NFPA® 1955

Standard on Personal Protective Equipment (PPE) for Surface Water Operations and Contaminated Water Operations

2025 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA® 1955

Standard on

Personal Protective Equipment (PPE) for Surface Water Operations and Contaminated Water Operations

2025 Edition

This edition of NFPA 1955, *Standard on Personal Protective Equipment (PPE) for Surface Water Operations and Contaminated Water Operations*, 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 November 16, 2024, with an effective date of December 6, 2024.

This edition of NFPA 1955 was approved as an American National Standard on December 6, 2024.

Origin and Development of NFPA 1955

This first edition of NFPA 1955 consolidates two standards: NFPA 1952 and NFPA 1953. This is part of the document consolidation plan affecting all the documents in the Emergency Response and Responder Safety (ERRS) project, first approved during the April 2019 Standards Council meeting. The content of each document was brought together with the others to form one complete standard, and each Technical Committee was still responsible for the content relative to their scope and purpose.

Overall, definitions were consolidated to account for meanings in both documents consolidated into NFPA 1955. The standard was written with separate scope and purpose chapters applying only to the specific content for that committee. To apply specific content from previous editions of each consolidated document, a roadmap was established in chapter one under the application heading and, in the annex, explaining how to do that.

NFPA 1955 does not deviate far from previous editions. There are some revisions to helmets and modifications to some of the test methods, including the removal of certain provisions deemed too restrictive because, as of the publication of this document, there are still no certified ensembles to NFPA 1952 or NFPA 1953. However, overall, NFPA 1955 is similar to the previous editions of NFPA 1952 and NFPA 1953. The committee will have to decide if they want to continue further developing this standard or cease making revisions and let it lapse.

For more information about the ERRS consolidation project, see nfpa.org/errs.

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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 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 firefighters 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.

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NFPA 1955

Standard on

Personal Protective Equipment (PPE) for Surface Water Operations and Contaminated Water Operations

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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 D.

Chapter 1 Administration

1.1 Scope

1.1.1 This standard provides minimum design, performance, testing, and certification requirements for the following:

(1) New protective clothing and equipment items, including full body suits, helmets, gloves, footwear, and personal flotation devices designed to provide limited protection from physical, environmental, thermal, and certain common chemical and biological hazards for emergency services personnel during surface water operations.
(2) New protective clothing and equipment items, including dry suits, 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 for any offshore water operations or any dive operations.

1.1.4 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.

1.1.5 This standard shall not specify requirements for protective clothing and protective equipment for any other technical rescue operation, any firefighting operations, or any hazardous materials emergencies.

1.1.6 This standard shall specify requirements for any accessories or enhancements built into, attached to, or sold with surface water 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 ensure the performance and functions of the surface water or contaminated water operations protective clothing and equipment.

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

1.2 Purpose.

1.2.1 The purpose of this standard is to specify minimum requirements for the protection of emergency services personnel assigned to or involved in the following:

(1) Surface water search and rescue operations or other surface water incident operations
(2) Search and rescue activities in and below the surface of contaminated water

1.2.2 This standard shall not serve as a detailed manufacturing or purchasing specification but shall be permitted to be referenced in purchase specifications as minimum requirements.

1.3* Application. This standard can be applied as follows:

(1) Chapters 1 through 3, 4 through 8, and Annexes A through D constitute NFPA 1952.
(2) Chapters 1 through 3, 9 through 13, and Annexes A and D constitute of NFPA 1953.

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,* 2021 edition.

NFPA 1952, *Standard on Surface Water Operations Protective Clothing and Equipment,* 2021 edition.

NFPA 1953, *Standard on Protective Ensembles for Contaminated Water Diving,* 2021 edition.

NFPA 1990, *Standard for Protective Ensembles for Hazardous Materials and CBRN Operations,* 2022 edition.

NFPA 2500, *Standard for Operations and Training for Technical Search and Rescue incidents and Life Safety Rope and Equipment for Emergency Services,* 2022 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 TM42, *Test Method for Water Resistance: Impact Penetration*, 2017e.

AATCC TM70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption*, 2015.

AATCC TM135, *Dimensional Changes of Fabrics After Home Laundering*, 2018.

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

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, 2019.

ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*, (2021).

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

ASTM D2061, *Standard Test Methods for Strength Tests for Zippers*, 2007 (2021).

ASTM D2062, *Standard Test Methods for Operability of Zippers*, 2003 (2021).

ASTM D2582, *Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting*, 2021.

ASTM D3884, *Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Abrader Method)*, 2022.

ASTM D3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*, 2007A (2019)e1.

ASTM D4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, 2013 (2022).

ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)*, 2022.

ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, 2021.

ASTM D5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*, 2011 (2019).

ASTM E810, *Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry*, 2020.

ASTM F392/F392M, *Standard Practice for Conditioning Flexible Barrier Materials for Flex Durability*, 2021.

ASTM F739, *Standard Test Method for Permeation of Liquids and Gases Through Protective Clothing Materials Under Conditions of Continuous Contact*, 2020.

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

ASTM F1001, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*, 2012 (2017).

ASTM F1342/F1342M, *Standard Test Method for Protective Clothing Material Resistance to Puncture*, 2005 (2022).

ASTM F1359/F1359M, *Standard Test Method for Liquid-Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin*, 2022.

ASTM F1446, *Standard Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear*, 2020.

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*, 2022.

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

ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate*, 2017.

ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Finger Dexterity Using a Modified Pegboard Test*, 2018.

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, L'Esplanade Laurier, 6th Floor East Tower, 140 O'Connor Street, Ottawa, ON K1A 0R5, Canada.

CAN/CGSB 65.16, *Marine Abandonment 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, confirmed 2014.

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 17021-1, *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 SAE Publications. SAE International, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J211, *Instrumentation for Impact Test — Part 1 — Electronic Instrumentation*, 2014.

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

ANSI/UL 1123, *Marine Buoyant Devices*, 2020.

ANSI/UL 1197, *Immersion Suits*, 2021.

2.3.7 US Government Publications. US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401.

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

2.3.8 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

2.4 References for Extracts in Mandatory Sections.

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents,* 2020 edition.

Chapter 3 Definitions

3.1 General.

3.1.1 The definitions contained in this chapter shall apply to the terms used in this standard.

3.1.2 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.

3.1.3 *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. 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 phrases "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* Basic Plane. The anatomical plane that includes the superior rim of the external auditory meatus, the upper edge of the external openings of the ear, and the interior margin of the orbit, which is the lowest point of the floor of the eye socket.

3.3.2 Body Borne Pathogen. An infectious bacteria or virus carried in human, animal, or clinical body fluids, organs, or tissues.

3.3.3 Body Fluids. Fluids that are produced by the body including, but not limited to, blood, semen, mucus, feces, urine, vaginal secretions, breast milk, amniotic fluid, cerebrospinal fluid, synovial fluid, and pericardial fluid.

3.3.4 Bootie. A sock-like extension of the garment or suit leg that covers the entire foot.

3.3.5 Brim. A part of the shell of the helmet extending around the entire circumference of the helmet.

3.3.6 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.

3.3.7 Chin Strap. An adjustable strap for the helmet that fits under or around the chin to secure the helmet to the head.

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

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

3.3.10 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.

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

3.3.12 Composite. The layer or layers of materials or components.

3.3.13 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.

3.3.14 Crown. The portion of the helmet that covers the head above the reference plane.

3.3.15 Crown Straps. The part of the helmet suspension that passes over the head.

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

3.3.17 Dry Suit. A suit that provides exposure protection for contaminated water operations. *(See also 3.3.59, Surface Water Operations Protective Dry Suit.)*

3.3.17.1 ***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.

3.3.17.2* ***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.

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

3.3.18 Energy Absorbing System. A material or system used to attenuate impact energy.

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

3.3.20 Flotation Device. See 3.3.66, Surface Water Operations Protective Personal Flotation Device.

3.3.21 Fluorescence. The process by which radiant flux of certain wavelengths is absorbed and reradiated nonthermally in other, usually longer, wavelengths.

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

3.3.23 Footwear. See 3.3.60, Surface Water Operations Protective Dry Suit Footwear; 3.3.64, Surface Water Operations Protective Ice Suit Footwear; and 3.3.68, Surface Water Operations Protective Wet Suit Footwear.

3.3.24 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.

3.3.25 Garment Closure. The garment component designed and configured to allow the wearer to don (put on) and doff (take off) the garment. [**1951,** 2020]

3.3.26 Garment Closure Assembly. The combination of the garment closure and the seam attaching the garment closure to the garment, including any protective flap or cover. [**1951,** 2020]

3.3.27 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.

3.3.28 Glove Body. The part of the glove that extends from the tip of the fingers to the wrist crease or a specified distance beyond the wrist crease.

3.3.29 Glove Liner. The innermost component of the glove body composite that comes into contact with the wearer's skin.

3.3.30 Hardware. Non-fabric components of the protective clothing and equipment including, but not limited to, those made of metal or plastic.

3.3.31 Headform. A device that simulates the configuration of the human head.

3.3.32 Helmet. See 3.3.62, Surface Water Operations Protective Helmet.

3.3.33 Horizontal Center Plane. Any plane passing through the helmet whose intersection with the helmet surface is equidistant from the top of the helmet at all points.

3.3.34 Ice Suit. See 3.3.63, Surface Water Operations Protective Ice Suit.

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

3.3.36 Insole. The inner component of the footwear upon which the foot rests.

3.3.37 Liquidborne Pathogen. See 3.3.3, Body Fluids.

3.3.38 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.

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

3.3.40* 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.

3.3.41* 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.

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

3.3.43 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.

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

3.3.45 Product. See 3.3.10, Compliant Product.

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

3.3.47 Reference Plane. A dimensionally defined plane, parallel to the basic plane, that is measured from the top of the applicable headform or the basic plane.

3.3.48 Reinforcement. An area of added mechanical protection.

3.3.49 Rescue Operations. Those activities operations directed at locating and removing endangered persons, and removing endangered persons from danger, treating the injured at an emergency incident, and providing transport to an appropriate health care facility.

3.3.50 Retention System. The complete assembly by which the helmet is retained in position on the head.

3.3.51 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.

3.3.52 Sample. The equipment, equipment component, ensemble, element, item, component, or composite that is conditioned for testing. *(See also 3.3.55, Specimen.)*

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

3.3.54* 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.

3.3.55 Specimen. The conditioned equipment, equipment component, ensemble, element, product, item, composite, or component, or opposite that is tested. Specimens are taken from samples. *(See also 3.3.52, Sample.)*

3.3.56 Suit. See 3.3.17, Dry Suit; 3.3.59, Surface Water Operations Protective Dry Suit; 3.3.63, Surface Water Operations Protective Ice Suit; and 3.3.67, Surface Water Operations Protective Wet Suit.

3.3.57 Suit Material. The primary protective principal material(s) used in the construction of surface water operations protective suits and contaminated water dry suits.

3.3.58 Surface Water Operations. Technical rescue activities requiring water functional capabilities involving surface water, swift water, tidal water, surf, and ice that do not require underwater respiratory equipment.

3.3.59* Surface Water Operations Protective Dry Suit. A suit that provides exposure protection for water operations.

3.3.60 Surface Water Operations Protective Dry Suit Footwear. An item of protective clothing used with surface water protective dry suits that are designed to provide minimum protection to the foot, ankle, and lower leg.

3.3.61 Surface Water Operations Protective Dry Suit Gloves. An item of protective clothing used with surface water protective dry suits that are designed to provide minimum protection to fingers, thumb, hand, and wrist.

3.3.62 Surface Water Operations Protective Helmet. An item of protective equipment designed to provide minimum protection to the head.

3.3.63* Surface Water Operations Protective Ice Suit. A suit that provides thermal and flotation protection for extreme cold water conditions.

3.3.64 Surface Water Operations Protective Ice Suit Footwear. An item of protective clothing used with surface water protective ice suits that are designed to provide minimum protection to the foot, ankle, and lower leg.

3.3.65 Surface Water Operations Protective Ice Suit Gloves. An item of protective clothing used with surface water protective ice suits that are designed to provide minimum protection to fingers, thumb, hand, and wrist.

3.3.66 Surface Water Operations Protective Personal Flotation Device. An item of protective equipment designed to provide flotation assistance to the wearer.

3.3.67* Surface Water Operations Protective Wet Suit. A permeable suit that preserves body heat by trapping water in between the suit and the body.

3.3.68 Surface Water Operations Protective Wet Suit Footwear. An item of protective clothing used with surface water protective wet suits that are designed to provide minimum protection to the foot, ankle, and lower leg.

3.3.69 Surface Water Operations Protective Wet Suit Gloves. An item of protective clothing used with surface water protective wet suits that are designed to provide minimum protection to fingers, thumb, hand, and wrist.

3.3.70 Surface Water Rescue. Rescue of a victim who is accessible from the surface of a body of water.

3.3.71 Suspension. An energy attenuating system of the helmet that is made up of the headband and crown strap.

3.3.72 Swiftwater. Water moving at a rate of greater than 1 knot (1.85 km/hr).

3.3.73* Tidal Water. Ocean water or bodies of water that are connected to oceans that either experience a twice daily rise and fall of their surface caused by the gravitational pull of the moon or experience a corresponding ebb and flow of water in response to the tides.

3.3.74 Trim. See 3.3.75, Visibility Markings.

3.3.75 Visibility Markings. Retroreflective and fluorescent conspicuity enhancements. Retroreflective enhancements improve nighttime conspicuity, and fluorescent enhancements improve daytime conspicuity.

3.3.76 Wet Suit. See 3.3.67, Surface Water Operations Protective Wet Suit.

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

Chapter 4 Certification

4.1 General Certification Requirements (NFPA 1952; NFPA 1953).

4.1.1 The process of certification of products as being compliant with NFPA 1952 and NFPA 1953, as incorporated in NFPA 1955, shall meet the requirements of Section 4.1, General Certification Requirements (NFPA 1952; NFPA 1953), through Section 4.8, Manufacturer's Safety Alert and Product Recall Systems, as well as with the associated certification requirements in Chapter 5 and Chapter 9.

4.1.2 All products that are labeled as being compliant with this standard shall meet or exceed all the 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.*

4.1.3.1 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 or use the NFPA name or the name or identification of this standard in any statements about their respective item(s) unless the item(s) is certified as compliant with this standard.

4.1.5 All compliant products shall be labeled and listed.

4.1.5.1 The listing shall uniquely identify the certified product by, at a minimum, style, model number, or part number.

4.1.6 All compliant products shall also have a product label that meets the requirements specified in the applicable label requirements.

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

4.1.8 The certification organization shall not issue any new certifications based on the following standards on or after the NFPA effective date of this edition of NFPA 1955:

(1) 2021 edition of NFPA 1952
(2) 2021 edition of NFPA 1953

4.1.9 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 2021 edition of NFPA 1952 or the 2021 edition of NFPA 1953 on the effective date of this edition of NFPA 1955, plus 18 months.

4.1.10 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2021 edition of NFPA 1952 or the 2021 edition of NFPA 1953 from all products that are under the control of the manufacturer on the effective date of this edition of NFPA 1955, plus 18 months, and verify that this action is taken.

4.2 Certification Program.

4.2.1* The certification organization shall not be owned or controlled by manufacturers or vendors of the 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 personal protective equipment (PPE) in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services.*

4.2.3.1 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 the 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 the 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 the applicable requirements of this standard.

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

4.2.6.1 The certification organization's laboratory facilities shall have a program in place and functioning for calibration of all instruments.

4.2.6.1.1 Procedures shall be in use to ensure proper control of all testing.

4.2.6.2 The certification organization's 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, Manufacturer's 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 for the manufacturing facilities of the compliant product with at least two random and unannounced visits per 12-month period to verify the product's continued compliance.

4.2.9.1 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 3.3.39)*.

4.2.9.2 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, the manufacturer's or manufacturing facility's in-house stock, or the open market.

4.2.9.3 Sample product shall be evaluated by the certification organization to verify the product's continued compliance to ensure 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.

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

4.2.9.5 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 4.2.9.2 against the applicable requirements of this standard.

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

4.2.11 The certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions.

4.2.11.1 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.

4.2.12.1 The certification organization's 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 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/IEC 17025, *General requirements for the competence of testing and calibration laboratories*.

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

4.3.3.3 The accreditation of a manufacturer's testing laboratory shall be issued by an accreditation body operating in accordance with ISO 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 required 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 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 the required label attachments, compliance statements, certification statements, and other product information are at least as specified for the products identified in Chapter 5 (NFPA 1952) or Chapter 10 (NFPA 1953).

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 infor-

mation, as permitted by 6.1.5 (NFPA 1952) or 11.1.5 (NFPA 1953), 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 6.2, User Information, (NFPA 1952), or Section 11.2, User Information, (NFPA 1953), 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 7 (NFPA 1952) or Chapter 11 (NFPA 1953) shall be performed on whole or complete products.

4.4 Annual Verification.

4.4.1 All products that are labeled as being compliant with this standard shall, on an annual basis, undergo a verification evaluation to all the requirements as required by this standard.

4.5 Manufacturer's 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, Manufacturer's Safety Alert and Product Recall Systems.

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

4.5.3 All the following entities shall either be registered to ISO 9001, *Quality management systems — Requirements*, or shall be listed as a covered location under an ISO 9001-registered entity:

(1) Manufacturer
(2) Manufacturing facility
(3) The entity that directs and controls compliant product design
(4) The entity that directs and controls compliant product quality assurance
(5) The entity that provides the warranty for the compliant product
(6) The entity that puts its name on the product label and markets and sells the product as its own

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

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

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.

4.5.4* Where the manufacturer uses subcontractors in the construction or assembly of the compliant product, the locations and names of all the subcontractor facilities shall be documented and 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.

4.6.1.1 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 situation that results in the exposure of 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 the 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 conduct its own investigation as specified in Section 4.7, Manufacturer's 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 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) Notify the 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) Notify the 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) Remove 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* Where a change to an NFPA standard(s) is felt to be necessary, the certification organization shall also provide a copy of the report and corrective actions indicated to the National Fire Protection Association and submit either a Public Input for a proposed change to the next revision of the applicable standard or a proposed Temporary Interim Amendment (TIA) to the current edition of the applicable standard.

4.7 Manufacturer's Investigation of Complaints and Returns.

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

4.7.2 A manufacturer's record 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 might 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 the information about the review to assist the certification organization with its investigation.

4.8 Manufacturer's 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 manufacturer's safety alert and product recall system shall provide the following:

(1) The establishment of a coordinator and their responsibilities for the handling of safety alerts and product recalls
(2) A method of notifying all dealers, distributors, purchasers, users, and 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 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 documenting the effectiveness of the product recall
(5) A plan for either repairing, replacing, or compensating purchasers for returned product

Chapter 5 Surface Water Operations PPE Certification Requirements (NFPA 1952)

5.1 Scope and Certification Requirements.

5.1.1* Scope.

5.1.1.1* Chapters 4 through 9 of this standard shall specify the minimum design, performance, testing, and certification requirements for protective clothing and equipment items, including full body suits, helmets, gloves, footwear, and personal flotation devices designed to provide limited protection from physical, environmental, thermal, and certain common chemical and biological hazards for emergency services personnel during surface water operations.

5.1.1.2* Chapters 4 through 9 of this standard shall specify requirements for protective clothing and protective equipment used during operations in surface water, swift water, tidal water, surf, and ice.

5.1.1.3 This standard shall not specify requirements for protective clothing and protective equipment for any offshore water or dive operations.

