

**8.28.2 Sample Preparation.**

**8.28.2.1** Samples shall be the dry suit closure assembly consisting of the closure in combination with the seam attaching the closure to the dry suit.

**8.28.2.2** Samples shall be conditioned as specified in 8.1.7 followed by 8.1.2.

**8.28.3 Specimens.**

**8.28.3.1** Following conditioning, a suitably sized specimen that properly fits the penetration test cell shall be cut from the conditioned sample, if necessary.

**8.28.3.2** At least three specimens shall be tested.

**8.28.4 Procedure.**

**8.28.4.1** Penetration resistance testing shall be conducted in accordance with ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, using the following modifications:

(1) All tests shall be conducted at 25°C, ±3°C (77°F, ±5°F).
(2) The test cell shall be permitted to be modified to accommodate the shape of the test specimens without affecting other parts of the test procedure.
(3) The polymethylmethacrylate (PMMA) shield shall be omitted from the test cell.
(4) Use of blotting paper at the end of the test shall be permitted to assist in the visual observation of liquid penetration. Visually observed chemical on the blotting paper shall constitute failure of this test.
(5) An observation to determine specimen penetration shall be made at the end of the chemical contact period.

**8.28.4.2*** The following ASTM F1101, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*, liquid chemicals at the specified concentrations shall be exposed for 1 hour, +1 minute/–0 minutes using Procedure C of ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, for those dry suits being represented for severe contamination:

(1) Acetonitrile
(2) Diethylamine
(3) Dimethylformamide
(4) Ethyl acetate
(5) Methanol
(6) Sodium hydroxide
(7) Sulfuric acid
(8) Tetrahydrofuran

**8.28.4.3*** The following additional mixtures shall be tested without dilution:

(1) IRM 901, specified in ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*
(2) Diesel/heating oil (ISO Liquid F), specified in ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*
(3) High octane (ISO Liquid C) specified in ISO 1817

**8.28.4.4** Dry suits being represented for severe contamination shall be tested using Procedure C of ASTM F903, *Standard Test*

*Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids.*

**8.28.4.5** Dry suits being represented for moderate contamination shall be tested using Procedure D of ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, using the following pressure/time sequence for a total 5-minute exposure:

(1) 5 minutes ambient pressure
(2) 1 minute at 13.8 kPa (2.0 psi)
(3) 4 minutes at ambient pressure

**8.28.5 Report.**

**8.28.5.1** The pass or fail results for each chemical tested shall be recorded and reported.

**8.28.5.2** The identification of the locations where penetration occurs, if discernible, shall be recorded and reported.

**8.28.6 Interpretation.** Observed liquid penetration at the end of the test for any specimen shall constitute failure of this test.

**8.29 Abrasion Resistance Test Three.**

**8.29.1 Application.** This test method shall apply to dry suit, dry suit bootie, and dry suit hood materials.

**8.29.2 Samples.**

**8.29.2.1** Samples for conditioning shall be at least 1 m (1 yd.) square of material.

**8.29.2.2** Samples shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

**8.29.3 Specimens.**

**8.29.3.1** Specimens shall be the size specified in 8.1.5(4).

**8.29.3.2** A minimum of ten specimens shall be tested.

**8.29.4 Procedure.**

**8.29.4.1** Five specimens shall be subjected to abrasion as specified in 8.1.5.

**8.29.4.2** After being abraded as specified in 8.1.5, both abraded and non-abraded specimens shall be tested for burst strength as specified in Section 8.5.

**8.29.5 Report.**

**8.29.5.1** The burst strength of each specimen shall be recorded and reported to the nearest 1 N (0.25 lbf).

**8.29.5.2** An average burst strength before and after abrasion shall be individually calculated and reported.

**8.29.5.3** The percentage change in burst strength between the non-abraded and abraded specimens shall be calculated as specified in the following equation:

**[8.29.5.3]**

$$\text{Percent change in burst strength} = \frac{\text{burst strength}_{\text{non-abraded}} - \text{burst strength}_{\text{abraded}}}{\text{burst strength}_{\text{non-abraded}}}$$

**8.29.6 Interpretation.** Pass or fail performance shall be based on the percent change in average burst strength after abrasion.

## Annex A Explanatory Material

*Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.*

**A.1.1** Some performance criteria in this standard were based on the U.S. Fire Administration Report FA-136, "Protective Clothing and Equipment Needs of Emergency Responders for Urban Search and Rescue Missions." This report documents the protective clothing and equipment needs for emergency responders engaged in surface water activities. Input was obtained from an emergency responder user requirements committee and resulted in proposed criteria based on a needs and risk analysis. The report contains survey results and test data for a number of materials.

**A.1.1.1** Emergency response personnel can encounter many common liquids during the normal performance of their duties. The reference to limited protection from chemical hazards in 1.1.1 and Chapter 7 should not be interpreted to mean that the protective suits are suitable or are permitted to be used for protection to the wearer during any hazardous materials situation.

**A.1.1.2** Contaminated water diving operations protective clothing and equipment is intended to protect emergency services personnel from physical dangers posed by exposure to in-water hazards and also those hazards that are associated with the climate and the adjacent area.

**A.1.1.4** Organizations responsible for any other technical rescue operations should use protective clothing and equipment specifically designed for those activities. The applicable standard is NFPA 1951.

Organizations responsible for fire-fighting applications should use protective clothing and equipment specifically designed for those activities. Applicable standards include the following:

(1) NFPA 1971
(2) NFPA 1977

Organizations responsible for hazardous chemical emergencies should use protective clothing and equipment specifically designed for those activities. Applicable standards include the following:

(1) NFPA 1991
(2) NFPA 1992

Organizations responsible for emergency medical operations should use protective clothing and equipment specifically designed for those activities. The applicable standard is NFPA 1999.

Organizations responsible for CBRN (chemical, biological, radiological, nuclear) incidents should use protective ensembles specifically designed for those activities. Applicable standards include NFPA 1994.

**A.1.1.5** Emergency services organizations are cautioned that accessories are not a part of the certified product but could be attached to the certified product by a means not engineered, manufactured, or authorized by the manufacturer. Emergency services organizations are cautioned that if the accessory or its means of attachment causes the structural integrity of the certified product to be compromised, the certified product might

not comply with the standard for which it was designed, manufactured, and marketed. Additionally, if the accessory or its attachment means are not designed and manufactured from materials suitable for the hazardous environments of emergency incidents, the failure of the accessory or its attachment means could cause injury to the emergency responder. Because the aftermarket for certified product accessories is so broad, emergency services organizations are advised to contact both the manufacturer of the accessory and the manufacturer of the certified product and verify that the accessory and its means of attachment are suitable for use in the intended emergency response environment. Emergency services organizations should seek and receive written documentation from both the accessory manufacturer and the manufacturer of the certified product to validate the following information:

(1) The accessory for a certified product and its attachment method will not degrade the designed protection or performance of the certified product below the requirements of the product standard to which it was designed, manufactured, tested, and certified.
(2) The accessory, when properly attached to the certified product, will not interfere with the operation or function of the certified product or with the operation or function of any certified product's component parts. Emergency services organizations are also cautioned that if the means of attachment of the accessory fails to safely and securely attach the accessory to the certified product, the accessory can inadvertently dislodge from the certified product, creating a risk to the wearer or other personnel in the vicinity.

**A.1.2.1** The authority having jurisdiction should perform a risk assessment to identify the hazards present and to determine the suitability of protective items specified by this standard. For each of the activities described as contaminated water dive incidents, the authority having jurisdiction should determine if the protection provided by compliant contaminated water dive operations protective clothing and equipment meeting this standard is commensurate with the level of protection needed as required by the hazards present.

**A.1.2.2** The testing requirements in Chapter 8 of this standard are not intended to establish the limitations of the working environment for contaminated water dive operations but are intended to establish material performance. Users should be advised that if unusual conditions prevail, or if there are signs of abuse or mutilation of the protective clothing and equipment or components thereof, or if modifications or replacements are made or accessories are added without authorization of the protective item manufacturer, the margin of protection could be reduced. Users should be advised that the protective properties in new contaminated water dive operations protective clothing and equipment, as required by this standard, can diminish as the product is worn and ages.