5.1.1.4* Chapters 4 through 9 of this standard shall not specify requirements for protective clothing and protective equipment for any other technical rescue operation, firefighting operation, or hazardous materials emergency.

5.1.1.5* Chapters 4 through 9 of this standard shall specify the requirements for any accessories or enhancements built into, attached to, or sold with surface water operations protective clothing and equipment by the protective clothing and equipment manufacturer for later attachment.

5.1.1.5.1 The accessories or enhancements shall be installed or attached and tested with the protective clothing and equipment to assure the performance and function of the surface water operations protective clothing and equipment.

5.1.1.6 Chapters 4 through 9 of this standard shall not be construed as addressing all of the safety concerns associated with the use of compliant surface water operations protective clothing and equipment.

5.1.1.6.1 It shall be the responsibility of the persons and organizations that use compliant surface water operations protective clothing and equipment to establish safety and health practices and determine the applicability of regulatory limitations prior to use.

5.1.1.7 Chapters 4 through 9 of 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.

5.1.1.7.1 It shall be the responsibility of the persons and organizations that use this standard to establish safety and health practices and determine the applicability of regulatory limitations prior to the use of this standard for designing, manufacturing, and testing.

5.1.1.8 Certification of surface water operations protective clothing and equipment to the requirements of Chapters 4 through 9 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.

5.1.1.9 Nothing herein shall restrict any authority having jurisdiction or manufacturer from exceeding these minimum requirements.

5.1.2 Purpose.

5.1.2.1* The purpose of Chapters 4 through 9 of this standard shall be to establish minimum levels of protection for emergency services personnel assigned to or involved in surface water search and rescue operations or other surface water incident operations.

5.1.2.2* Controlled laboratory tests used to determine compliance with the performance requirements of Chapters 4 through 9 of this standard shall not be deemed as establishing performance levels for all situations to which emergency services personnel might respond.

5.1.2.3* The requirements in Chapters 4 through 9 of this standard are not intended to be detailed manufacturing or purchase specifications but shall be permitted to be referenced in purchase specifications as minimum requirements.

5.1.3 Application.

5.1.3.1 Chapters 4 through 9 of this standard shall apply to the design, manufacture, and certification of new surface water operations protective clothing and equipment.

5.1.3.2 Chapters 4 through 9 of this standard shall not apply to any surface water operations protective clothing and equipment manufactured to the requirements of any other organization's standards.

5.1.3.3 Chapters 4 through 9 of this standard shall not apply to the use of any surface water 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.

5.1.3.4 Chapters 4 through 9 of this standard shall apply to protective clothing and protective equipment used during operations in surface water, swift water, tidal water, surf, and ice.

5.1.3.5 This standard shall not apply to protective clothing and protective equipment for any offshore water operations or any dive operations.

5.1.3.6 Chapters 4 through 9 of this standard shall not apply to protective clothing and protective equipment for any other technical rescue operation, firefighting operation, or hazardous materials emergency.

5.1.3.7 Chapters 4 through 9 of this standard shall not apply to protection from all biological agents or hazardous chemicals.

5.1.3.8* Chapters 4 through 9 of this standard shall apply to any accessories or enhancements built into, attached to, or sold with the surface water operations protective clothing and equipment by the protective clothing and equipment manufacturer for later attachment.

5.1.3.8.1 The accessories or enhancements shall be installed or attached and tested with the protective clothing and equipment to assure the performance and function of the surface water operations protective clothing and equipment.

5.1.4* Units.

5.1.4.1 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.

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

5.2 General.

5.2.1 The process of certifying products as being compliant with Chapters 4 through 9 of this standard shall meet the requirements of Section 4.1, General Certification Requirements (NFPA 1952; NFPA 1953); Section 4.2, Certification Program; Section 4.3, Inspection and Testing; Section 4.4, Annual Verification; Section 4.5, Manufacturer's Quality Assurance Program; Section 4.6, Hazards Involving Compliant Product; Section 4.7, Manufacturer's Investigation of Complaints and Returns; and Section 4.8, Manufacturer's Safety Alert and Product Recall Systems.

5.2.2 All compliant products that are labeled as being compliant with Chapters 4 through 9 of this standard shall meet or exceed all the applicable requirements specified in Chapters 4 through 9 and shall be certified.

5.3 Inspection and Testing.

5.3.1 Testing to determine product compliance with the performance requirements specified in Chapter 9 shall be conducted by the certification organization in accordance with the specified testing requirements of Chapter 10.

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

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

5.3.2 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 as the actual final product or product component.

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

5.3.4 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.

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

5.3.6 The certification organization shall test ensemble elements with the specific ensembles with which they are to be certified.

5.3.7 Any change in the design, construction, or materials of a compliant product shall necessitate new inspection and testing to verify compliance with all the applicable requirements of this standard that the certification organization determines can be affected by such change.

5.3.7.1 Recertification shall be conducted before labeling the modified product as being compliant with this standard.

5.3.8 The manufacturer shall maintain all the design and performance inspection and test data from the certification organization used in the certification of the manufacturer's compliant product.

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

5.4 Annual Verification.

5.4.1 All products that are labeled as being compliant with Chapters 4 through 9 of this standard shall undergo recertification on an annual basis.

5.4.1.1 The 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 5.4.1.1 on all manufacturer models and components within the following protocol:
    (a) Where a test method incorporates testing both before and after the laundering preconditioning specified in 9.1.3 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 9.1.3 and the test generates nonquantitative results, recertification 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 the required conditioning is 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.

5.4.1.2 This annual verification shall include inspection and evaluation to all the design requirements and testing to all the performance requirements as required by this standard on all the manufacturer's models and components as required by 5.4.3.

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

5.4.1.4 For the purposes of this standard, models shall include each unique pattern, style, or design of the product.

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

5.4.3 For the purposes of this standard, models shall include each unique pattern, style, or design of the individual element.

5.4.4 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 for annual verification.

5.4.5 The manufacturer shall maintain all the design, inspection, performance, and test data from the certification organization used in the recertification of manufacturer models and components.

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

Table 5.4.1.1 Annual Verification Schedule

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
Wet suit					
8.1.1 Overall Donning Efficiency Test	X				
8.1.2 Breaking Strength Test	X		X		
8.1.3 Puncture Propagation Tear Resistance Test	X				
8.1.4 Seam/Closure Breaking Strength Test	X	X	X	X	X
8.1.5 Liquid Absorption Resistance Test	X				
8.1.6 Retroreflectivity Test	X				
8.1.7 Zipper Strength Test	X				
8.1.8 Resistance to Twist of Pull and Slider Test	X				
8.1.9 Opening and Closing of Zippers Test	X				
8.1.10 Corrosion Resistance Test	X				
8.1.11 Label Durability and Legibility Test	X				
Ice suit					
8.3.1 Overall Liquid Integrity Test One	X				
8.3.2 Air Retention Test	X	X	X	X	X
8.3.3 Viral Penetration Resistance Test	X				
8.3.4 Overall Donning Efficiency Test	X				
8.3.5 Thermal Insulation Test	X		X		
8.3.6 Breaking Strength Test	X		X		
8.3.7 Puncture Propagation Tear Resistance Test	X		X		
8.3.8 Seam/Closure Breaking Strength Test	X	X	X	X	X
8.3.9 Liquid Absorption Resistance Test	X		X		
8.3.10 Liquid Penetration Resistance Test	X				
8.3.11 Retroreflectivity Test	X				
8.3.12 Water Penetration and Air Evacuation Test	X				
8.3.13 Buoyancy Test	X				
8.3.14 Corrosion Resistance Test	X				
8.3.15 Label Durability and Legibility Test	X				
8.3.16 Zipper Point Breaking Strength Test	X				
8.3.17 Zipper Leak Resistance Test	X	X	X	X	X

(continues)

Table 5.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
8.3.18 Opening and Closing of Zippers Test	X				
8.3.19 Zipper Opening and Closing Force Test	X				
Wet suit gloves					
8.5.1 Cut Resistance Test	X			X	
8.5.2 Puncture Resistance Test	X		X		
8.5.3 Abrasion Resistance Test Two	X			X	
8.5.4 Glove Hand Function Test	X				
8.5.5 Grip Test	X				
8.5.6 Glove Donning Test	X				
8.5.7 Corrosion Resistance Test	X				
8.5.8 Label Durability and Legibility Test	X				
Dry suit gloves					
8.6.1 Cut Resistance Test	X			X	
8.6.2 Puncture Resistance Test	X		X		
8.6.3 Abrasion Resistance Test Two	X			X	
8.6.4 Glove Hand Function Test	X				
8.6.5 Grip Test	X				
8.6.6 Glove Donning Test	X				
8.6.7 Corrosion Resistance Test	X				
8.6.8 Liquid Penetration Resistance Test	X				
8.6.9 Viral Penetration Resistance Test	X				
8.6.10 Overall Liquid Integrity Test Two	X		X		
8.6.11 Label Durability and Legibility Test	X				
PFD					
8.10.1 Buoyancy Test — SG3, SG20 of UL 1123	X				
8.10.2 Label Durability and Legibility Test	X				
8.10.3 Corrosion Resistance Test	X				
7.11.1 Water Entry Test — SG3, SG16 of UL 1123	X				
7.11.1 Flotation Stability Test — SG3, SG16 of UL 1123	X				
7.11.1 Buoyancy Distribution Test — SG3, SG19 of UL 1123	X				

(continues)

Table 5.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
7.11.1 Tensile Strength — SG3, SG24 of UL 1123	X				
7.11.1 750-Pound Shoulder Tensile Test — SG3, SG10, SG24 of UL 1123	X				
7.11.1 730-Pound Harness Strength Test (without accelerated weathering) — SG9 of UL 1123	X				
7.11.1 Pamphlet Strength of Attachment Test — SG3, SG35 of UL 1123	X				
7.11.1 Pull Toggle Security of Attachment — SG7A of UL 1123	X				
Helmet					
8.4.1 Helmet Bucketing Test	X				
8.4.2 Top Impact Resistance Test (Force)	X				
8.4.3 Physical Penetration Resistance Test	X				
8.4.4 Suspension System Retention Test	X				
8.4.5 Retention System Test	X				
8.4.6 Corrosion Resistance Test	X				
8.4.7 Retroreflectivity Test	X				
8.4.8 Label Durability and Legibility Test	X				
8.4.9 Floatability Test	X				
8.4.10 Impact Resistance Test — Acceleration	X	X	X	X	X
8.4.11 Helmet Roll Off Test	X				
7.4.12 Helmet Water Absorption Test	X				
Dry suit					
8.2.1 Air Retention Test	X	X	X	X	X
8.2.2 Overall Liquid Integrity Test One	X				
8.2.3 Overall Donning Efficiency Test	X				
8.2.4 Water Penetration and Air Evacuation Test	X				
8.2.5 Breaking Strength Test	X		X		
8.2.6 Puncture Propagation Tear Resistance Test	X				
8.2.7 Cleaning Shrinkage Resistance Test	X		X		X
8.2.8 Seam Closure Breaking Strength Test	X	X	X	X	X

(continues)

Table 5.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
8.2.9 Liquid Absorption Resistance Test	X				
8.2.10 Liquid Penetration Resistance Test	X				
8.2.11 Viral Penetration Resistance Test	X				
8.2.12 Zipper Strength Test	X				
8.2.13 Resistance to Twist of Pull and Slider Test	X				
8.2.14 Opening and Closing of Zippers Test	X				
8.2.15 Zipper Point Breaking Strength Test	X				
8.2.16 Zipper Leak Resistance Test	X				
8.2.17 Zipper Opening and Closing Force Test	X				
8.2.18 Retroreflectivity Test	X				
8.2.19 Chemical Permeation Resistance Test	X	3 chem	3 chem	3 chem	3 chem
8.2.20 Closure Penetration Resistance Test	X	3 chem	3 chem	3 chem	3 chem
8.2.21 Corrosion Resistance Test	X				
8.2.22 Closure Penetration Test	X	3 chem	3 chem	3 chem	3 chem
8.2.24 Label Durability and Legibility Test	X				
Wet suit footwear					
8.8.1 Footwear Drainage Test	X				
8.8.2 Abrasion Resistance Test Two (Upper)	X			X	
8.8.3 Cut Resistance Test	X			X	
8.8.4 Puncture Resistance Test (Upper)	X		X		
8.8.5 Abrasion Resistance Test Two (Sole)	X			X	
8.8.6 Puncture Resistance Test (Sole)	X		X		
8.8.7 Slip Resistance Test	X				
8.8.8 Corrosion Resistance Test	X				
8.8.9 Label Durability and Legibility Test	X				
Ice suit footwear					
8.9.1 Abrasion Resistance Test Two (Upper)	X			X	
8.9.2 Cut Resistance Test	X			X	
8.9.3 Puncture Resistance Test (Upper)	X		X		

(continues)

Table 5.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
8.9.4 Abrasion Resistance Test Two	X			X	
8.9.5 Puncture Resistance Test (Sole)	X		X		
8.9.6 Slip Resistance Test	X				
8.9.7 Liquid Penetration Resistance Test	X				
8.9.8 Viral Penetration Resistance Test	X				
8.9.9 Corrosion Resistance Test	X				
8.9.10 Label Durability and Legibility Test	X				
8.9.11 Thermal Insulation Test	X		X		
Dry suit footwear					
8.8.1 Footwear Drainage Test	X				
8.8.2 Abrasion Resistance Test Two (Upper)	X			X	
8.8.3 Cut Resistance Test	X			X	
8.8.4 Puncture Resistance Test (Upper)	X		X		
8.8.5 Abrasion Resistance Test Two (Sole)	X			X	
8.8.6 Puncture Resistance Test (Sole)	X		X		
8.8.7 Slip Resistance Test	X				
8.8.8 Corrosion Resistance Test	X				
8.8.9 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				

Chapter 6 Surface Water Operations PPE Labeling and Information (NFPA 1952)

6.1 Product Label Requirements.

6.1.1* Each item of protective clothing and equipment shall have a product label or labels permanently and conspicuously located inside each product when the product is properly assembled with all layers and components in place.

6.1.2 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.

6.1.3* 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 (1⁄4 in.) in height and shall be placed in a conspicuous location.

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

6.1.5 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.

6.1.6 The following statement shall be printed legibly on the product label:

THIS SURFACE WATER OPERATIONS [*insert appropriate item term*] MEETS THE REQUIREMENTS OF NFPA 1955 (1952), [*insert edition year*] EDITION.

DO NOT REMOVE THIS LABEL!

6.1.6.1 The appropriate term for the item type (suit type, helmet, glove type, footwear type, personal flotation device) shall be inserted in the compliance statement text where indicated.

6.1.6.2 All letters shall be at least 2.5 mm (3⁄32 in.) in height.

6.1.7 Where dry suits are certified as compliant with the nonoptional requirements of this standard and also certified as compliant with the optional protection against chemical hazards specified in 8.2.19, the following statement shall be printed legibly on the product label:

THIS SURFACE WATER OPERATIONS *[insert appropriate item term]* MEETS THE REQUIREMENTS OF NFPA 1955 (1952), [*insert edition year*] EDITION, AND THE OPTIONAL PROTECTION AGAINST CHEMICAL HAZARDS REQUIREMENTS OF NFPA 1955.

DO NOT REMOVE THIS LABEL!

6.1.7.1 All letters shall be at least 2.5 mm (3⁄32 in.) high.

6.1.8 The following information shall also be printed legibly on the product label. 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
(10) For suits, the clo value specified in 8.1.2 or 8.3.5
(11) Total heat loss (THL) as required by 7.2.11

6.1.9 Supplementary Product Labels.

6.1.9.1 Where the protective clothing items consist of items or layers that can be separated from each other, each separable layer shall have a supplementary product label permanently attached.

6.1.9.2 Supplementary product labels shall also meet the requirements of 6.1.4 and 6.1.5.

6.2 User Information.

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

6.2.2 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.

6.2.3 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.

6.2.4* 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) 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 surface water operations, use consistent with NFPA 2500, Chapter 16.
(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

Chapter 7 Surface Water Operations PPE Design Requirements (NFPA 1952)

7.1* Surface Water Operations Protective Wet Suit Design Requirements.

7.1.1 Protective wet suits shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.1.2 Protective wet suits shall be permitted to be single-layer or multiple-layer suits.

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

7.1.4 The protective wet suit shall cover the wearer's upper torso and arms to the neck and wrist, and lower torso and legs to the ankle.

7.1.5 All protective wet suit hardware finish shall be free of rough spots, burrs, or sharp edges.

7.1.6 Protective wet suit metal components and closure systems shall not come in direct contact with the body.

7.1.7 Visibility Markings. Where visibility markings are provided for protective wet 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, "Retroreflective Material for Lifesaving Equipment."
(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.).

7.1.8* Protective Wet Suit Sizing.

7.1.8.1 Protective wet suit chest circumferences shall be provided in circumferences from 760 mm to 1475 mm (30 in. to 58 in.) in 50 mm (2 in.) increments or shall be cut to order.

7.1.8.2 Protective wet suit sleeve lengths shall be provided in lengths from 760 mm to 915 mm (30 in. to 36 in.) in 25 mm (1 in.) increments or shall be cut to order.

7.1.8.3 Protective wet suit waist circumferences shall be provided in circumferences from 660 mm to 1270 mm (26 in. to 50 in.) in 50 mm (2 in.) increments or shall be cut to order.

7.1.8.4 Protective wet suit inseam lengths shall be provided in lengths from 660 mm to 915 mm (26 in. to 36 in.) in 25 mm (1 in.) increments or shall be cut to order.

7.1.8.5 Men's and women's sizing shall be accomplished by the use of individual patterns for men's and women's wet suits.

7.2* Surface Water Operations Protective Dry Suit Design Requirements.

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

7.2.2 Protective dry suits shall be permitted to be single-layer or multiple-layer suits.

7.2.3 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.

7.2.4 Protective dry suits shall be designed to cover the wearer's upper torso to the neck and the arms to the wrist; shall cover the wearer's lower torso, legs, and feet; and shall be designed with size-adjustable seals at the neck or face and at the wrists.

7.2.5 Protective dry suits shall be designed with an integrated bootie that shall cover the entire foot.

7.2.6 Protective dry suits shall be designed to accommodate gloves, which shall be permitted to be a separate item or a detachable item of the dry suit.

7.2.7 Where dry suits are designed to accommodate a hood, the hood shall be permitted to be a separate item or a detachable item of the dry suit. Where hoods are provided, the hood shall provide protection to at least the head and neck.

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

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

7.2.10 Protective dry suits shall be reinforced at buttocks, forearms, elbow, and knees.

7.2.11* When the manufacturer designates a dry suit as "breathable," the total heat loss shall be measured as specified in Section 9.39, Total Heat Loss Test, and the result shall be printed on the product label as required by 6.1.8(11).

7.2.12 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.).

7.2.13* Protective Dry Suit Sizing.

7.2.13.1 Protective dry suit chest circumferences shall be provided in circumferences from 760 mm to 1475 mm (30 in. to 58 in.) in 100 mm (4 in.) increments or shall be cut to order.

7.2.13.2 Protective dry suit sleeve lengths shall be provided in lengths from 760 mm to 915 mm (30 in. to 36 in.) in 50 mm (2 in.) increments or shall be cut to order.

7.2.13.3 Protective dry suit waist circumferences shall be provided in circumferences from 660 mm to 1270 mm (26 in. to 50 in.) in 100 mm (4 in.) increments or shall be cut to order.

7.2.13.4 Protective dry suit inseam lengths shall be provided in lengths from 660 mm to 915 mm (26 in. to 36 in.) in 50 mm (2 in.) increments or shall be cut to order.