**A.1.2.3** This standard is not designed to be utilized as a purchase specification. It is prepared, as far as practicable, with regard to required performance, avoiding restriction of design wherever possible. Purchasers should specify departmental requirements for such items as color, markings, closures, and visibility marking patterns. Tests specified in this standard should not be deemed as defining or establishing performance levels for protection from all contaminated water diving environments.

**A.1.3.8** See A.1.1.5.

**A.1.4** Metric units are used throughout with U.S. equivalents provided in parentheses.

**A.3.2.1 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

**A.3.2.2 Authority Having Jurisdiction (AHJ).** The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**A.3.2.4 Listed.** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**A.3.3.10.2 Dry Suit Footwear.** Dry suit footwear could be an integrated attached boot or an integrated attached bootie with a separate overboot. The footwear is intended to be waterproof and to provide chemical and physical protection.

**A.3.3.20 Moderate Contamination.** It is recognized that real-time water quality analysis and monitoring are not feasible in the emergency setting. It is the responsibility of the authority having jurisdiction to conduct a risk analysis of the response area to determine the most likely exposure to contaminated water and the levels of protection needed for the rescuers. Examples include body recoveries, vehicle recovery, golf course ponds, farm ponds, drainage canals, and water with large numbers of waterfowl.

**A.3.3.23 Permeation.** Permeation involves the following: (1) sorption of molecules of the chemical into the contacted (challenge side) surface of the material, (2) diffusion of the absorbed molecules in the material, and (3) desorption of the molecules from the opposite (collection side) surface of the material.

**A.3.3.30 Severe Contamination.** It is recognized that real-time water quality analysis and monitoring are not feasible in the emergency setting. It is the responsibility of the authority having jurisdiction to conduct a risk analysis of the response

area to determine the possibility of exposure to contaminated water and the levels of protection needed for the rescuers. Examples of response areas include obvious fuel slicks; industrial chemical releases; aircraft, rail, and highway incidents where copious amounts of product or fuel are present; effluent ponds; and sewerage operations.

**A.4.1.4** The NFPA, from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment might be carrying labels falsely identifying them as compliant with an NFPA standard. The NFPA advises those purchasing protective ensembles or protective ensemble elements to be aware of the information regarding product certification and labeling in the following paragraphs.

For protective ensembles or protective ensemble elements to meet the requirements of NFPA 1953, they must be certified by an independent third-party certification organization. In addition, the item must carry the label, symbol, or other identifying mark of that certification organization. *A protective ensemble or element that does not bear the mark of an independent third-party certification organization is not compliant with NFPA 1953, even if the product label states that the protective ensemble or element is compliant.*

For further information about certification and product labeling, Chapters 4 and 5 of NFPA 1953 should be referenced. Also, the definitions of *certification/certified*, *labeled*, and *listed* in Chapter 3 should be reviewed.

Third-party certification is an important means of ensuring the quality of fire and emergency services protective clothing and equipment. To be certain that an item is properly certified, labeled, and listed, the NFPA recommends that prospective purchasers require appropriate evidence of certification for the specific product and model from the manufacturer before purchasing. Prospective purchasers also should contact the certification organizations and request copies of the certification organization's list of certified products to the appropriate NFPA standard. This listing is a requirement of third-party certification by this standard and is a service performed by the certification organization.

All NFPA standards on fire and emergency services protective clothing and equipment require that the item be certified by an independent third-party certification organization and, as with NFPA 1953 protective ensembles or protective ensemble elements, all items of fire and emergency services protective clothing and equipment must carry the label, symbol, or other identifying mark of that certification organization. *Any item of protective clothing or protective equipment covered by an NFPA standard that does not bear the mark of an independent third-party certification organization is not compliant with the appropriate NFPA standard, even if the product label states that the item is compliant.*

**A.4.2.1** The certification organization should have sufficient breadth of interest and activity so that the loss or award of a specific business contract would not be a determining factor in the financial well-being of the agency.