7.2.13.5 Men's and women's sizing shall be accomplished by the use of individual patterns for men's and women's dry suits.

7.3* Surface Water Operations Protective Ice Suit Design Requirements.

7.3.1 Protective ice suits shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.3.2 Protective ice suits shall be designed to cover the wearer's entire body. The suit shall be permitted to cover the wearer's nose. The suit shall not cover the wearer's eyes.

7.3.3 Protective ice suits shall incorporate a hood, either detachable or integrated, that covers the wearer's neck and head, excluding the face.

7.3.4 Protective ice suits shall be permitted to be single-layer or multiple-layer suits.

7.3.5 Where multiple layers are provided to meet the requirements of this standard, the protective ice suit shall have a means for securing the layers together.

7.3.6 Protective ice suits shall incorporate integrated gloves and footwear of a compatible material that meets the performance requirements for protective ice suits in Chapter 8.

7.3.7 All protective ice suit hardware finish shall be free of rough spots, burrs, or sharp edges.

7.3.8 Protective ice suit metal components and closure systems shall not come in direct contact with the body.

7.3.9 Protective ice suits shall be reinforced at buttocks, forearms, elbow, and knees.

7.3.10 Protective ice suits shall have a means to automatically exhaust air from the lower extremities of the suit.

7.3.11 Visibility markings on protective ice suits shall meet the following criteria:

(1) They shall be Type 1 retroreflective material that is USCG approved in accordance with 46 CFR 164.018, "Retroreflective Material for Lifesaving Equipment."
(2) They shall provide visibility of the wearer to include arms, front and back of the upper torso, and head.
(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.).

7.3.12* Protective Ice Suit Sizing.

7.3.12.1 Protective ice suit chest circumferences shall be provided in circumferences from 760 mm to 1475 mm (30 in. to 58 in.) in 100 mm (4 in.) increments, shall be adjustable from 760 mm to 1475 mm (30 in. to 58 in.), or shall be cut to order.

7.3.12.2 Protective ice suit sleeve lengths shall be provided in lengths from 760 mm to 915 mm (30 in. to 36 in.) in 50 mm (2 in.) increments, shall be adjustable from 760 mm to 915 mm (30 in. to 36 in.), or shall be cut to order.

7.3.12.3 Protective ice suit waist circumferences shall be provided in circumferences from 660 mm to 1270 mm (26 in. to 50 in.) in 100 mm (4 in.) increments, shall be adjustable from 660 mm to 1270 mm (26 in. to 50 in.), or shall be cut to order.

7.3.12.4 Protective ice suit inseam lengths shall be provided in lengths from 660 mm to 915 mm (26 in. to 36 in.) in 50 mm (2 in.) increments, shall be adjustable from 660 mm to 915 mm (26 in. to 36 in.), or shall be cut to order.

7.3.12.5 Men's and women's sizing shall be accomplished by the use of individual patterns for men's and women's ice suits.

7.4 Surface Water Operations Protective Helmet Design Requirements.

7.4.1 Surface water protective helmets shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.4.2 Surface water protective helmets shall be designed to consist of at least a means of absorbing energy and a chinstrap.

7.4.3 The back and sides of the surface water helmet shall extend a minimum of 40 mm (1.57 in.) downward from the reference plane when measured on an ISO J headform 50 mm (2 in.) behind the coronal plane.

7.4.4 Surface water protective helmets shall be permitted to have ventilation holes or shall be permitted to be continuous and tight fitting so that they do not collect water.

7.4.5 All materials used in the construction of the surface water protective helmet that are designed to come in contact with the wearer's head or skin shall be known to be nonirritating to normal skin.

7.4.6 The complete surface water protective helmet shall not weigh more than 710 g (25 oz) when dry.

7.4.7 Surface water protective helmets shall be permitted to have retroreflective visibility markings, fluorescent visibility markings, or both retroreflective and fluorescent visibility markings on the helmet exterior.

7.4.8 Where present, a minimum of 2580 mm^2 (4 $in.^2$) of retroreflective visibility markings shall be visible when the helmet is viewed from the top, left side, right side, and rear.

7.4.9 Product labels and any other identification labels or markers used on the surface water protective helmet shall be affixed without using materials or methods that would negate the purpose of the design or performance requirements of the helmet.

7.4.10 Surface water protective helmets shall not have hardware that projects more than 2 mm (0.08 in.) beyond the outer surface. All hardware edges shall be smooth and edges shall be rounded to a radius of not less than 1 mm (0.04 in.). All rigid internal projections shall be covered with protective padding.

7.4.11 Surface water protective helmets shall be available in sizes to fit head circumferences of 510 mm to 650 mm (20 in. to 25 in.) when measured at the circumference of the headband.

7.5 Surface Water Operations Protective Wet Suit Glove Design Requirements.

7.5.1 Protective wet suit gloves shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.5.2 Protective wet 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 glove is made up of multiple layers or where multiple gloves are used, all layers of the glove or all gloves shall be individually graded per size.

7.5.3 Protective wet suit gloves shall be designed with a cut- and puncture-resistant palm and palmside fingers area.

7.5.4 The protective wet suit glove body shall extend circumferentially not less than 50 mm (2 in.) beyond the wrist crease where measured from the tip of the finger. The location of the wrist crease shall be determined as shown in Figure 7.5.4.

7.5.5 In order to label or otherwise represent a protective wet suit glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in not less than four separate and distinct sizes.

7.5.6 All protective wet suit glove hardware finishes shall be free of rough spots, burrs, or sharp edges.

7.6 Surface Water Operations Protective Dry Suit Glove Design Requirements.

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

7.6.2 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.

7.6.3 Protective dry suit gloves shall be designed with a cut- and puncture-resistant palm and palmside fingers area.

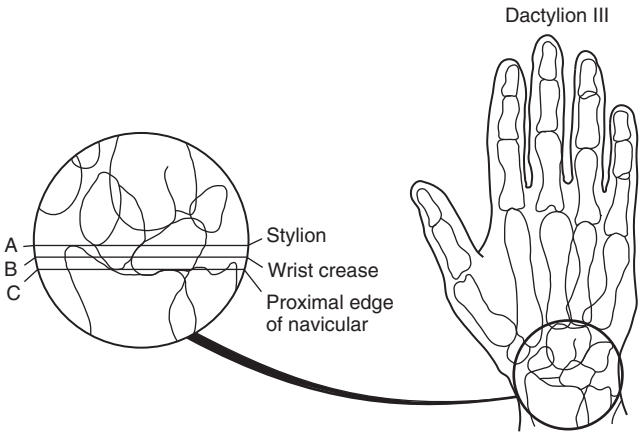


FIGURE 7.5.4 Anatomical Landmarks at Base of Hand, Palm Side Down.

7.6.4 The protective dry suit glove body shall extend circumferentially not less than 50 mm (2 in.) beyond the wrist crease where measured from the tip of the finger. The location of the wrist crease shall be determined as shown in Figure 7.5.4.

7.6.5 In order to label or otherwise represent a protective dry suit glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in not less than four separate and distinct sizes.

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

7.7 Surface Water Operations Protective Ice Suit Glove Design Requirements.

7.7.1 Protective ice suit gloves shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.7.2 Protective ice 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 ice 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.

7.7.3 Protective ice suit gloves shall be designed with a cut- and puncture-resistant palm and palmside fingers area.

7.7.4 The protective ice suit glove body shall extend circumferentially not less than 50 mm (2 in.) beyond the wrist crease where measured from the tip of the finger. The location of the wrist crease shall be determined as shown in Figure 7.5.4.

7.7.5 In order to label or otherwise represent a protective ice suit glove as compliant with the requirements of this standard, the manufacturer shall provide ice suit gloves in not less than four separate and distinct sizes.

7.7.6 All protective ice suit glove hardware finishes shall be free of rough spots, burrs, or sharp edges.

7.8 Surface Water Operations Protective Wet Suit Footwear Design Requirements.

7.8.1 Protective wet suit footwear shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.8.2 Protective wet suit footwear shall consist of a composite that shall be permitted to be configured as a continuous or joined single layer or continuous or joined multiple layers.

7.8.3 Where the protective wet suit footwear is made up of multiple layers, all layers of the footwear shall be individually graded per size.

7.8.4 Protective wet suit footwear height shall be determined by measuring inside the footwear from the center of the insole at the heel up to a perpendicular reference line extending across the width of the footwear up to the highest point where the footwear composite completely and continuously encircles the leg. Removable insole inserts shall be removed prior to measurement.

7.8.5 All protective wet suit footwear hardware finishes shall be free of rough spots, burrs, or sharp edges.

7.9 Surface Water Operations Protective Dry Suit Footwear Design Requirements.

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

7.9.2 Protective dry suit footwear shall consist of a composite that shall be permitted to be configured as a continuous or joined single layer or continuous or joined multiple layers.

7.9.3 Where the protective dry suit footwear is made up of multiple layers, all layers of the footwear shall be individually graded per size.

7.9.4 Protective dry suit footwear height shall be determined by measuring inside the footwear from the center of the insole at the heel up to a perpendicular reference line extending across the width of the footwear up to the highest point where the footwear composite completely and continuously encircles the leg. Removable insole inserts shall be removed prior to measurement.

7.9.5 All protective dry suit footwear hardware finishes shall be free of rough spots, burrs, or sharp edges.

7.10 Surface Water Operations Protective Ice Suit Footwear Design Requirements.

7.10.1 Protective ice suit footwear shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

7.10.2 Protective ice suit footwear shall consist of a composite that shall be permitted to be configured as a continuous or joined single layer or continuous or joined multiple layers.

7.10.3 Where the protective ice suit footwear is made up of multiple layers, all layers of the footwear shall be individually graded per size.

7.10.4 Protective ice suit footwear height shall be determined by measuring inside the footwear from the center of the insole at the heel up to a perpendicular reference line extending across the width of the footwear up to the highest point where the footwear composite completely and continuously encircles the leg. Removable insole inserts shall be removed prior to measurement.

7.10.5 All protective ice suit footwear hardware finishes shall be free of rough spots, burrs, or sharp edges.

7.11 Surface Water Operations Protective Personal Flotation Device Design Requirements.

7.11.1 Protective personal flotation devices shall be certified to UL 1123, *Marine Buoyant Devices*, as defined in Supplement SG, Type V Rescuer's Harness PFD's, excluding Markings – SG 11.

7.11.2 Protective personal flotation devices shall be available in a range of chest sizes from 760 mm to 1475 mm (30 in. to 58 in.).

7.11.3 Personal flotation devices (PFDs) shall have visibility markings on the exterior of the shell. A minimum of 200 cm^2 (31 $in.^2$) of retroreflective visibility markings shall be visible when the PFD is viewed from the front, and a minimum of 200 cm^2 (31 $in.^2$) retroreflective visibility markings shall be visible when the PFD is viewed from the rear.

7.11.4 All protective personal flotation device hardware finishes shall be free of rough spots, burrs, or sharp edges.

Chapter 8 Surface Water Operations PPE Performance Requirements (NFPA 1952)

8.1 Surface Water Operations Protective Wet Suit Performance Requirements.

8.1.1 Protective wet suits shall be tested for donning efficiency as specified in Section 9.4, Overall Donning Efficiency Test, and shall be donned in 3 minutes or less.

8.1.2 Protective wet suit materials shall be tested for snag resistance strength as specified in Section 9.8, Puncture Propagation Tear Resistance Test, and shall have a puncture resistance of not less than 25 N (5.5 lbf).

8.1.3 All protective wet suit seam assemblies shall be tested for seam strength as specified in Section 9.11, Seam/Closure Breaking Strength Test, and shall demonstrate a breaking strength of 158 N (35 lbf) or greater for each seam type.

8.1.4 Protective wet suit materials shall be tested for water absorption resistance as specified in Section 9.12, Liquid Absorption Resistance Test, and shall not have a water absorption greater than 10 percent.

8.1.5 Where protective wet suit visibility markings are specified, the visibility markings shall be tested for retroreflectivity as specified in Section 9.15, Retroreflectivity Test, and shall have a total coefficient of retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2).

8.1.6 Protective wet suit zippers shall be tested for strength as specified in Section 9.29, Zipper Strength Test, and shall have a minimum strength of 222 N (50 lbf).

8.1.7 Protective wet suit zippers shall be tested for resistance to twist as specified in Section 9.30, Resistance to Twist of Pull and Slider Test, and shall have a minimum force of 0.79 N-m (7 lbf-in.).

8.1.8 Protective wet suit zippers shall be tested for operability as specified in Section 9.31, Opening and Closing of Zippers Test, and shall have a minimum force of 67 N (15 lbf).

8.1.9 All protective wet suit metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.1.10 Protective wet suit product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.1.11 Protective wet suit closures other than zippers shall be tested for strength as specified in Section 9.11, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 158 N (35 lbf).

8.2 Surface Water Operations Protective Dry Suit Performance Requirements.

8.2.1 Protective dry suits shall be tested for air penetration resistance as specified in Section 9.2, Air Retention Test, and shall not show any sign of leakage.

8.2.2 Protective dry suits shall be tested for liquid penetration resistance as specified in Section 9.3, Overall Liquid Integrity Test One, and shall not allow liquid penetration.

8.2.3 Protective dry suits shall be tested for donning efficiency as specified in Section 9.4, Overall Donning Efficiency Test, and shall be donned in 3 minutes or less.

8.2.4 Protective dry suits shall be tested for water penetration and air evacuation as specified in Section 9.32, Water Penetration and Air Evacuation Test, and shall not allow water ingress while allowing for evacuation of air from the suit.

8.2.5 Protective dry suit materials, dry suit bootie materials, and dry suit hood materials shall be tested for strength as specified in Section 9.7, Breaking Strength Test, and shall have a breaking strength of not less than 445 N (100 lbf).

8.2.6 Protective dry suit materials, dry suit bootie materials, and dry suit hood materials shall be tested for snag resistance as specified in Section 9.8, Puncture Propagation Tear Resistance Test, and shall have a puncture resistance of not less than 25 N (5.5 lbf).

8.2.7 Protective dry suit materials shall be individually tested for cleaning shrinkage resistance as specified in Section 9.10, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5.0 percent in either direction.

8.2.8 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 9.11, Seam/Closure Breaking Strength Test, and shall have a seam breaking strength of not less than 158 N (35 lbf) for each seam type.

8.2.9 Protective dry suit materials, dry suit bootie materials, and dry suit hood materials shall be tested for water absorption resistance as specified in Section 9.12, Liquid Absorption Resistance Test, and shall not have a water absorption greater than 10 percent.

8.2.10 Protective dry suit materials and seams, dry suit bootie materials and seams, and dry suit hood materials and seams shall be tested for liquid penetration resistance as specified in Section 9.13, Liquid Penetration Resistance Test, and shall not show any chemical penetration.

8.2.11 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 9.14, Viral Penetration Resistance Test, and shall not show any viral penetration.

8.2.12 Protective dry suit zippers shall be tested for strength as specified in Section 9.29, Zipper Strength Test, and shall have a minimum strength of 222 N (50 lbf).

8.2.13 Protective dry suit zippers shall be tested for resistance to twist as specified in Section 9.30, Resistance to Twist of Pull and Slider Test, and shall have a minimum force of 0.79 N-m (7 lbf-in.).

8.2.14 Protective dry suit zippers shall be tested for operability as specified in Section 9.31, Opening and Closing of Zippers Test, and shall have a minimum force of 67 N (15 lbf).

8.2.15 Protective dry suit zippers shall be tested for point breaking strength as specified in Section 9.37, Zipper Point Breaking Strength Test, and shall have a minimum strength of 440 N (90 lbf).

8.2.16 Protective dry suit zippers shall be tested for resistance to leakage as specified in Section 9.38, Zipper Leak Resistance Test, and shall not allow any water ingress.

8.2.17 Protective dry suit zippers shall be tested for opening and closing force as specified in Section 9.35, Zipper Opening and Closing Force Test, and shall have a minimum strength as defined in Table 8.2.17.

8.2.18 Where protective dry suit visibility markings are specified, the visibility markings shall be tested for retroreflectivity as specified in Section 9.15, Retroreflectivity Test, and shall have a total coefficient of retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2).

8.2.19 Dry suits and dry suit booties that are intended to provide protection against chemical hazards shall have materials and seams tested for permeation resistance after flexing and abrading as specified in Section 9.41, Chemical Permeation Resistance Test, and the average cumulative permeation mass shall not exceed 6.0 μg/cm^2.

8.2.20 Dry suits and dry suit booties that are intended to provide protection against chemical hazards shall have materials and seams tested for penetration resistance as specified in Section 9.40, Closure Penetration Resistance Test, and shall show no penetration.

Table 8.2.17 Zipper Force Test Strengths

Conditioning	Minimum Strength (N)
8.1.2, Room Temperature Conditioning Procedure	The opening and closing force shall not exceed 9 (40) and 11 (50) at the top stop.
720 hours of salt spray with 5 percent sodium chloride (ASTM B117) 24 hours under 4 in. (100 mm) head of No. 2 marine diesel oil at 64°F–68°F (18°C–20°C)	The opening and closing force shall not exceed 39 (175).
8 hours at room temperature[a,b]; 149°F (65°C) for 8 hours[a,b]; 8 hours at room temperature[a,b]; and –22°F (–30°C) for 8 hours[a,b,c]	The opening and closing force shall not exceed 13 (60).

[a]The exposure sequence shall be performed five times.
[b]Prior to exposures, the sample shall be folded in half lengthwise to form a radius of not more than 0.9 in. (25 mm).
[c]The test shall be performed no less than 10 minutes after being removed from exposure.

8.2.21 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, Corrosion Resistance Test, 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.

8.2.22 Closures used in dry suits that are intended to provide protection against chemical hazards shall be tested for chemical penetration resistance as specified in Section 9.40, Closure Penetration Resistance Test, and shall exhibit no penetration.

8.2.23 Protective dry suit product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.2.24 Protective dry suit closures other than zippers shall be tested for strength as specified in Section 9.11, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 158 N (35 lbf).

8.3 Surface Water Operations Protective Ice Suit Performance Requirements.

8.3.1 Protective ice suits shall be tested for liquid penetration resistance as specified in Section 9.3, Overall Liquid Integrity Test One, and shall not allow liquid penetration.

8.3.2 Protective ice suits shall be tested for air penetration resistance as specified in Section 9.2, Air Retention Test, and shall not show any sign of leakage.

8.3.3 Protective ice suit materials and seams and ice suit hood materials and seams shall be tested for biopenetration resistance as specified in Section 9.14, Viral Penetration Resistance Test, and shall not show any viral penetration.

8.3.4 Protective ice suits shall be tested for donning efficiency as specified in Section 9.4, Overall Donning Efficiency Test, and shall be donned in 3 minutes or less.

8.3.5* Protective ice suit and protective ice suit hood materials shall be tested for thermal insulation as specified in Section 9.5, Thermal Insulation Test, and shall have a clo value of at least 2.

8.3.6 Protective ice suit and protective ice suit hood materials shall be tested for strength as specified in Section 9.7, Breaking Strength Test, and shall have a breaking strength of not less than 445 N (100 lbf).

8.3.7 Protective ice suit and protective ice suit hood materials shall be tested for snag resistance strength as specified in Section 9.8, Puncture Propagation Tear Resistance Test, and shall have a puncture resistance of not less than 25 N (5.5 lbf).

8.3.8 Protective ice suit and protective ice suit hood seam assemblies shall be tested for seam strength as specified in Section 9.11, Seam/Closure Breaking Strength Test, and shall demonstrate a breaking strength of 158 N (35 lbf) or greater for each seam type.

8.3.9 Protective ice suit and protective ice suit hood materials shall be tested for water absorption resistance as specified in Section 9.12, Liquid Absorption Resistance Test, and shall not have a water absorption greater than 10 percent.

8.3.10 Protective ice suit materials and seams and ice suit hood materials and seams shall be tested for liquid penetration resistance as specified in Section 9.13, Liquid Penetration Resistance Test, and shall not show any chemical penetration.

8.3.11 Protective ice suit visibility markings shall be tested for retroreflectivity as specified in Section 9.15, Retroreflectivity Test, and shall have a total coefficient of retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2).

8.3.12 Protective ice suits shall be tested for water penetration and air evacuation as specified in Section 9.32, Water Penetration and Air Evacuation Test, and shall not allow water ingress while allowing for evacuation of air from the suit.

8.3.13 Protective ice suits shall be tested for buoyancy as specified in Section 9.34, Buoyancy Test, and the adjusted buoyancy shall be at least 100 N (22 lb) and the measured buoyancy shall not be reduced by more than 5 percent after 24 hours submersion in fresh water.

8.3.14 All protective ice suit metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.3.15 All protective ice suit product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.3.16 Protective ice suit zippers shall be tested for point breaking strength as specified in Section 9.37, Zipper Point Breaking Strength Test, and shall have a minimum strength of 440 N (90 lbf).

8.3.17 Protective ice suit zippers shall be tested for resistance to leakage as specified in Section 9.38, Zipper Leak Resistance Test, and shall not allow any water ingress.

8.3.18 Protective ice suit zippers shall be tested for operability as specified in Section 9.31, Opening and Closing of Zippers Test, and shall have a minimum force of 67 N (15 lbf).

8.3.19 Protective ice suit zippers shall be tested for opening and closing force as specified in Section 9.35, Zipper Opening and Closing Force Test and shall have a minimum strength as defined in Table 8.2.17.

8.3.20 Protective dry suit zippers shall be tested for strength as specified in Section 9.29, Zipper Strength Test, and shall have a minimum strength of 222 N (50 lbf).

8.3.21 Protective ice suit zippers shall be tested for strength as specified in Section 9.30, Resistance to Twist of Pull and Slider Test, and shall have a minimum force of 0.79 N-m (7 lbf-in.).

8.3.22 Protective ice suit closures other than zippers shall be tested for strength as specified in Section 9.11, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 158 N (35 lbf).

8.4 Surface Water Operations Protective Helmet Performance Requirements.

8.4.1 Protective helmets shall be tested for top impact resistance as specified by Section 9.18, Top Impact Resistance Test

(Force), and shall not transmit an average force of more than 3780 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf).

8.4.2 Protective helmets shall be tested for physical penetration resistance as specified in Section 9.19, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration striker and the headform.

8.4.3 Protective helmets shall be tested for retention system and chin strap efficiency as specified in Section 9.20, Retention System Test, and the retention system shall not break or show any slip or stretch greater than 20 mm ($^{13}/_{16}$ in.). Chinstraps shall have a width not less than 15 mm (0.6 in.) under a load of 250 N (56 lbf).

8.4.4 All protective helmet metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.4.5 Where helmet visibility markings are specified, the visibility markings shall be tested for retroreflectivity as specified in Section 9.15, Retroreflectivity Test, and shall have a total coefficient of retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2), and shall be designated as fluorescent.

8.4.6 Specimens of all protective helmet product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.4.7 Protective helmets shall be tested for impact acceleration as specified in Section 9.36 Impact Resistance Test — Acceleration, and shall not transmit a force of more than 200 Gn (1961 m/s^2, 6435 ft/s^2).

8.4.8 Protective helmets shall be tested for stability as specified in Section 9.6, Helmet Roll Off Test.

8.4.8.1 The retention system shall remain intact.

8.4.8.2 The helmet shall not fully expose the coronal plane of the headform.

8.4.9 Protective helmets shall be tested for water absorption as specified in Section 9.9, Helmet Water Absorption Test, and shall not weigh more than 110 percent of the original dry weight.

8.5 Surface Water Operations Protective Wet Suit Glove Performance Requirements.

8.5.1 Protective wet suit glove palm composite materials and palmside finger composite materials shall be tested for resistance to cut as specified in Section 9.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm ($^3/_4$ in.).

8.5.2 Protective wet suit glove palm composite materials and palmside finger composite materials shall be tested for puncture resistance as specified in Section 9.23, Puncture Resistance Test, and shall not puncture under an applied force of 12 N (2.7 lbf).

8.5.3 Protective wet suit glove palm composite materials, palmside finger composite materials, and back-of-hand composite materials shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.5.4 Wet suit protective gloves shall be tested for hand function as specified in Section 9.25, Glove Hand Function Test, and shall not have an average percent of barehand control exceeding 150 percent.

8.5.5 Wet suit protective gloves shall be tested for grip as specified in Section 9.26, Grip Test, and shall have a weight-pulling capacity not less than 120 percent of the barehand control values.

8.5.6 Wet suit protective gloves shall be tested for ease of donning as specified in Section 9.27, Glove Donning Test, and shall have a final donning time less than 20.0 seconds, shall have no detachment of the glove liner, and shall allow full insertion of all digits.

8.5.7 All wet suit protective glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.5.8 Wet suit protective glove product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.6 Surface Water Operations Protective Dry Suit Glove Performance Requirements.

8.6.1 Protective dry suit glove palm composite materials and palmside finger composite materials shall be tested for resistance to cut as specified in Section 9.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm ($^3/_4$ in.).

8.6.2 Protective dry suit glove palm composite materials and palmside finger composite materials shall be tested for puncture resistance as specified in Section 9.23, Puncture Resistance Test, and shall not puncture under an applied force of 12 N (2.7 lbf).

8.6.3 Protective dry suit glove palm composite materials, palmside finger composite materials, and back-of-hand composite materials shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.6.4 Dry suit protective gloves shall be tested for hand function as specified in Section 9.25, Glove Hand Function Test, and shall not have an average percent of barehand control exceeding 150 percent.

8.6.5 Dry suit protective gloves shall be tested for grip as specified in Section 9.26, Grip Test, and shall have a weight-pulling capacity not less than 120 percent of the barehand control values.

8.6.6 Dry suit protective gloves shall be tested for ease of donning as specified in Section 9.27, Glove Donning Test, and shall have a final donning time less than 20 seconds, shall have

no detachment of the glove liner, and shall allow full insertion of all digits.

8.6.7 All dry suit protective glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.6.8 Protective dry suit glove composite materials and seams shall be tested for liquid penetration resistance as specified in Section 9.13, Liquid Penetration Resistance Test, and shall not show any chemical penetration.

8.6.9 Protective dry suit glove composite materials and seams shall be tested for biopenetration resistance as specified in Section 9.14, Viral Penetration Resistance Test, and shall not show any viral penetration.

8.6.10 Dry suit protective gloves shall be tested for overall watertight integrity as specified in Section 9.21, Overall Liquid Integrity Test Two, and shall show no water penetration.

8.6.11 Dry suit protective glove product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.7 Surface Water Operations Protective Ice Suit Glove Performance Requirements.

8.7.1 Protective ice suit glove palm composite materials and palmside finger composite materials shall be tested for resistance to cut as specified in Section 9.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

8.7.2 Protective ice suit glove palm composite materials and palmside finger composite materials shall be tested for puncture resistance as specified in Section 9.23, Puncture Resistance Test, and shall not puncture under an applied force of 12 N (2.7 lbf).

8.7.3 Protective ice suit glove palm composite materials, palmside finger composite materials, and back-of-hand composite materials shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.7.4 Ice suit protective gloves shall be tested for hand function as specified in Section 9.25, Glove Hand Function Test, and shall not have an average percent of barehand control exceeding 150 percent.

8.7.5 Ice suit protective gloves shall be tested for grip as specified in Section 9.26, Grip Test, and shall have a weight-pulling capacity not less than 120 percent of the barehand control values.

8.7.6 Ice suit protective gloves shall be tested for ease of donning as specified in Section 9.27, Glove Donning Test, and shall have a final donning time less than 20 seconds, shall have no detachment of the glove liner, and shall allow full insertion of all digits.

8.7.7 All ice suit protective glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, Corrosion Resistance Test, and shall not have metals that are inherently resistant to corrosion zinc 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.

8.7.8 Protective ice suit glove composite materials and seams shall be tested for liquid penetration resistance as specified in Section 9.13, Liquid Penetration Resistance Test, and shall not show any chemical penetration.

8.7.9 Protective ice suit glove composite materials and seams shall be tested for biopenetration resistance as specified in Section 9.14, Viral Penetration Resistance Test, and shall not show any viral penetration.

8.7.10 Ice suit protective glove product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.7.11* Ice suit protective glove materials shall be tested for thermal insulation as specified in Section 9.5, Thermal Insulation Test, and shall have a clo value of at least 2.

8.8 Surface Water Operations Protective Wet Suit and Protective Dry Suit Footwear Performance Requirements.

8.8.1 Wet suit and dry suit protective footwear shall be tested for drainage as specified in Section 9.33, Footwear Drainage Test, and shall retain less than 100 g (0.22 lb) of water.

8.8.2 Wet suit and dry suit protective footwear uppers shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.8.3 Wet suit and dry suit protective footwear uppers shall be tested for cut resistance as specified in Section 9.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

8.8.4 Wet suit and dry suit protective footwear uppers shall be tested for puncture resistance as specified in Section 9.23, Puncture Resistance Test, and shall not puncture under an applied force of 45 N (10 lbf).

8.8.5 Wet suit and dry suit protective footwear soles shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.8.6 Wet suit and dry suit protective footwear soles shall be tested for penetration (physical) resistance as specified in Section 9.23, Puncture Resistance Test, and shall not have a puncture force of less than 90 N (20 lbf).

8.8.7 Wet suit and dry suit protective footwear shall be tested for slip resistance as specified in Section 9.28, Slip Resistance Test, and shall have a static coefficient friction of 0.45 or greater under wet conditions.

8.8.8 All wet suit and dry suit protective footwear metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.8.9 Wet suit and dry suit protective footwear product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.9 Surface Water Operations Protective Ice Suit Footwear Performance Requirements.

8.9.1 Ice suit protective footwear uppers shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.9.2 Ice suit protective footwear uppers shall be tested for cut resistance as specified in Section 9.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

8.9.3 Ice suit protective footwear uppers shall be tested for puncture resistance as specified in Section 9.23, Puncture Resistance Test, and shall not puncture under an applied force of 45 N (10 lbf).

8.9.4 Ice suit protective footwear soles shall be tested for abrasion resistance as specified in Section 9.24, Abrasion Resistance Test Two, and shall not wear through.

8.9.5 Ice suit protective footwear soles shall be tested for penetration (physical) resistance as specified in Section 9.23, Puncture Resistance Test, and shall not have a puncture force of less than 90 N (20 lbf).

8.9.6 Ice suit protective footwear shall be tested for slip resistance as specified in Section 9.28, Slip Resistance Test, and shall have a static coefficient friction of 0.45 or greater under wet conditions.

8.9.7 Ice suit protective footwear materials and seams shall be tested for liquid penetration resistance as specified in Section 9.13, Liquid Penetration Resistance Test, and shall show no chemical penetration.

8.9.8 Ice suit protective footwear materials and seams shall be tested for biopenetration resistance as specified in Section 9.14, Viral Penetration Resistance Test, and shall show no viral penetration.

8.9.9 All ice suit protective footwear metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 9.16, 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.

8.9.10 Ice suit protective footwear product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.9.11* Ice suit protective footwear materials shall be tested for thermal insulation as specified in Section 9.5, Thermal Insulation Test, and shall have a clo value of at least 2.

8.10 Surface Water Operations Protective Personal Flotation Device Performance Requirements.

8.10.1 Protective personal flotation devices shall be tested for buoyancy as specified in Section 9.34, Buoyancy Test, and shall have a buoyancy of at least 100 N (22 lb).

8.10.2 Protective personal flotation device product labels shall be tested for legibility as specified in Section 9.17, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

8.10.3 Protective personal flotation devices shall be tested for corrosion as specified in Section 9.16, 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.

Chapter 9 Surface Water Operations PPE Test Methods (NFPA 1952)

9.1 Sample Preparation Procedures.

9.1.1 Application.

9.1.1.1 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.

9.1.1.2 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.

9.1.2 Room Temperature Conditioning Procedure for Protective Suits, Protective Suit Materials, Protective Suit Material Seams, Hood Materials, Hood Material Seams, Helmets, Gloves, Glove Material Seams, Footwear, Bootie Materials and Bootie Material Seams, and Personal Flotation Devices.

9.1.2.1 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.

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

9.1.3 Washing and Drying Procedure for Protective Suits, Protective Suit Materials, Protective Suit Material Seams, Bootie Materials, and Bootie Material Seams, Hood Materials, Hood Material Seams, Gloves, and Glove Material Seams.

9.1.3.1 Samples shall be subjected to 10 cycles of washing.

9.1.3.2 A front-loading washer/extractor shall be used.

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

9.1.3.4 The wash cycle procedure in Table 9.1.3.4 shall be followed.

9.1.3.5 Samples shall be completely dried after the last washing cycle by air drying prior to conducting the test.

9.1.4 Flexural Fatigue Procedure for Protective Suit Materials, Protective Suit Hood Materials, and Bootie Materials.

9.1.4.1 Samples shall be subjected to flexural fatigue in accordance with ASTM F392/F392M, *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.

Table 9.1.3.4 Wash Cycle Procedure

Operation	Time (min)	Temperature		Water Level
		±3°C	±5°F	
Suds using AATCC detergent #1993, 1.0 g/gal water	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			
Rinse	2	38	100	High
Drain	1			
Extract	5			

(2) Anisotropic materials shall be tested in both machine and transverse directions.

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

9.1.5 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 abraded for 25 continuous cycles.

9.1.6 Wet Conditioning Procedure for Protective Helmets.

9.1.6.1 Sample helmets shall be conditioned by immersing them in water at a temperature of 20°C to 28°C (68°F to 82°F) for at least 4 hours, but not more than 24 hours.

9.1.6.2 The helmet shall be tested within 10 minutes after removal from water.

9.1.7 Wet Conditioning Procedure for Protective Gloves.

9.1.7.1 Samples shall be conditioned by complete immersion in water at a temperature of 21°C, ±3°C (70°F, ±5°F) for 2 minutes.

9.1.7.2 Samples shall be removed from water, hung in a vertical position for 5 minutes, laid horizontal with AATCC blotting paper both under and over the sample, under a weight of 3.5 kPa, ±0.35 kPa (0.50 psi, ±0.05 psi) for a period of 20 minutes. The AATCC blotting paper shall be in accordance with paragraph 5.4 of AATCC TM70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption*.

9.1.8 Low Temperature Environmental Conditioning Procedure for Helmets.

9.1.8.1 Sample helmets shall be conditioned by exposing them to a temperature of −18°C ± 1°C (0°F ± 2°F) for at least 4 hours but not more than 24 hours.

9.1.8.1.1 The impact/penetration test shall be completed within 15 seconds ± 5 seconds after removal from the cold temperature environment or the helmet shall be reconditioned and tested.

9.1.8.2 If, during testing, as specified in Section 9.18, Top Impact Resistance Test (Force), and Section 9.19, Physical Penetration Resistance Test, a helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet.

9.1.8.3 If the time out of the environment exceeds 4 minutes, the helmet shall be returned to the environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or for a maximum of 12 hours, whichever is less, before the resumption of testing with that helmet.

9.2 Air Retention Test.

9.2.1 Application. This test method shall apply to complete protective dry suits and complete protective ice suits.

9.2.2 Samples.

9.2.2.1 Samples shall be complete protective suits assembled with all layers that are required for the suit to be compliant.

9.2.2.2 Samples shall be conditioned as specified in 9.1.2.

9.2.3 Specimens. A minimum of three specimens shall be tested.

9.2.4 Procedure. Air retention performance testing shall be performed in accordance with Section 34, Air Retention Test, of UL 1197, *Immersion Suits*, with the following modifications:

(1) The suit shall be pressurized to 2 psi (13.8 kPa).
(2) The suit shall be totally immersed in water and inspected for leaks.

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

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

9.3 Overall Liquid Integrity Test One.

9.3.1 Application. This test method shall apply to complete protective dry suits and complete protective ice suits.

9.3.2 Samples.

9.3.2.1 Samples shall be complete protective ice suits assembled with all layers that are required for the suit to be compliant.

9.3.2.2 Samples shall be preconditioned as specified in 9.1.3 followed by 9.1.2.

9.3.3 Specimens.

9.3.3.1 A minimum of three specimens shall be tested.

9.3.3.2 The size of the ice suits comprising the specimens shall be chosen to conform with the dimensions of the mannequin for proper fit of the specimen on the mannequin in accordance with the manufacturer's sizing system.

9.3.3.3 The size of the ice suits comprising the specimens shall be the same size as the mannequin in terms of chest circumference, waist circumference, and inseam height.

9.3.4 Apparatus. The apparatus and supplies for testing shall be those specified in ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin,* with the following modifications:

(1) The surface tension of the water used in testing shall be 34 dynes/cm, ±5 dynes/cm.
(2) The mannequin used in testing shall have straight arms and legs, with the arms positioned at the mannequin's side.

9.3.5 Procedure. Liquidtight integrity testing of suits shall be conducted in accordance with ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin,* with the following modifications:

(1) The method used for mounting of the mannequin in the spray chamber shall not interfere with the water spray.
(2) The suited mannequin shall be exposed to the liquid spray for a total of 20 minutes — 5 minutes in each of the four specified mannequin orientations.
(3) At the end of the liquid spray exposure period, excess liquid shall be removed from the surface of the specimen.
(4) The specimen shall be inspected within 5 minutes of the end of the liquid spray exposure period for evidence of liquid penetration.

9.3.6 Report. A diagram shall be prepared for each test that identified the locations of any liquid leakage as detected on the liquid-absorptive suit.

9.3.7 Interpretation. Any evidence of liquid on the liquid-absorptive suit as determined by visual, tactile, or absorbent toweling, shall constitute failure of the specimen.

9.4 Overall Donning Efficiency Test.

9.4.1 Application. This test method shall apply to complete protective wet suits, complete protective dry suits, and complete protective ice suits.

9.4.2 Samples.

9.4.2.1 Samples shall be complete protective suits assembled with all layers that are required for the suit to be compliant.

9.4.2.2 Samples shall be conditioned as specified in 9.1.3 followed by 9.1.2.

9.4.3 Specimens.

9.4.3.1 A minimum of three specimens shall be tested.

9.4.3.2 The size of the suits comprising the specimens shall be chosen for proper fit of the specimen on the test subject in accordance with the manufacturer's sizing system.

9.4.3.3 The size of the suits comprising the specimens shall be the same size as the test subject in terms of chest circumference, waist circumference, and inseam height.

9.4.4 Procedure.

9.4.4.1 A different test subject shall be used for evaluating the donning efficiency of each specimen.

9.4.4.2 The test subject will be provided instructions in the proper donning of the suit and shall practice donning and doffing the suit prior to testing.

9.4.4.3 To begin the test, the test subject shall be standing with the suit draped over a chair next to the test subject.

9.4.4.4 A timer shall be started when the test subject is instructed to begin donning the suit.

9.4.4.5 The timer shall be stopped when the test subject has completely donned the suit, ensuring that all closures are secured.