**A.4.2.5** The contractual provisions covering a certification program should contain clauses advising the manufacturer that if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently listed products. Without such clauses, certifiers would not be able to move quickly to protect their name, marks, or reputation. A product safety certification program would be deficient without these contractual provisions and the administrative means to back them up.

**A.4.2.6** Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the agency before any major testing is undertaken.

**A.4.2.7.1** For further information and guidance on recall programs, see 21 CFR 7, Subpart C.

**A.4.2.9** Such inspections should include, in most instances, witnessing of production tests. With certain products the certification organization inspectors should select samples from the production line and submit them to the main laboratory for countercheck testing. With other products, it can be desirable to purchase samples in the open market for test purposes.

**A.4.5.4** For example, this situation exists when a product is wholly manufactured and assembled by another entity or entities for a separate entity that puts its name and label on the product (frequently called "private labeling") and markets and sells the product as its own product.

**A.4.5.5** Subcontractors include, but are not limited to, a person or persons, company, firm, corporation, partnership, or other organization having an agreement with or under contract with the compliant product manufacturer to supply or assemble the compliant product or portions of the compliant product.

**A.4.6.2** By definition, a hazard might involve a condition that can be imminently dangerous to the end user. For that reason, the investigation should be started immediately and completed in as timely a manner as is appropriate considering the particulars of the hazard being investigated.

**A.4.6.11** The determination of the appropriate corrective action for the certification organization to initiate should take into consideration the severity of the product hazard and its potential consequences to the safety and health of end users. The scope of testing and evaluation should consider, among other things, testing to the requirements of the standard to which the product was listed as compliant, the age of the product, the type of use and conditions to which the compliant product has been exposed, care and maintenance that has been provided, the use of expertise on technical matters outside the certification organization's area of competence, and product hazards caused by circumstances not anticipated by the requirements of the applicable standard. As a guideline for determining which is more appropriate, a safety alert or a product recall, the following product hazard characteristics, which are based on 42 CFR 84, Subpart E, §84.41, are provided:

(1) Critical: A product hazard that judgment and experience indicate is likely to result in a condition immediately hazardous to life or health (IHLH) for individuals using or depending on the compliant product. If an IHLH condition occurs, the user will sustain, or will be likely to sustain, an injury of a severity that could result in loss of life or in significant bodily injury or loss of bodily function, either immediately or at some point in the future.

(2) Major A: A product hazard other than Critical that is likely to result in failure to the degree that the compliant product does not provide any protection or reduces protection and is not detectable to the user. The phrase *reduced protection* means the failure of specific protective

design(s) or feature(s) that results in degradation of protection in advance of reasonable life expectancy to the point that continued use of the product is likely to cause physical harm to the user or where continued degradation could lead to IHLH conditions.

(3) Major B: A product hazard other than Critical or Major A that is likely to result in reduced protection and is detectable to the user. The phrase *reduced protection* means the failure of specific protective design(s) or feature(s) that results in degradation of protection in advance of reasonable life expectancy to the point that continued use of the product is likely to cause physical harm to the user or where continued degradation could lead to IHLH conditions.

(4) Minor: A product hazard other than Critical, Major A, or Major B that is not likely to materially reduce the usability of the compliant product for its intended purpose or a product hazard that is a departure from the established applicable standard and has little bearing on the effective use or operation of the compliant product for its intended purpose.

Where the facts are conclusive, based on characteristics of the hazard classified as indicated in the preceding list, the certification organization should consider initiating the following corrective actions with the authorized and responsible parties:

(1) Critical product hazard characteristics: Product recall
(2) Major A product hazard characteristics: Product recall or safety alert, depending on the nature of the specific product hazard
(3) Major B product hazard characteristics: Safety alert or no action, depending on the nature of the specific product hazard
(4) Minor product hazard characteristic: No action

**A.5.1.1** Purchasers could wish to include a requirement in the purchase specifications for an additional label that includes certain information such as the date of manufacture, manufacturer's name, and suit identification number to be located in a protected location on the suit to reduce the chance of label degradation and as a backup source of information to aid in suit tracking or during an investigation.