9.4.5 Report. The donning time for each test subject shall be reported.

9.4.6 Interpretation. Any donning time greater than 3.0 minutes shall constitute failure of the specimen.

9.5 Thermal Insulation Test.

9.5.1 Application. This test method shall apply to protective ice suit materials, ice suit hood materials, ice suit glove materials, and ice suit footwear materials.

9.5.2 Samples.

9.5.2.1 Samples shall be at least a 1 m (1 yd) square of each material.

9.5.2.2 Samples shall be preconditioned as specified in 9.1.2.

9.5.3 Specimens.

9.5.3.1 A minimum of three specimens shall be tested.

9.5.3.2 Specimens shall consist of all layers used in the construction of the suit, excluding any areas of reinforcement, arranged in the order and orientation as worn.

9.5.4 Apparatus. The test apparatus shall be as specified in ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate.*

9.5.5 Procedure. Testing shall be conducted in accordance with ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate,* using Part D.

9.5.6 Report. The average intrinsic thermal resistance (R_{cf}) of the sample shall be recorded and reported.

9.5.7 Interpretation. Pass or fail determination shall be based on the average reported intrinsic thermal resistance measurement of all specimens tested.

9.6 Helmet Roll Off Test.

9.6.1 Application. This test shall be applied to complete helmets.

9.6.2 Samples. Samples shall be complete helmets.

9.6.3 Specimens.

9.6.3.1 A minimum of three specimens shall be tested.

9.6.3.2 Specimens shall be conditioned as specified in 9.1.2 and 9.1.8 prior to each test.

9.6.4 Procedure.

9.6.4.1 Specimens shall be tested as specified in Section 12.7.2, Roll Off Test, of ASTM F1446, *Standard Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear*.

9.6.4.2 A drop weight of 10 ± 0.1 kg (22 ± 0.2 lb), and a drop height of 0.175 ±0.010 m (6.9 ± 0.4 in.) shall be used.

9.6.5 Report.

9.6.5.1 The rotation of the helmet from the original position shall be measured, recorded, and reported for each helmet.

9.6.5.2 Damage to the retention system resulting in the retention system not remaining intact shall be recorded and reported.

9.6.6 Interpretation.

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

9.6.6.2 One or more helmet specimens failing this test shall constitute failing performance.

9.7 Breaking Strength Test.

9.7.1 Application.

9.7.1.1 This test method shall apply to protective wet suit materials; protective dry suit materials, dry suit hood materials, and dry suit bootie materials; and protective ice suit materials and ice suit hood materials.

9.7.1.2 Where the suit or hood is constructed of several separable layers, then all layers shall be individually tested.

9.7.2 Samples.

9.7.2.1 Samples shall be at least 1 m (1 yd) square of material.

9.7.2.2 Samples shall be conditioned as specified in 9.1.2.

9.7.3 Specimens.

9.7.3.1 Specimens shall be the size specified in ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*.

9.7.3.2 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.

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

9.7.4 Procedure. Specimens shall be tested for breaking strength in accordance with ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*.

9.7.5 Report.

9.7.5.1 The breaking strength of each specimen shall be recorded and reported to the nearest 0.2 N (0.1 lb) of force.

9.7.5.2 An average breaking strength shall be individually calculated, recorded, and reported for the warp and filling directions.

9.7.5.3 For isotropic materials, a single average breaking strength shall be calculated, recorded, and reported.

9.7.6 Interpretation.

9.7.6.1 Pass or fail performance shall be based on the average breaking strength in the warp and filling directions.

9.7.6.2 Failure in any one direction shall constitute failure for the material.

9.8 Puncture Propagation Tear Resistance Test.

9.8.1 Application. This test method shall apply to protective wet suit materials; protective dry suit materials, dry suit hood materials, and dry suit bootie materials; and protective ice suit materials and ice suit hood materials.

9.8.2 Samples.

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

9.8.2.2 Samples shall be conditioned as specified in 9.1.3 followed by the conditioning specified in 9.1.2.

9.8.3 Specimens.

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

9.8.3.2 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.

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

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

9.8.5 Report.

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

9.8.5.2 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.

9.8.6 Interpretation.

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

9.8.6.2 Failure in any one direction constitutes failure for the material.

9.9 Helmet Water Absorption Test.

9.9.1 Application. This test shall apply to complete helmets.

9.9.2 Specimens. Specimens shall be complete helmets.

9.9.3 Procedure.

9.9.3.1 A minimum of three specimens shall be tested.

9.9.3.2 Specimens shall be weighed to the nearest gram.

9.9.3.3 Specimens shall be completely immersed in a sufficiently sized vessel of fresh water at a temperature of 21°C, ±3°C (70°F, ±5°F) for a period of 24 hours, +1/−0 hour.

9.9.3.4 Specimens shall be removed from the water and allowed to drain for 5 minutes, +1/−0 minutes.

9.9.3.5 Specimens shall be weighed to the nearest gram.

9.9.3.6 The percent difference in weight shall be determined using the following equation:

[9.9.3.6]

$$\% \text{ Difference} = \frac{W - D}{W} \times 100$$

where:
W = wet weight in grams
D = dry weight in grams

9.9.4 Report. The dry weight, wet weight, and percent difference shall be calculated, recorded, and reported for each specimen.

9.9.5 Interpretation.

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

9.9.5.2 Any individual specimen failing this test shall constitute failing performance.

9.10 Cleaning Shrinkage Resistance Test.

9.10.1 Application. This test method shall apply to dry suit materials.

9.10.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.10.3 Specimens. Cleaning shrinkage resistance testing shall be conducted on three specimens of each material, and each material shall be tested separately.

9.10.4 Procedure.

9.10.4.1 Specimens shall be tested using five cycles of Machine Cycle 3, Wash Temperature II, and Drying Procedure Aiii, of AATCC TM135, *Dimensional Changes of Fabrics After Home Laundering*.

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

9.10.4.3 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC TM135, *Dimensional Changes of Fabrics After Home Laundering*.

9.10.5 Report.

9.10.5.1 The percent change in the width and length dimensions of each specimen shall be calculated and reported.

9.10.5.2 Results shall be reported as the average of all three specimens in each direction.

9.10.6 Interpretation.

9.10.6.1 The average percent change in both directions shall be used to determine pass or fail performance.

9.10.6.2 Failure in any one dimension constitutes failure for the entire sample.

9.11 Seam/Closure Breaking Strength Test.

9.11.1 Application. This test method shall apply to protective wet suit seam and closure assemblies; protective dry suit seam assemblies, dry suit hood seam assemblies, and dry suit bootie seam assemblies; and protective ice suit seam assemblies and ice suit hood seam assemblies.

9.11.1.1 Modifications to this test method for testing seams shall be as specified in 9.11.7.

9.11.1.2 Modifications to this test method for testing closure assemblies shall be as specified in 9.11.8.

9.11.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.11.3 Specimens.

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

9.11.3.2 At least five specimens shall be tested for each seam/closure type.

9.11.4 Procedure. All seam/closure 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).

9.11.5 Report.

9.11.5.1 The breaking strength for each specimen shall be recorded and reported.

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

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

9.11.6 Interpretation. The average seam/closure breaking strength for each seam/closure type shall be used to determine pass or fail performance.

9.11.7 Specific Procedures for Testing Seams.

9.11.7.1 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.

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

9.11.7.3 Specimens shall be conditioned as specified in 9.1.2.

9.11.8 Specific Procedures for Testing Closure Assemblies.

9.11.8.1 Samples shall be full suits.

9.11.8.2 Specimens shall be cut from the finished suit.

9.12 Liquid Absorption Resistance Test.

9.12.1 Application. This test method shall apply to protective dry suit materials and dry suit hood materials; and also protective ice suit materials, ice suit hood materials and seams, and ice suit glove materials.

9.12.2 Samples.

9.12.2.1 Samples shall be at least 1 m (1 yd) square of each material.

9.12.2.2 Samples shall be conditioned as specified in 9.1.3.

9.12.3 Specimens.

9.12.3.1 Specimens shall be 200 mm × 200 mm (8 in. × 8 in.).

9.12.3.2 A minimum of three specimens shall be tested.

9.12.4 Apparatus. The test apparatus shall be as specified in AATCC TM42, *Test Method for Water Resistance: Impact Penetration*, with the following modifications:

(1) A metal roller 113 mm, ±6 mm (4.5 in., ±¼ in.) long and weighing 1 kg (2.25 lb) shall be used.
(2) Embroidery hoops, measuring 150 mm to 180 mm (6 in. to 7 in.) in diameter shall be used for mounting the specimen.
(3) The liquid for testing shall be water treated to a surface tension of 35 dynes/cm, ±2 dynes/cm.

9.12.5 Procedure.

9.12.5.1 The conditioned specimen shall be securely mounted in the metal embroidery hoops with sufficient tension to ensure a uniformly smooth surface.

9.12.5.2 The direction of the flow of water down the specimen shall coincide with the warpwise direction of the specimen as placed on the stand.

9.12.5.3 The mounted specimen shall be placed on the block with the center of the specimen directly beneath the center of the nozzle and the plane of the surface of the specimen at a 45 degree angle with the horizontal.

9.12.5.4 A 500 ml volume of the test liquid at a temperature of 27°C, ±1°C (80°F, ±2°F) shall be poured quickly into the funnel and allowed to spray onto the specimen.

9.12.5.5 The following operations shall then be executed as rapidly as possible:

(1) The specimen shall be removed from the hoops and placed between sheets of blotting paper on a flat horizontal surface.
(2) The metal roller shall be rolled quickly forward and back one time over the paper without application of any pressure other than the weight of the roller.
(3) A square 100 mm × 100 mm (4 in. × 4 in.) shall be cut out of the center of the wet portion of the specimen and weighed to the nearest 0.05 g. This weight shall be designated the "wet weight." Not more than 30 seconds shall elapse between the time the water has ceased flowing through the spray nozzle and the start of the weighing.
(4) The same 100 mm (4 in.) square shall be conditioned as specified in 9.1.2 until it has dried and reached moisture equilibrium with the surrounding standard atmosphere for textiles.
(5) Following this conditioning it shall be reweighed.
(6) This weight shall be designated the "dry weight."

9.12.5.6 The percent liquid absorption shall be calculated using the following equation:

[9.12.5.6]

$$\%\ \text{liquid absorption} = \frac{W - D}{D} \times 100$$

where:
W = wet weight in grams
D = dry weight in grams

9.12.6 Report.

9.12.6.1 The percent liquid absorption for each specimen shall be recorded and reported.

9.12.6.2 The average percent liquid absorption for all tested specimens shall be calculated, recorded, and reported.

9.12.7 Interpretation. The average percent liquid absorption shall be used to determine pass or fail performance.

9.13 Liquid Penetration Resistance Test.

9.13.1 Application.

9.13.1.1 This test method shall apply to protective dry suit materials and seams, dry suit hood materials and seams, dry suit glove materials and seams, and dry suit bootie materials and seams; and protective ice suit materials and seams, ice suit hood materials and seams, ice suit glove materials and seams, and ice suit footwear materials and seams.

9.13.1.2 Modifications to this test method for testing protective suit materials and suit hood materials and protective bootie materials and bootie material seams shall be as specified in 9.13.7.

9.13.1.3 Modifications to this test method for testing protective suit and suit hood seams and protective bootie materials and bootie material seams shall be as specified in 9.13.8.

9.13.1.4 Modifications to this test method for testing protective glove materials shall be as specified in 9.13.9.

9.13.1.5 Modifications to this test method for testing protective footwear materials shall be as specified in 9.13.10.

9.13.2 Samples.

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

9.13.2.2 Samples shall be conditioned as specified in 9.1.2 after the conditioning specified in the modifications.

9.13.3 Specimens.

9.13.3.1 Specimens shall be the size specified in ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids.*

9.13.3.2 A minimum of three specimens per liquid shall be tested for each material type.

9.13.3.3 Where the same materials are used as the barrier layer throughout the product, testing of seams only in lieu of testing both material and seams shall be permitted.

9.13.4 Procedure.

9.13.4.1 Liquid 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 exposure procedure C, with the following modifications:

(1) All tests shall be conducted at 25°C, ±3°C (77°F, ±5°F) and 65 percent, ±5 percent relative humidity.
(2) The plexiglass shield shall be omitted from the test cell.
(3) Use of blotting paper at the end of the test shall be permitted to assist in the visual observation of liquid penetration.
(4) An observation to determine specimen penetration shall be made at the end of the chemical contact period.

9.13.4.2 Each of the following liquids shall be tested separately against each specimen:

(1) Fire-resistant hydraulic fluid, phosphate ester-based
(2) Surrogate gasoline fuel C as defined in ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids,* a 50/50 percent volume of toluene and isooctane
(3) Swimming pool chlorinating chemical containing at least 65 percent free chlorine (saturated solution)
(4) Diesel fuel

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

9.13.5 Report.

9.13.5.1 The pass or fail result for each specimen shall be recorded and reported.

9.13.5.2 Where applicable, identification of the location where penetration occurs, if discernible, shall be recorded and reported.

9.13.6 Interpretation.

9.13.6.1 Visually observed chemical on the blotting paper shall constitute failure of this test.

9.13.6.2 One or more failures of any specimen against any liquid shall constitute failure of the material.

9.13.7 Specific Requirements for Testing Protective Suits, Suit Hood Materials, and Booties.

9.13.7.1 Samples shall be 200 mm × 280 mm (8 in. × 11 in.) rectangles and shall consist of all layers as configured in the dry suit, ice suit, dry suit bootie, dry suit hood, and ice suit hood.

9.13.7.2 Samples shall first be conditioned by flexing as specified in 9.1.5.

9.13.7.3 Following abrasion, one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion.

9.13.7.4 The penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test and the center of the abraded sample coincide.

9.13.7.5 Where suit materials, suit hood materials, or bootie materials are the same, only one material shall be tested.

9.13.8 Specific Requirements for Testing Protective Suit Seams, Bootie Seams, and Hood Seams.

9.13.8.1 Protective dry suit seams, dry suit hood seams, dry suit bootie seams, protective ice suit seams, and ice suit hood seams shall consist of seams from the separable layer that is intended to prevent the penetration of liquids.

9.13.8.2 A minimum of three 75 mm (3 in.) squares for each material type shall be tested.

9.13.8.3 Where suit materials and seams, bootie materials and seams, or suit hood materials and seams are the same, only one seam-material configuration shall be tested.

9.13.9 Specific Requirements for Testing Glove Materials.

9.13.9.1 Specimens shall be taken from dry suit and ice suit glove specimens at the palm, back, and seam areas.

9.13.9.2 Only the separable layer of the specimen that is intended to prevent the penetration of liquids shall be tested.

9.13.9.3 Where the layer used for the prevention of liquid penetration is the same in palm and back areas, testing of the seams only shall be permitted.

9.13.9.4 A minimum of three 75 mm (3 in.) squares for each material type shall be tested.

9.13.10 Specific Requirements for Testing Footwear Materials.

9.13.10.1 Specimens shall be taken from the footwear upper and any upper seam areas. The footwear upper shall include the toe, vamp, quarter, shaft, collar, and throat, but shall not include the sole.

9.13.10.2 Only that separable layer of the footwear item intended to prevent the penetration of liquids shall be tested.

9.13.10.3 Where the layer used for the prevention of liquid penetration is the same throughout the footwear item, testing of the seams only shall be permitted.

9.13.10.4 A minimum of three 75 mm (3 in.) squares for each material type shall be tested.

9.14 Viral Penetration Resistance Test.

9.14.1 Application.

9.14.1.1 This test method shall apply to protective dry suit materials and seams, dry suit hood materials and seams, dry suit glove materials and seams, and dry suit bootie materials and seams, and also to protective ice suit materials and seams, ice suit hood materials and seams, ice suit glove materials and seams, and ice suit footwear materials and seams.

9.14.1.2 Modifications to this test method for testing suit and suit hood materials and booties shall be as specified in 9.14.7.

9.14.1.3 Modifications to this test method for testing suits, suit hood materials, and bootie seams shall be as specified in 9.14.8.

9.14.1.4 Modifications to this test method for testing glove materials shall be as specified in 9.14.9.

9.14.1.5 Modifications to this test method for testing footwear materials shall be as specified in 9.14.10.

9.14.2 Samples.

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

9.14.2.2 Samples shall be conditioned as specified in 9.1.2 after the conditioning specified in the modifications.

9.14.3 Specimens.

9.14.3.1 A minimum of three specimens shall be tested.

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

9.14.4 Procedure.

9.14.4.1 Biopenetration resistance testing shall be conducted in accordance with 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.*

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

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

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

9.14.7 Specific Requirements for Testing Suits, Suit Hood Materials, and Booties.

9.14.7.1 Samples shall be 200 mm × 280 mm (8 in. × 11 in.) rectangles and shall consist of all layers as configured in the suit, suit hood, or bootie.

9.14.7.2 Two samples shall first be conditioned by flexing as specified in 9.1.4.

9.14.7.3 One sample shall be flexed with the longitudinal axis parallel to the machine direction of the material, and the second sample shall be flexed with the longitudinal axis parallel to the cross machine direction of the material.

9.14.7.4 Following flexing, two samples for abrasion conditioning, each measuring 45 mm × 230 mm (1¾ in. × 9 in.), shall be cut from the center of the flexed samples.

9.14.7.5 At least one specimen for abrasion conditioning shall be taken from a sample flexed in the machine direction, and at least one specimen for abrasion conditioning shall be taken from a sample flexed in the cross machine direction for each chemical tested.

9.14.7.6 These new samples shall then be conditioned by abrading as specified in 9.1.5.

9.14.7.7 Following abrasion, only one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion.

9.14.7.8 The penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test specimen and the center of the abraded sample coincide.

9.14.7.9 Where suit materials, suit hood materials, or bootie materials are the same, only one material shall be tested.

9.14.8 Specific Requirements for Testing Suit, Suit Hood, and Bootie Seams.

9.14.8.1 Protective dry suit seams, dry suit hood seams, and dry suit bootie seams, as well as protective ice suit seams and ice suit hood seams shall consist of seams from the separable layer that is intended to prevent the penetration of liquids.

9.14.8.2 A minimum of three 75 mm (3 in.) squares for each material type shall be tested.

9.14.8.3 Where suit materials and seams, bootie materials and seams, or suit hood materials and seams are the same, only one seam-material configuration shall be tested.

9.14.9 Specific Requirements for Testing Glove Materials.

9.14.9.1 Specimens shall be taken from sample gloves at the palm, back, and seam areas.

9.14.9.2 Only that separable layer of the glove that is intended to prevent the penetration of liquids shall be tested.

9.14.9.3 Where the layer used for the prevention of liquid penetration is the same in palm and back areas, testing of the seams only shall be permitted.

9.14.9.4 A minimum of three 75 mm (3 in.) squares for each material type shall be tested.

9.14.10 Specific Requirements for Testing Footwear Materials.

9.14.10.1 Specimens shall be taken from the footwear upper and any upper seam areas. The footwear upper shall include the toe, vamp, quarter, shaft, collar, and throat, but shall not include the sole.

9.14.10.2 Only that separable layer of the footwear item intended to prevent the penetration of liquids shall be tested.

9.14.10.3 Where the layer used for the prevention of liquid penetration is the same throughout the footwear item, testing of the seams only shall be permitted.

9.14.10.4 A minimum of three 75 mm (3 in.) squares for each material type shall be tested.

9.15 Retroreflectivity Test.

9.15.1 Application.

9.15.1.1 This test method shall apply to visibility markings used on suits, PFDs, and helmets.

9.15.1.2 Visibility markings shall be tested for each procedure specified in 9.15.4.

9.15.2 Samples.

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

9.15.2.2 Samples shall be conditioned as specified in 9.1.2.

9.15.3 Specimens.

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

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

9.15.3.3 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.

9.15.4 Procedures for Measurement of Coefficient of Retroreflection.

9.15.4.1 The coefficient of retroreflection (R_a) 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.

9.15.4.2 The R_a shall be calculated by the following equation:

[9.15.4.2]

$$R_a = \frac{R_I}{A_r}$$

where:
R_I = the coefficient of luminous intensity measured as specified in 9.15.4.1
A_r = only the retroreflective surface area of the visibility marking test specimen's surface area

9.15.4.3 A_r shall be calculated by subtracting the nonretroreflective surface area from the test specimen's total surface area.

9.16 Corrosion Resistance Test.

9.16.1 Application.

9.16.1.1 This test method shall apply to hardware items on suits, helmets, gloves, footwear, and personal flotation devices.

9.16.1.2 Modifications to this test method for testing suit, glove, footwear, and personal flotation device hardware shall be as specified in 9.16.7.

9.16.1.3 Modifications to this test method for testing helmet hardware shall be as specified in 9.16.8.

9.16.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.16.3 Specimens. A total of three specimens of each hardware type shall be tested.

9.16.4 Procedure.

9.16.4.1 Specimens shall be tested in accordance with ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus.* Hardware items shall be exposed to a 5 percent, ±1 percent, saline solution for a period of 20 hours.

9.16.4.2 Immediately following the storage specified in 9.16.4.1 and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

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

9.16.4.4 The functionality of each specimen shall be evaluated.

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

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

9.16.7 Specific Requirements for Testing Protective Suit, Glove, Footwear, and Personal Flotation Device Hardware.

9.16.7.1 Samples shall be whole hardware items.

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

9.16.8 Specific Requirements for Testing Helmets. Samples shall be whole helmets.

9.17 Label Durability and Legibility Test.

9.17.1 Application.

9.17.1.1 This test method shall apply to labels on protective suits, helmets, gloves, footwear, and personal flotation devices.

9.17.1.2 Modifications to this test method for testing protective suit labels shall be as specified in 9.17.7.

9.17.1.3 Modifications to this test method for testing protective helmet labels shall be as specified in 9.17.8.

9.17.1.4 Modifications to this test method for testing protective glove labels shall be as specified in 9.17.9.

9.17.1.5 Modifications to this test method for testing protective footwear labels shall be as specified in 9.17.10.

9.17.1.6 Modifications to this test method for testing protective personal flotation device labels shall be as specified in 9.17.11.

9.17.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.17.3 Specimens.

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

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

9.17.4 Procedures.

9.17.4.1 Laundering Durability Test.

9.17.4.1.1 Specimens shall be subjected to 10 cycles of laundering and drying using Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai of AATCC TM135, *Dimensional Changes of Fabrics After Home Laundering.*

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

9.17.4.1.3 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.

9.17.4.2 Abrasion Durability Test.

9.17.4.2.1 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.

9.17.4.2.2 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.

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

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

9.17.7 Specific Requirements for Testing Protective Suit Labels.

9.17.7.1 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.

9.17.7.2 The ballast material shall be as specified in AATCC TM135, *Dimensional Changes of Fabrics After Home Laundering*.

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

9.17.7.4 Specimens shall be tested separately for legibility after laundering and abrasion as specified in 9.17.4.1 and 9.17.4.2, respectively.

9.17.8 Specific Requirements for Testing Protective Helmet Labels.

9.17.8.1 Samples shall be whole protective helmets with labels attached.

9.17.8.2 Samples shall be conditioned as specified in 9.1.6.

9.17.8.3 Label 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.

9.17.9 Specific Requirements for Testing Protective Glove Labels.

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

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

9.17.9.3 Specimens shall be tested separately for legibility after laundering and abrasion as specified in 9.17.4.1 and 9.17.4.2, respectively.

9.17.10 Specific Requirements for Testing Protective Footwear Labels.

9.17.10.1 For testing label legibility after laundering, specimens shall include protective gloves with labels attached.

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

9.17.10.3 Specimens shall be tested separately for legibility after laundering and abrasion as specified in 9.17.4.1 and 9.17.4.2, respectively.

9.17.11 Specific Requirements for Testing Personal Flotation Device Labels.

9.17.11.1 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.

9.17.11.2 The ballast material shall be as specified in AATCC TM135, *Dimensional Changes of Fabrics After Home Laundering*.

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

9.17.11.4 Specimens shall be tested separately for legibility after laundering and abrasion as specified in 9.17.4.1 and 9.17.4.2, respectively.

9.18 Top Impact Resistance Test (Force).

9.18.1 Application. This test method shall apply to protective helmets.

9.18.2 Samples. Samples shall be complete protective helmets.

9.18.3 Specimens.

9.18.3.1 Specimens shall be conditioned for the environmental conditions specified in 9.1.2, 9.1.6, and 9.1.8 prior to each impact.

9.18.3.2 A minimum of three helmet specimens of each shell/liner size combination shall be tested as specified for each environmental condition.

9.18.4 Apparatus.

9.18.4.1 An aluminum ISEA size 7 headform shall be used.

9.18.4.2 The headform shall have a mass of 3.6 kg, ±0.5 kg (8 lb, ±1.0 lb).

9.18.4.3 The test headform shall have the nominal dimensions of the headform in Table 9.18.4.3 and Figure 9.18.4.3(a) through Figure 9.18.4.3(c).

9.18.4.4 A steel drop mass of 3.58 kg, ±0.05 kg (7.9 lb, ±0.10 lb) shall be used. The striking face of the drop mass shall be a spherical segment with a radius of 48 mm, ±8 mm (1.9 in., ±0.3 in.) and a chord length of at least 75 mm (3 in.).

Table 9.18.4.3 Data for Contour Drawing of ISEA Headform (all dimensions in mm)

Horizontal Plane	Distance from Datum Plane	Vertical Sections												
		0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
0-0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
1-1	95	22.5	22.5	23.0	25.5	26.5	28.0	28.5	31.0	33.0	36.0	39.0	38.7	40.0
2-2	90	39.5	40.0	40.0	40.5	40.5	40.5	41.5	43.5	47.5	50.0	53.0	53.0	54.5
3-3	85	53.5	54.0	55.7	51.5	50.5	50.0	51.5	53.5	57.0	60.5	64.0	64.5	65.5
4-4	80	62.5	63.0	60.9	59.0	57.0	57.0	57.5	60.5	63.5	67.3	70.7	70.7	72.2
5-5	70	72.5	74.0	71.5	68.2	65.5	64.5	65.3	68.0	72.0	75.7	79.1	80.0	82.0
6-6	60	82.0	82.0	79.5	75.0	71.0	69.4	70.1	73.0	77.5	81.7	85.1	87.5	87.9
7-7	50	87.3	87.0	84.5	79.0	74.0	71.5	72.0	75.7	80.9	85.8	89.4	91.0	92.3
8-8	40	90.2	90.5	87.5	81.5	75.5	73.0	73.5	76.9	82.7	88.3	91.3	93.5	95.0
9-9	20	94.0	94.0	90.5	83.5	77.1	73.7	74.2	77.8	84.3	91.0	95.5	97.6	98.5
Datum Plane														
10-10	0	96.5	96.5	93.0	84.6	77.5	73.5	74.2	79.0	85.0	92.5	96.5	98.8	99.9
11-11	20	96.5	96.5	93.0	84.6	77.5	73.5	72.0	70.0	78.5	84.0	90.0	91.0	95.0
12-12	40	96.5	96.5	93.0	84.6	77.5	73.5	70.0	63.5	70.0	75.0	81.0	82.0	84.0
13-13	60	96.5	96.5	93.0	84.6	77.5	73.5	68.0	58.0	57.5	63.0	69.0	69.0	72.0
14-14	80	96.5	96.5	93.0	84.6	77.5	73.5	66.0	54.0	48.0	53.0	59.0	60.0	63.0
15-15	100	96.5	96.5	93.0	84.6	77.5	73.5	64.0	52.0	48.0	49.0	54.0	56.0	59.0
16-16	115.9	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5
17-17	128.6	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5

Note: All dimensions ±5 mm.
For SI units, 25 mm = 1 in.

9.18.4.5 An electronic force measurement system with the following minimum specifications shall be used:

(1) Range: 4450 N (1000 lbf)
(2) Peak force measurement accuracy: ±2.5 percent
(3) Resolution: 22 N (5 lbf)
(4) Load cell rigidity:

[9.18.4.5]

For SI units:
$4.4Y \times 10^9\ N/m$
For U.S. units:
$2.5Y \times 10^7$ lb/in.

(5) Minimum mechanical resonant frequency of the headform/load cell system: 5000 Hz
(6) Load cell diameter: 75 mm (3 in.)

9.18.4.6 The system frequency response shall comply with SAE J211, *Instrumentation for Impact Test — Part 1 — Electronic Instrumentation*, Channel Frequency Class 1000 specifications. The minimum mechanical resonant frequency shall be calculated from the following formula:

[9.18.4.6]

$$\int = \sqrt{\frac{kg/m}{2\pi}}$$

where:
kg = load cell rigidity (N/m or lbf/ft)
m = mass of the structure on top of the load cell (kg or slugs)

9.18.4.7 All surfaces in contact with the load cell shall have a surface finish of at least 0.8×10^{-6} m (32×10^{-6} in.) rms. In addition, those surfaces in contact with the load cell shall be flat to within 12.7×10^{-6} m (500×10^{-6} in.).

9.18.4.8 The load cell shall have a backup mass of at least 540 kg (1200 lb). The load cell assembly shall be rigidly mounted between the headform structure and a steel plate at least 305 mm (1 ft) square and 25 mm (1 in.) thick. The backup mass shall be concrete or a rigid material of equal or greater density at least 610 mm (2 ft) square.

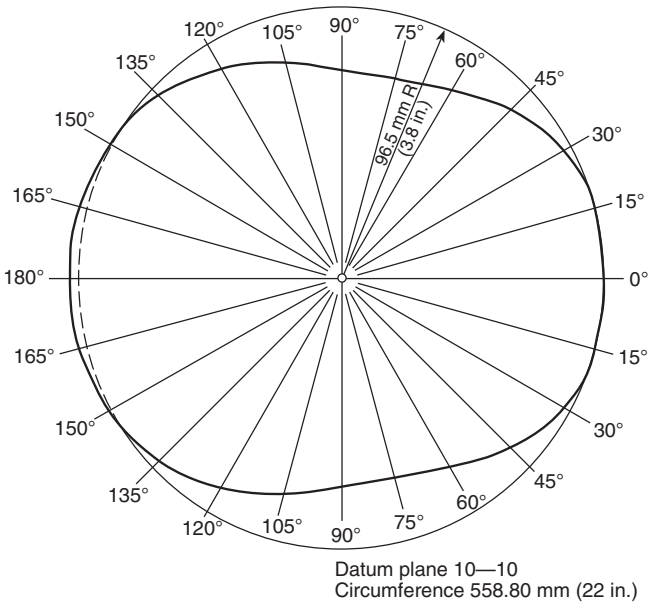


FIGURE 9.18.4.3(a) ISEA Size 7 Headform, Top.

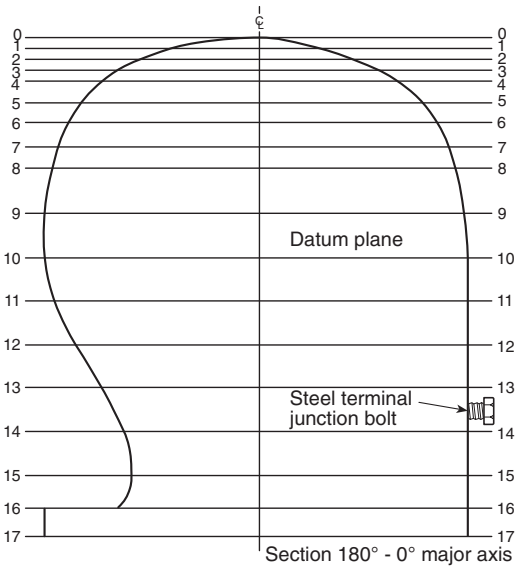


FIGURE 9.18.4.3(b) ISEA Size 7 Headform, Side with Modification for Steel Terminal Junction Bolt.

9.18.4.9 The surface of the steel plate, in the area of the load cell assembly mounting, shall be flat within ±0.15 mm (±0.005 in.) and within 1 degree of level. The steel plate shall be rigidly attached to, and in intimate contact with, the backup mass.

9.18.4.10 The vertical centerline of the drop mass, the headform, and the load cell shall all be colinear within 3 mm (⅛ in.). The sensitive axis of the load cell shall be aligned within 1 degree of vertical. The guide or guides shall be vertical (or in the case of a double guide system, parallel) to within 6 mm (¼ in.) per 3 m (10 ft) of length.

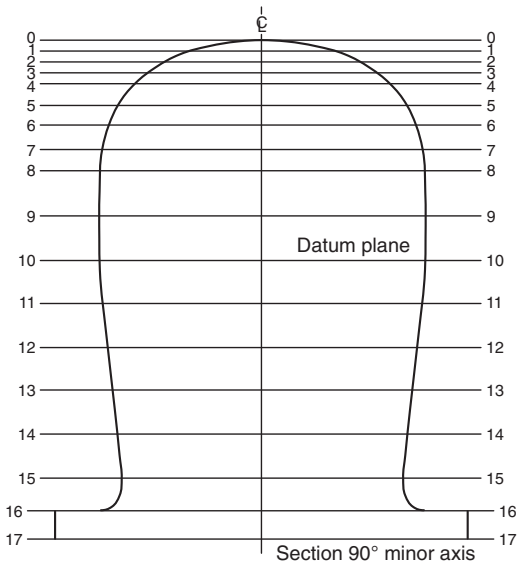


FIGURE 9.18.4.3(c) ISEA Size 7 Headform, Front.

9.18.4.11 The instrumentation calibration shall be verified at least before and after each test series or at the beginning and end of each day of testing, whichever is the shorter length of time. *(See Annex B for more information.)*

9.18.4.12 The test system shall be analyzed dynamically to ensure that any mechanical resonances associated with transducer mountings do not distort the output data.

9.18.4.13 Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

9.18.4.14 Throughout calibration, verification, and testing, the ambient temperature shall be 20°C to 28°C (68°F to 82°F) and the relative humidity shall be 30 to 70 percent.

9.18.5 Procedure.

9.18.5.1 Specimens shall be adjusted to a size sufficiently large to prevent binding.

9.18.5.2 Specimens shall be positioned and secured to properly fit on the headform with the horizontal center plane parallel within 5 degrees of the reference plane.

9.18.5.3 The front-to-back centerline of the shell shall be within 13 mm (½ in.) of the midsagittal plane of the headform. The midsagittal plane shall be the plane perpendicular to the basic plane and coronal planes that bisects the head symmetrically.

9.18.5.4 Specimens shall be subjected to the environmental conditions specified in 9.1.2, 9.1.6, and 9.1.8 prior to each impact and within the specified time after being removed from conditioning.

9.18.5.5 The impactor shall be dropped from a height that yields an impact velocity within 2 percent of 5.47 m/s (17.9 ft/s).

9.18.5.6 A means of verifying the impact velocity to within 2 percent for each impact shall be incorporated.

9.18.5.7 The verification tests shall demonstrate an accuracy of 2.5 percent or better in the measured force.

9.18.6 Report.

9.18.6.1 The peak force and impact velocity shall be recorded and reported for each test.

9.18.6.2 The results of each system verification shall be made part of the test results for the helmets being tested.

9.18.7 Interpretation.

9.18.7.1 Disengagement of, deformation of, or damage to the helmet shell or component parts shall not of itself constitute failure.

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

9.18.7.3 One or more helmet specimens failing this test shall constitute failing performance.

9.19 Physical Penetration Resistance Test.

9.19.1 Application. This test method shall apply to protective helmets.

9.19.2 Samples.

9.19.2.1 Samples shall be complete protective helmets.

9.19.2.2 Samples shall be conditioned for the environmental conditions specified in 9.1.2, 9.1.6, and 9.1.8 prior to each physical penetration.

9.19.3 Specimens. A minimum of three helmets shall be tested for each environmental condition.

9.19.4 Apparatus.

9.19.4.1 The ISO size J headform shall conform to the nominal dimensions in Figure 9.19.4.1. Above the test line, the headform shall have an electrically conductive surface that is electrically connected to the contact indicator.

9.19.4.2 The penetration striker shall have a mass of 1 kg, +0.02/−0.00 kg (2.2 lb, +0.01/−0.00 lb).

9.19.4.3 The point of the striker shall be a cone with an included angle of 60 degrees, ±½ degree, a height of 38 mm (1½ in.), and a tip radius of 0.5 mm, ±0.1 mm (0.020 in., ±0.004 in.).

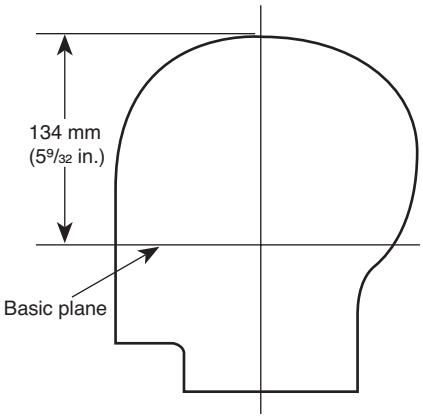


FIGURE 9.19.4.1 ISO Size J Headform.

9.19.4.4 The hardness of the striking tip shall be Rockwell Scale C-60, minimum. The penetration striker shall be electrically connected to the contact indicator.

9.19.4.5 The contact indicator shall indicate when electrical contact has been made between the penetration striker and the conductive surface of the test headform.

9.19.4.6 The contact indicator shall have a response time of less than 0.5 second.

9.19.4.7 The test shall be conducted at an ambient temperature of 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

9.19.5 Procedure.

9.19.5.1 The environmentally conditioned helmet shall be placed on the rigidly mounted test headform and secured by the helmet retention system or by other means that will not interfere with the test.

9.19.5.2 The helmet shall be positioned so that the penetration striker shall impact perpendicular to the helmet.

9.19.5.3 The helmet shall be adjusted to a size sufficient to properly fit on the headform with the horizontal center plane parallel and within 5 degrees of the reference plane.

9.19.5.4 The front-to-back centerline of the shell shall be within 13 mm (½ in.) of the midsagittal plane of the headform. The midsagittal plane shall be the plane perpendicular to the basic plane and coronal planes that bisects the head symmetrically.

9.19.5.5 The drop height of the penetration striker shall be adjusted so that the velocity at impact is at 7 m/s, ±0.1 m/s (23 ft/s, ±0.5 ft/s).

9.19.5.6 The penetration striker shall be dropped to apply a minimum of two strikes by a striker anywhere above the test zone and impact points spaced at a distance of 75 mm (3 in.) from each other.

9.19.5.6.1 The area to be struck shall be applied to the top area of the helmet from the temple area upward.

9.19.5.7 The penetration striker shall not fall on any portion of the ridges of the helmet shell or make contact with the headform.