**A.5.1.3** The NFPA, from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment could be carrying labels falsely identifying those items as compliant with an NFPA standard. The requirement for placing the certification organization's mark on or next to the product label is to help ensure that the purchaser can readily determine compliance of the product through independent third-party certification.

**A.5.2.4** A statement should be included in the user information specifying that, upon the purchaser's request, the manufacturer is to furnish all documentation required by this standard and the test data showing compliance with this standard. A statement also should be included in the user information specifying that, upon the purchaser's request, the manufacturer is to furnish a complete specification of all materials and components comprising each certified product.

**A.6.1.2** Divers adjust the level of insulation used under a dry suit to adjust for water temperature and anticipated thermal exposure. Therefore the available insulation layers that may be worn are outside the scope of this document and are not considered as a layer in multi-layer suits.

**A.6.1.5** It is highly recommended that a positive pressure full-face mask, similar to an SCBA mask, be used to minimize the risk of exposure to vapor contamination on the water's surface.

**A.6.1.7** The wrist seal would prevent contaminated water from entering the suit in the event the glove is breached. The neck seal would provide the same function in the event the hood or suit is breached.

**A.6.1.16** Protective clothing size is related directly to a suit's ability to function properly. Issues of proper fit are directly associated with the risk of injury. In occupations such as emergency services, proper fit and function of protective clothing are related directly to an individual's ability to perform jobs that are often hazardous. In addition, protective suit size has a direct impact on maintaining appropriate protection in areas where the protective suit has an interface with additional safety equipment or other protective suits.

**A.8.8.4.2** A subset of chemicals from the battery of chemicals was chosen on the basis of recommendations in U.S. Fire Administration Report FA-136, "Protective Clothing and Equipment Needs of Emergency Responders for Urban Search and Rescue Missions." This report recommended specifying chemicals from the list of chemicals in ASTM F1001, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*, that did not have high vapor pressures, that were not water reactive, and that had a measurable solubility in water. The report also recommended specifying chemicals with a vapor pressure cutoff of 250 mm Hg. Based on these criteria, the battery of 15 chemicals has been reduced to 8 chemicals.

An additional qualifier has been test to chemicals as a solution of water, based on the chemicals' relative solubility in water. The following rules were applied:

(1) Chemicals with relatively limited solubility or no solubility in water are not tested.
(2) Water-soluble chemicals are diluted in water to a maximum 25 percent concentration.
(3) At a lower level of solubility, the challenge chemical is saturated in water to its maximum solubility at room temperature.

The application of a subset of the chemicals from the ASTM F1001 battery is intended to address the potential of first responder exposure to unanticipated chemicals.

**A.8.28.4.2** See A.8.8.4.2.

**A.8.28.4.3** See A.8.8.4.4.

## Annex B Informational References

**B.1 Referenced Publications.** The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

**B.1.1 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*, 2020 edition.

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

NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*, 2016 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents*, 2016 edition.

NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies*, 2018 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incidents*, 2018 edition.

NFPA 1999, *Standard on Protective Clothing and Ensembles for Emergency Medical Operations*, 2018 edition.

**B.1.2 Other Publications.**

**B.1.2.1 ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM F1101, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*, 2017.

**B.1.2.2 FEMA Publications.** Federal Emergency Management Agency, U.S. Department of Homeland Security, 500 C Street, SW, Washington, DC 20472.

U.S. Fire Administration Report FA-136, "Protective Clothing and Equipment Needs of Emergency Responders for Urban Search and Rescue Missions," 1993.

**B.1.2.3 US Government Publications.** US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 21, Code of Federal Regulations, Part 7, Subpart C, 1997.

Title 42, Code of Federal Regulations, Part 84, Subpart E.

**B.2 Informational References. (Reserved)**

**B.3 References for Extracts in Informational Sections. (Reserved)**

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