9.19.6 Report. The pass or fail results for each helmet shall be recorded and reported.

9.19.7 Interpretation. One or more helmet specimens failing this test shall constitute failing performance.

9.20 Retention System Test.

9.20.1 Application. This test method shall apply to helmets.

9.20.2 Samples.

9.20.2.1 Samples shall be complete helmets.

9.20.2.2 Samples shall be conditioned as specified in 9.1.2, 9.1.6, and 9.1.8.

9.20.3 Specimens. A minimum of three helmets shall be tested for each test.

9.20.4 Apparatus.

9.20.4.1 An ISO size J headform shall be used. The nominal dimensions of the headform shall be as specified in Figure 9.19.4.1.

9.20.4.2 The mechanical chin structure shall consist of two rollers 13 mm (½ in.) in diameter with centers 75 mm (3 in.) apart. The mechanical chin structure shall conform with Figure 9.20.4.2 or equivalent.

9.20.4.3 The mechanical chin structure shall be designed to be used with a calibrated tensile test machine that shall be capable of measuring the force applied to the retention system within 2 percent at the specified force.

9.20.4.4 The test shall be conducted at an ambient temperature of 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

9.20.4.5 Prior to testing, the test machine shall be allowed to warm up until stability is achieved.

9.20.5 Procedure.

9.20.5.1 The headform and mechanical chin structure shall be positioned so the distance between the bottom of the rollers and the top of the headform is 210 mm, ±10 mm (8¼ in., ±⅓ in.).

9.20.5.2 The chin strap shall pass around the rollers, and the helmet shall be secured to the headform.

9.20.5.3 The chin strap shall be adjusted and preloaded to 45 N, ±5 N (10 lb, ±1 lb).

9.20.5.4 The distance between the top of the helmet and the rollers shall be measured, recorded, and reported to the nearest 0.5 mm (1/64 in.).

9.20.5.5 The force applied to the retention system shall be slowly increased to 445 N, ±5 N (100 lb, ±1 lb). The force shall be increased smoothly from 45 N (10 lb) to 445 N (100 lb) at between 9.0 N/s (2 lb/s) and 45 N/s (10 lb/s).

9.20.5.6 When using a tensile testing machine, the load rate shall be 25 mm (1 in.) per minute to a limit of 445 N (100 lb).

9.20.5.7 The distance between the top of the helmet and the rollers shall be measured, recorded, and reported to the nearest 0.5 mm (1/64 in.) again after the force has been maintained at 445 N (100 lb) for 60 seconds, +15/-0 seconds.

9.20.5.8 The difference between the second measurement and the first measurement shall be the retention system elongation.

9.20.6 Report. The retention system elongation shall be measured, recorded, and reported for each helmet specimen.

9.20.7 Interpretation. One or more helmet specimens failing this test shall constitute failing performance.

9.21 Overall Liquid Integrity Test Two.

9.21.1 Application. This test method shall apply to dry suit protective gloves.

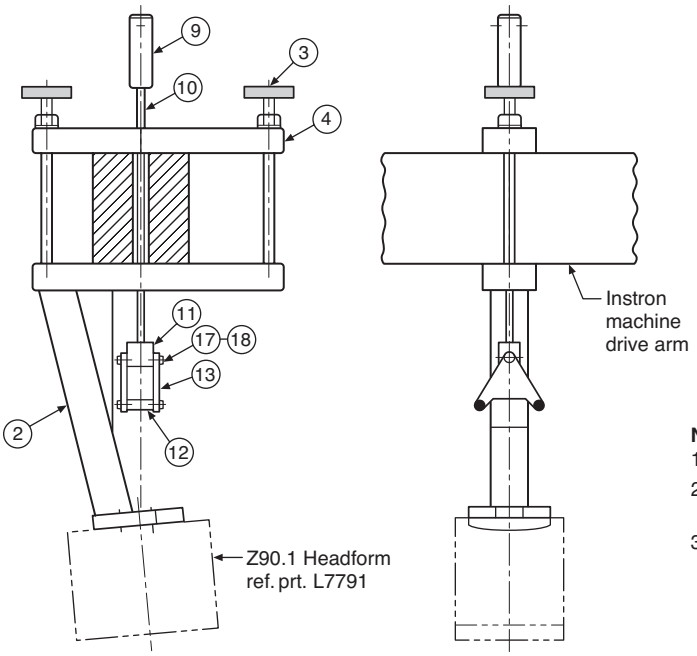
9.21.2 Samples.

9.21.2.1 Samples shall be whole protective glove pairs and shall be in sizes small and large.

9.21.2.2 Samples shall be conditioned as specified in 9.1.3 following by the conditioning as specified in 9.1.2.

9.21.3 Specimens.

9.21.3.1 Specimens shall be whole glove pairs, sizes small and large.



ITEM NO.	PART NO.	SHT. NO.	DESCRIPTION	MAT'L.	VEND. OR STR. SIZE	QTY.
1	L8539	1	Retention Test Fixt. Assy.	—	—	1
2		2	Main Support Assy.	—	—	1
3		2	Knurled Knob Assy.	—	—	2
4		2	Rect. Alum. Bar	6061-T6	1 1/2 x 3 x 14 Lg.	1
5		2	Rect. Alum. Bar	6061-T6	1 1/2 x 3 x 14 Lg.	1
6		2	Alum. Bar	6061-T6	2 x 2 x 7 1/2 Lg.	1
7		2	Alum. Bar	6061-T6	2 x 2 x 12.96 Lg.	1
8		2	Alum. Flat	6061-T6	3/4 x 4 1/2 x 5 Lg.	1
9		2	C.F. Steel Rod	Stl.	1 1/4 Dia. x 4 Lg.	1
10		2	C.F. Steel Rod	Stl.	3/8 Dia. x 22 Lg.	1
11		2	C.F. Steel Flat	Stl.	1 x 1 1/4 x 1 1/2 Lg.	1
12		2	Hollow Steel Tube	Stl.	.500 O.D. .384 I.D. x 1 1/2	2
13		2	C.F. Steel Flat	Stl.	1/4 x 3 1/4 x 3 3/4 Lg.	2
14		2	C.F. Steel Flat	Stl.	39 x 3/4 Thk.	2
15		2	C.F. Steel Rod	Stl.	3/4 ∅ x 10 1/2 Lg.	2
16		2	Hex Nut	Stl.	3/4 - 10 Unc.	2
17		1	Hex Hd. Bolt	Stl.	3/8 - 24 Unf. x 2 1/2 Lg.	3
18		1	Hex Nut	Stl.	3/8 - 24 Unf.	3

Notes:
1. Remove burrs and break sharp edges.
2. All steel parts are to be solvent cleaned and zinc plated 0.00762 mm to 0.0254 mm (0.0003 to 0.0010 in.) thick.
3. Headform is to be bolted in place using 3 socket-head cap screws 1/2–13 UNC x 1 1/2 Lg.

FIGURE 9.20.4.2 Retention System Test Setup.

9.21.3.2 At least three glove pairs each for small and large sizes shall be tested.

9.21.4 Apparatus.

9.21.4.1* A water markable glove shall cover all areas of the tester's hand. The water markable glove shall be constructed of a fabric that is easily watermarked to determine leakage.

9.21.4.2 The water used for integrity testing shall be treated with a nonfoaming surfactant to lower its surface tension to 35 dynes/cm, ±2 dynes/cm.

9.21.5 Procedure.

9.21.5.1 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.

9.21.5.2 The test subject shall don the glove specimen over the water markable glove.

9.21.5.3 The test subject shall immerse the glove specimen to within 25 mm (1 in.) of the top of the body of the glove specimen for 5 minutes in 20°C, ±3°C (68°F, ±5°F) water. The test subject shall flex the glove specimen in a fist clenching motion every 10 seconds.

9.21.5.4 The glove specimen shall be removed from the test subject's hand and the inner glove shall be inspected for water marks.

9.21.6 Report. The appearance of water marks on the inner glove after testing any of the three gloves shall be recorded and reported.

9.21.7 Interpretation. The appearance of water marks on the inner glove after testing any glove shall be considered leakage and shall constitute failing performance.

9.22 Cut Resistance Test.

9.22.1 Application.

9.22.1.1 This test method shall apply to dry suit glove material, dry suit footwear material, ice suit glove material, ice suit footwear material, wet suit glove material, and wet suit footwear material.

9.22.1.2 Modifications to this test method for evaluation of protective glove materials shall be as specified in 9.22.7.

9.22.1.3 Modifications to this test method for evaluation of protective footwear upper materials shall be as specified in 9.22.8.

9.22.2 Samples.

9.22.2.1 Samples shall be whole protective gloves or protective footwear uppers.

9.22.2.2 Samples shall be conditioned as specified in 9.1.2.

9.22.3 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.

9.22.4 Procedure. Specimens shall be evaluated in accordance with ASTM F1790/F1790M, *Standard Test Method for Measuring 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.

9.22.5 Report.

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

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

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

9.22.7 Specific Requirements for Testing Protective Glove Materials.

9.22.7.1 Specimens shall be taken from the palm and palm-side fingers of the glove and shall not include seams.

9.22.7.2 Cut resistance testing shall be performed under a load of 75 g (0.16 lb).

9.22.8 Specific Requirements for Testing Protective Footwear Upper Materials.

9.22.8.1 Specimens shall be taken from the parts of the footwear upper that provide uniform thickness and shall not include seams. The footwear upper shall include the toe, vamp, quarter, shaft, collar, and throat, but shall not include the sole.

9.22.8.2 Cut resistance testing shall be performed under a load of 350 g (0.77 lb).

9.23 Puncture Resistance Test.

9.23.1 Application.

9.23.1.1 This test method shall apply to protective wet suit protective gloves, wet suit footwear upper materials, and wet suit footwear soles; protective dry suit gloves, dry suit footwear upper materials, and dry suit footwear soles; and protective ice suit glove palm composites, ice suit footwear upper materials, and ice suit footwear soles.

9.23.1.2 Modifications to this test method for testing protective glove materials shall be as specified in 9.23.7.

9.23.1.3 Modifications to this test method for testing protective footwear upper material shall be as specified in 9.23.8.

9.23.1.4 Modifications to this test method for testing footwear soles shall be as specified in 9.23.9.

9.23.2 Samples.

9.23.2.1 Samples shall be complete protective gloves or protective footwear sections.

9.23.2.2 Samples shall be conditioned as specified in 9.1.2.

9.23.3 Specimens.

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

9.23.3.2 At least three specimens shall be tested.

9.23.4 Procedure. Specimens shall be tested in accordance with ASTM F1342/F1342M, *Standard Test Method for Protective Clothing Material Resistance to Puncture*, Method A.

9.23.5 Report.

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

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

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

9.23.7 Specific Requirements for Testing Protective Glove Materials.

9.23.7.1 Specimens shall not include seams and shall be taken from the palm and palmside fingers of the glove.

9.23.7.2 Where the specimen composites of the palm and palmside of the fingers are identical, only one representative composite shall be required to be tested.

9.23.8 Specific Requirements for Testing Protective Footwear Upper Materials.

9.23.8.1 Specimens shall consist of each composite of the footwear item used in the actual suit footwear configuration, with layers arranged in proper order.

9.23.8.2 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.

9.23.9 Specific Requirements for Testing Protective Footwear Soles.

9.23.9.1 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.

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

9.24 Abrasion Resistance Test Two.

9.24.1 Application.

9.24.1.1 This test method shall apply to protective dry suit gloves, dry suit footwear uppers, and dry suit footwear soles; protective wet suit gloves, wet suit footwear uppers, and wet suit footwear soles; and protective ice suit gloves, ice suit footwear uppers, and ice suit footwear soles.

9.24.1.2 Modifications to this test method for testing protective glove composite shall be as specified in 9.24.7.

9.24.1.3 Modifications to this test method for testing protective footwear upper materials shall be as specified in 9.24.8.

9.24.1.4 Modifications to this test method for testing protective footwear soles shall be as specified in 9.24.9.

9.24.2 Samples.

9.24.2.1 Samples shall be as specified in 9.24.7, 9.24.8, or 9.24.9.

9.24.2.2 Samples shall be conditioned as specified in 9.1.2.

9.24.3 Specimens.

9.24.3.1 Specimens shall be as specified in 9.24.7, 9.24.8, or 9.24.9.

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

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

9.24.4 Procedure.

9.24.4.1 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.

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

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

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

9.24.7 Requirements for Testing Protective Glove Composites.

9.24.7.1 Samples shall be full gloves.

9.24.7.2 Samples and specimens shall be permitted to be materials representative of those used in the construction of the glove.

9.24.7.3 Specimens shall not include seams and shall be taken from the palm, palmside fingers, and back of the glove.

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

9.24.8 Requirements for Testing Protective Footwear Upper Materials.

9.24.8.1 Samples shall be complete footwear items.

9.24.8.2 Samples and specimens shall be permitted to be materials representative of those used in the constriction of the footwear.

9.24.8.3 Specimens shall be taken from the footwear upper and shall not include seams. The footwear upper shall include the toe, vamp, quarter, shaft, collar, and throat, but shall not include the sole.

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

9.24.9 Requirements for Testing Protective Footwear Soles.

9.24.9.1 Samples shall be complete footwear items.

9.24.9.2 Samples and specimens shall be permitted to be materials representative of those used in the construction of the footwear.

9.24.9.3 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.

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

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

9.25 Glove Hand Function Test.

9.25.1 Application. This test shall apply to wet suit, dry suit, and ice suit protective gloves.

9.25.2 Samples.

9.25.2.1 Samples shall be whole protective glove pairs, sizes small and large.

9.25.2.2 Samples shall be conditioned as specified in 9.1.3 followed by conditioning as specified in 9.1.2.

9.25.3 Specimens.

9.25.3.1 Specimens shall be whole glove pairs, sizes small and large, in new, as-distributed condition.

9.25.3.2 At least three glove pairs each for small and large sizes shall be tested.

9.25.3.3 Each glove pair shall be tested as a complete set of gloves in new, as-distributed condition.

9.25.3.4 Glove pair specimens shall not receive special softening treatments prior to tests.

9.25.4 Procedures. Testing shall be conducted in accordance with ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Finger Dexterity Using a Modified Pegboard Test*, with the following modifications:

(1) Each size of gloves shall be evaluated with at least one separate test subject with the same pair of gloves.
(2) A minimum of three different glove pairs shall be evaluated for each size specified in 9.25.2.1.

9.25.5 Report.

9.25.5.1 The average percent of barehand control shall be recorded and reported for each test subject.

9.25.5.2 The average percent of barehand control for all test subjects shall be calculated, recorded, and reported.

9.25.6 Interpretation. The average percent of barehand control for all test subjects shall be used to determine pass or fail performance.

9.26 Grip Test.

9.26.1 Application. This test shall apply to wet suit, dry suit, and ice suit protective gloves.

9.26.2 Samples.

9.26.2.1 Samples shall be whole protective glove pairs, sizes small and large, in new, as-distributed condition.

9.26.2.2 Samples shall be conditioned as specified in 9.1.3, followed by conditioning as specified in 9.1.2.

9.26.2.3 Other samples shall be conditioned as specified in 9.1.3, followed by conditioning as specified in 9.1.7.

9.26.3 Specimens.

9.26.3.1 Specimens shall be whole protective glove pairs, sizes small and large.

9.26.3.2 At least three glove pairs each for small and large sizes shall be tested.

9.26.3.3 Glove pair specimens shall not receive special softening treatments prior to tests.

9.26.3.4 Specimens shall be tested for each material and construction combination.

9.26.4 Apparatus. Grip testing shall be evaluated with the use of a 9.5 mm (3⁄8 in.) diameter, 3-strand prestretched polyester rope attached to a calibrated force measuring device.

9.26.5 Procedure.

9.26.5.1 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.

9.26.5.2 Each test subject shall make three successive attempts to exert as much horizontal pulling force as possible, using both hands, one in front of the other. Thumbs shall not overlap the fingers, and both feet shall be firmly planted on the ground. The average weight hoisted over the three trials shall be the barehand weight lift capability.

9.26.5.3 Dry-conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

9.26.5.4 Wet-conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

9.26.5.5 Each test subject shall be tested with a minimum of three pairs of gloves. Test subjects shall attempt one trial with each pair of gloves for a minimum of six grip tests for each set of conditions, with at least three grip tests with small sized gloves and three grip test with large sized gloves.

9.26.5.6 The weight pulling capacity with gloves shall be compared with barehand weight-lifting capability. The percentage of weight-pulling capacity with gloves to barehand weight-lifting capability shall be calculated as follows:

[9.26.5.6]

$$\frac{WPC_g}{WLC_b} \times 100$$

where:
WPC_g = weight-pulling capacity with gloves
WLC_b = barehand weight-lifting capability

9.26.6 Report. The percent of barehand control shall be calculated, recorded, and reported for each glove pair specimen, condition, and test subject tested.

9.26.7 Interpretation. One or more glove pair specimens failing this test shall constitute failing performance.

9.27 Glove Donning Test.

9.27.1 Application. This test shall apply to wet suit, dry suit, and ice suit gloves.

9.27.2 Samples.

9.27.2.1 Samples shall be whole protective glove pairs, sizes small and large.

9.27.2.2 Samples shall be conditioned as specified in 9.1.2.

9.27.3 Specimens.

9.27.3.1 Specimens shall be whole protective glove pairs, sizes small and large.

9.27.3.2 At least three glove pairs each for small and large sizes shall be tested.

9.27.4 Procedure.

9.27.4.1 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.

9.27.4.2 The time to don one glove of the glove pair specimen shall be determined by measuring the time it takes for the test subject to don the single glove on three consecutive trials without altering the sample glove linings between donnings.

9.27.4.3 Each donning trial shall start with the glove lying in front of the test subject and shall end when the test subject's fingers are seated in the glove sample.

9.27.4.4 The baseline donning time shall be the average of the first three donning times as determined in 9.27.4.2. The baseline donning time shall not exceed 10 seconds. The doffing time between donnings shall not exceed 10 seconds.

9.27.4.5 Glove pair specimens shall then be conditioned as specified in 9.1.3.

9.27.4.6 The final donning time shall be the average of the times for the first three donnings after removal from the final drying cycle as specified in 9.27.4.5.

9.27.4.7 No preparation of the gloves shall be permitted.

9.27.5 Report.

9.27.5.1 The final donning time and the baseline donning time shall be calculated and reported to the nearest 0.1 second for each trial.

9.27.5.2 The average final and average baseline donning times shall be calculated, recorded, and reported.

9.27.5.3 Any glove liner or barrier layer separations shall be recorded and reported.

9.27.5.4 Any glove digits that do not allow full insertion shall be recorded and reported.

9.27.6 Interpretation.

9.27.6.1 Pass or fail determinations shall be made using the average final and average baseline donning times.

9.27.6.2 Any detachment of the glove liner or barrier layer shall constitute failing performance.

9.28 Slip Resistance Test.

9.28.1 Application. This test method shall apply to protective wet suit footwear, protective dry suit footwear, and protective ice suit footwear.

9.28.2 Samples.

9.28.2.1 Samples shall be at least three of each whole protective footwear.

9.28.2.2 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.*

9.28.3 Specimens.

9.28.3.1 Specimens shall be at least three of each whole protective footwear.

9.28.3.2 At least three specimens shall be tested.

9.28.4 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:

(1) Footwear shall be tested in the forepart and the heel positions.
(2) Footwear shall be tested in the wet condition.
(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 10 tests specified in ASTM F2913 shall be equivalent to 50 test runs.

9.28.5 Report. The coefficient of friction of each specimen and the average coefficient of friction of all specimens for each configuration shall be calculated, recorded, and reported.

9.28.6 Interpretation. The average coefficient of friction for each configuration shall be used to determine pass or fail performance.

9.29 Zipper Strength Test.

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

9.29.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.29.3 Specimens. A minimum of three specimens shall be tested.

9.29.4 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 Strength of Stops, Sections 17–24, Bottom Stop Holding, Crosswise

9.29.5 Report.

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

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

9.29.6 Interpretation.

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

9.29.6.2 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.

9.30 Resistance to Twist of Pull and Slider Test.

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

9.30.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.30.3 Specimens. A minimum of three specimens shall be tested.

9.30.4 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*.

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

9.30.6 Interpretation.

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

9.30.6.2 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.

9.31 Opening and Closing of Zippers Test.

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

9.31.2 Samples. Samples shall be conditioned as specified in 9.1.2.

9.31.3 Specimens. A minimum of three specimens shall be tested.

9.31.4 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*.

9.31.5 Report.

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

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

9.31.6 Interpretation.

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

9.31.6.2 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.

9.32 Water Penetration and Air Evacuation Test.

9.32.1 Application. This test method shall apply to protective dry suits and protective ice suits.

9.32.2 Samples.

9.32.2.1 Samples shall be whole protective suits.

9.32.2.2 Samples shall be conditioned as specified in 9.1.2.

9.32.3 Specimens. A minimum of three specimens of each type of suit shall be tested.

9.32.4 Specific Requirements for Testing Protective Dry Suits.

9.32.4.1 One subject shall be tested in each specimen as specified in accordance with manufacturing sizing guidelines.

9.32.4.2 Each subject shall be dressed in underwear (short-sleeved, short-legged) beneath a liquid absorptive suit.

9.32.4.3 Each subject shall don the suit in accordance with the manufacturer's instructions and step gently into the water.

9.32.4.4 After entering the water, the subject shall be instructed to perform the following bobbing procedure three times:

(1) The subject shall start bobbing action by extending the arms straight out from the sides of the body at the water's surface with palms facing down.
(2) While in this position, the subject shall push down on the water with both hands in an open, flat orientation to initiate upward motion of the body.
(3) While pushing down on the water and bringing the hands down by the sides, the subject shall fully inhale.
(4) After reaching the upward peak, the subject shall bring the hands together above the head and fully exhale while sinking into the water until the head is completely submerged.

9.32.4.5 At the conclusion of the last bobbing action, the subject shall exit the water.

9.32.4.6 The water on the outside of the suit shall be removed so that when the suit is removed, the water does not enter the device.

9.32.5 Specific Requirements for Testing Protective Ice Suits.

9.32.5.1 One subject shall be tested in each specimen as specified in accordance with manufacturing sizing guidelines.

9.32.5.2 Each subject shall be dressed in underwear (short-sleeved, short-legged) beneath a liquid absorptive suit.

9.32.5.3 Each subject shall don the suit in accordance with the manufacturer's instructions and slide gently into the water, feet first, on his/her stomach.

9.32.5.4 After the subject enters the water, the subject shall assume a vertical position and maintain that position for 1 minute.

9.32.5.5 The subject shall then exit the water and the water on the outside of the suit shall be removed so that when the suit is removed, the water does not enter the device.

9.32.6 Report. Any evidence of liquid on the liquid absorptive suit from water ingress, as determined by visual or tactile evidence or absorbent toweling, shall constitute failure of the specimen. Also, any evidence of limited mobility of the subject due to entrapped air that is not expelled by the subject or by the design of the suit shall constitute failure of the specimen.

9.32.7 Interpretation. Water ingress and unintentional air entrapment in the suit shall be used to determine pass or fail performance.

9.33 Footwear Drainage Test.

9.33.1 Application. This test method shall apply to protective dry suit footwear and protective wet suit footwear.

9.33.2 Samples.

9.33.2.1 Samples shall be whole protective dry suit footwear and protective wet suit footwear.

9.33.2.2 Samples shall be conditioned as specified in 9.1.2.

9.33.3 Specimens. At least three complete protective dry suit footwear specimens and three protective wet suit footwear specimens shall be tested.

9.33.4 Procedure.

9.33.4.1 Individual dry suit footwear specimens and individual wet suit footwear specimens shall be weighed to the nearest gram.

9.33.4.2 Specimens shall be fully submerged in an upright position in a tank of water for a period of 5 minutes.

9.33.4.3 Water in tank shall be tap water maintained at 21°C, +/−3°C (70°F, +/−5°F).

9.33.4.4 Specimens shall be removed from the water completely and allowed to drain in the upright position for a period of 60 seconds.

9.33.4.5 Within 30 seconds following draining, the individual dry suit footwear specimens shall be weighed to the nearest gram. The weights of each specimen shall be recorded.

9.33.4.6 Within 30 seconds following draining, the individual wet suit footwear specimens shall be weighed to the nearest gram. The weights of each specimen shall be recorded.

9.33.5 Report.

9.33.5.1 The weights of the individual dry suit footwear specimens before submersion shall be recorded and reported.

9.33.5.2 The weights of the individual wet suit footwear specimens before submersion shall be recorded and reported.

9.33.5.3 The weights of the individual dry suit footwear specimens after submersion shall be recorded and reported.

9.33.5.4 The weights of the individual wet suit footwear specimens after submersion shall be recorded and reported.

9.33.5.5 The difference between the before-submersion weight and the after-submersion weight of the individual dry suit footwear specimens shall be recorded and reported.

9.33.5.6 The difference between the before-submersion weight and the after-submersion weight of the individual wet suit footwear specimens shall be recorded and reported.

9.33.6 Interpretation.

9.33.6.1 For the dry suit footwear specimens, the difference between dry and wet weights shall be used to determine pass or fail performance.

9.33.6.2 For the wet suit footwear specimens, the difference between dry and wet weights shall be used to determine pass or fail performance.

9.33.6.3 One or more footwear specimens failing this test shall constitute failing performance.

9.34 Buoyancy Test.

9.34.1 Application. This test method shall apply to protective ice suits and protective personal flotation devices.

9.34.2 Samples.

9.34.2.1 Samples shall be whole protective ice suits or protective personal flotation devices.

9.34.2.2 Samples shall be conditioned as specified in 9.1.2.

9.34.3 Specimens. A minimum of three specimens shall be tested.

9.34.4 Procedure.

9.34.4.1 Protective ice suit specimens shall be tested as specified in Section 25, Buoyancy Test, of UL 1197, *Immersion Suits*.

9.34.4.2 Protective personal flotation device specimens shall be tested as specified in Section 20, Buoyancy Test, of UL 1123, *Marine Buoyant Devices*.

9.34.5 Report. The measured buoyancy shall be calculated, recorded, and reported.

9.34.6 Interpretation.

9.34.6.1 Pass or fail determinations shall be based on the average reported buoyancy force of all specimens.

9.34.6.2 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.

9.35 Zipper Opening and Closing Force Test.

9.35.1 Application. This test method shall apply to protective dry suit zippers and protective ice suit zippers.

9.35.2 Samples.

9.35.2.1 Dry suit zipper samples shall be conditioned as specified in Table 8.2.17.

9.35.2.2 Ice suit zipper samples shall be conditioned as specified in Table 8.2.17.

9.35.2.3 The opening force samples shall be conditioned with the zippers closed, and the closing force samples shall be conditioned with the zippers opened (separated).

9.35.3 Specimens. A minimum of two specimens (1 open/1 closed) for each condition shall be tested.

9.35.4 Procedure. Zippers shall be tested as specified in Section 6.3.6.1, Opening and Closing Force Test, of CAN/CGSB 65.16, *Marine Abandonment Immersion Suit Systems*.

9.35.5 Report.

9.35.5.1 The average opening and closing force of each specimen shall be recorded and reported.

9.35.5.2 The average opening and closing force of all specimens shall be calculated, recorded, and reported.

9.35.6 Interpretation.

9.35.6.1 The average opening and closing force shall be used to determine pass or fail performance.

9.35.6.2 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.

9.36 Impact Resistance Test — Acceleration.

9.36.1 Application. This test shall be applied to complete protective helmets.

9.36.2 Samples. Samples shall be complete protective helmets.

9.36.3 Specimens.

9.36.3.1 Three helmet specimens shall be tested for each condition specified.

9.36.3.2 Specimens shall be conditioned for each environmental condition specified in 9.1.2, 9.1.6, and 9.1.8 prior to each impact.

9.36.3.3 Where testing helmet specimens following the conditioning environment specified in 9.1.6, if the specimen is returned to the conditioning environment within 4 minutes, the specimen shall be kept in the conditioning environment for a minimum of 3 minutes before resumption of testing with that specimen.

9.36.3.4 When a specimen has been out of the conditioning environment more than 4 minutes, before resumption of testing with that specimen, the specimen shall be returned to the conditioning environment for a minimum of 3 minutes for each minute, or portion thereof, that the specimen remained out of the conditioning environment in excess of 4 minutes, or a maximum of 24 hours, whichever is less.

9.36.4 Apparatus.

9.36.4.1 An ISO size J headform conforming to the nominal dimensions in Figure 9.36.4.1 shall be used.

9.36.4.2 The ISO size J test headform shall exhibit no resonant frequencies below 3000 Hz, and it shall be made of any low-resonance alloy, such as magnesium K-1A.

9.36.4.3 A drop assembly shall be used. The drop assembly shall consist of the test headform, the accelerometer, and the moving portion of the headform guidance assembly.

9.36.4.4 The drop assembly shall have a total mass of 5.17 kg, ±0.18 kg (11.4 lb, ±0.4 lb).

9.36.4.5 The guidance assembly shall comprise not more than 20 percent of the total mass of the drop assembly.

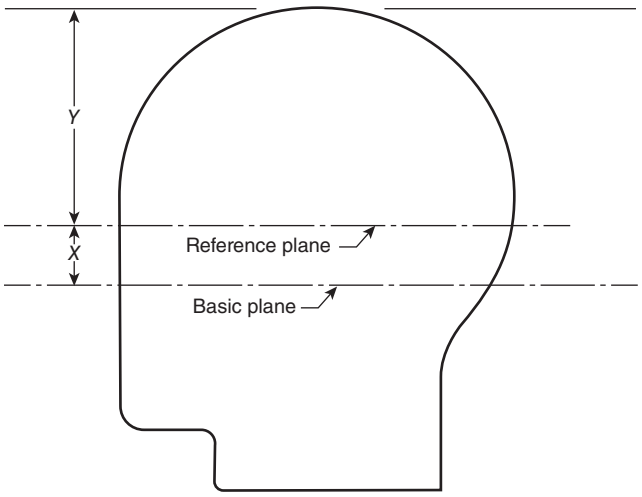
9.36.4.6 The center of mass of the drop assembly shall lie within a cone of 10 degrees included angle about the vertical, with the apex at the point of the targeted impact over the center of the test anvil.

9.36.4.7 A steel test anvil shall be used and shall have a smooth, flat striking surface 125 mm, ±15 mm (5 in., ±⅝ in.), in diameter.

9.36.4.7.1 The anvil shall be mounted securely on a steel plate at least 305 mm (1 ft) square and 25 mm (1 in.) thick.

9.36.4.7.2 The steel plate shall be rigidly attached to, and in intimate contact with, a backup mass of at least 540 kg (1200 lb).

9.36.4.7.3 The backup mass shall be of concrete or a rigid material of equal or greater density that has an area of at least 0.185 m^2 (2 ft^2).



Headform	Size (mm)	X (mm)	Y (mm)
A	500	24	90
B	540	26	96
J	570	27.5	102.5
M	600	29	107
O	620	30	110

For US customary units, 25.4 mm = 1 in.

FIGURE 9.36.4.1 Location of Reference Plane.

9.36.4.8 An electronic acceleration measurement system with the following minimum specifications shall be used:

(1) Range: 500 Gn
(2) Peak acceleration measurement: ±2.5 percent accuracy
(3) Resonant frequency: 5000 Hz
(4) Accelerometer shock limit: 2000 Gn
(5) Resolution: 5 Gn

9.36.4.9 The system frequency response shall comply with SAE J211, *Instrumentation for Impact Test — Part 1 — Electronic Instrumentation*, Channel Frequency Class 1000, specifications. The time duration of acceleration levels shall be measured to within ±0.2 milliseconds.

9.36.4.10 A reference anvil shall be substituted for the test anvil to verify the calibration of the acceleration measurement system. The reference anvil shall be constructed of any material that will yield reproducible test results during a period of at least 4 months.

9.36.4.11 For calibration, the center of the reference anvil shall be aligned within 3 mm (⅛ in.) of the impact point on the headform. The sensitive axis of the accelerometer shall be aligned within 1 degree of vertical and shall be colinear within 3 mm (⅛ in.) with the center of the reference anvil and the impact point on the headform. The guide(s) shall be vertical and, in the case of a double guide system, parallel to within 6 mm per 3 m (¼ in. per 10 ft) of length. *(See Annex C for more information.)*

9.36.4.12 The instrumentation calibration shall be verified at least before and after each test series or at the beginning and

end of each day of testing, whichever is the shorter length of time.

9.36.4.13 The test system shall be analyzed dynamically to ensure that any mechanical resonance does not distort the output data.

9.36.4.14 Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

9.36.4.15 Throughout calibration, verification, and testing, the ambient temperature shall be 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

9.36.5 Procedure.

9.36.5.1 A conditioned specimen shall be positioned on the headform with the horizontal center plane of the helmet parallel within 5 degrees of the reference plane of the headform.

9.36.5.2 The specimen shall be secured to the drop assembly by its retention system to maintain the position stated in 9.36.5.1 during the test.

9.36.5.3 No part of the specimen shell shall be cut away to accommodate the test system.

9.36.5.4 No part of the test system, other than the anvil, shall contact the specimen shell either as mounted or during an impact test.

9.36.5.5 The drop assembly with a specimen attached shall be dropped from a height that yields an impact velocity within 2 percent of 3.0 m/sec (9.8 ft/sec).

9.36.5.6 A means of verifying the impact velocity within 2 percent for each impact shall be incorporated in the test system.

9.36.5.7 The acceleration time duration values, peak acceleration, and impact velocity shall be recorded for each test.

9.36.5.8 Each specimen shall be environmentally conditioned prior to each impact in each of the five impact areas specified in Figure 9.36.5.8.

9.36.5.9 Specimens shall be impacted at the top, front, rear, and side impact areas.

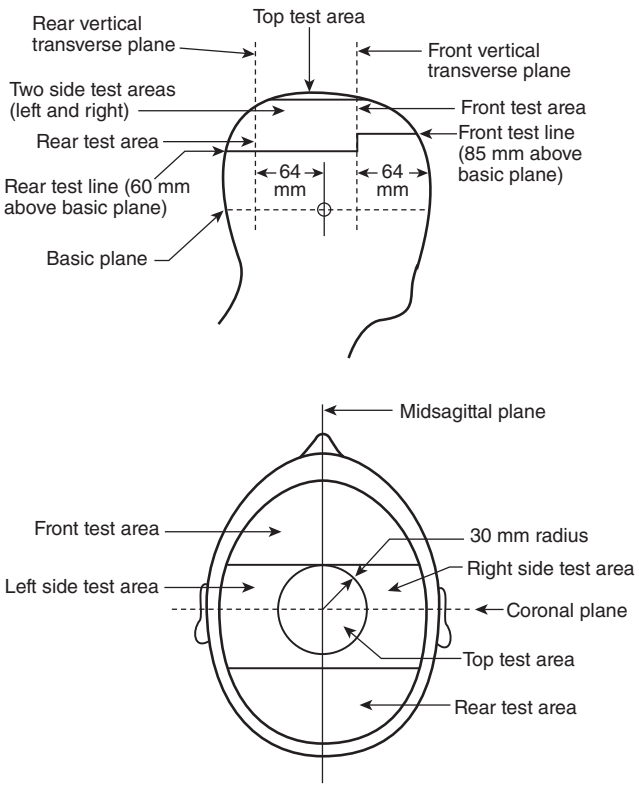
9.36.5.10 Specimen front, rear, and side targeted impact areas shall be at a distance of 63 mm, +13/−0 mm (2½ in., +½/−0 in.) above the test line as shown in Figure 9.36.5.8.

9.36.5.11 The headform with mounted specimen shall be rotated such that the targeted helmet impact area is over the center of the anvil.

9.36.5.12 The impact areas shall be as specified in Figure Figure 9.36.5.8. The top, front, rear, and side areas of the specimen shall be tested.

9.36.5.13 The top impact area shall consist of a 30 mm (1$\frac{3}{16}$ in.) radius measured from a point located on the headform at the junction of the coronal plane and midsagittal plane.

9.36.5.14 The front impact test area shall consist of an area defined as extending forward on the headform from the front vertical transverse plane to the test line.



For US customary units, 25.4 mm = 1 in.

FIGURE 9.36.5.8 Helmet Test Areas and Landmarks.

9.36.5.15 The rear impact test area shall consist of an area defined as extending backward on the headform from the rear vertical transverse plane extending down to the test line.

9.36.5.16 The side test areas shall consist of the areas between the top test area and test line extending from the rear vertical transverse plane and the front vertical transverse plane.

9.36.5.17 Each conditioned specimen in a series shall be impacted once on the top, rear, front, and side test areas of the specimens as defined in Figure 9.36.5.8. At least one impact shall occur in each test area.

9.36.5.18* The initial point of contact of the specimen with the anvil shall not occur on the brim of the specimen.

9.36.5.19 The verification tests shall demonstrate an accuracy of 20 percent or better in the measured acceleration.

9.36.6 Report.

9.36.6.1 The results of each system verification shall be recorded and reported as part of the test results for the specimens being tested.

9.36.6.2 The maximum acceleration shall be recorded and reported for each test.

9.36.7 Interpretation.

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

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

9.37 Zipper Point Breaking Strength Test.

9.37.1 Application. This test method shall apply to zippers used in protective dry suits and protective ice suits.

9.37.2 Samples.

9.37.2.1 Dry suit zipper samples shall be conditioned as specified in Table 8.2.17.

9.37.2.2 Ice suit zipper samples shall be conditioned as specified in Table 8.2.17.

9.37.3 Specimens. A minimum of three specimens shall be tested.

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

9.37.5 Report.

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

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

9.37.6 Interpretation.

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

9.37.6.2 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.

9.38 Zipper Leak Resistance Test.

9.38.1 Application. This test method shall apply to zippers used in protective dry suits and protective ice suits.

9.38.2 Samples. Samples shall be conditioned as specified in Section 6.3.6.4, Leak Resistance Test, of CAN/CGSB 65.16, *Marine Abandonment Immersion Suit Systems.*

9.38.3 Specimens. A minimum of three specimens shall be tested.

9.38.4 Procedure.

9.38.4.1 Zippers shall be tested as specified in Section 6.3.6.4, Leak Resistance Test, of CAN/CGSB 65.16, *Marine Abandonment Immersion Suit Systems.*

9.38.4.2 Following the test procedure, the specimens shall be examined for any water leakage.

9.38.5 Report. Water leakage shall be recorded and reported.

9.38.6 Interpretation. Any amount of water leakage in any of the test specimens shall constitute failing performance.

9.39 Total Heat Loss Test.

9.39.1 Application. This test method shall apply to the protective dry suit base composites.

9.39.2 Sample Preparation.

9.39.2.1 Samples for conditioning shall be at least a 1 m (1 yd) square of each material.

9.39.2.2 Samples to be tested shall be conditioned as specified at a temperature of 25°C, ±7°C (75°F, ±12°F) and a relative humidity of 65 percent, ±5 percent, for at least 5 hours.

9.39.3 Specimens.

9.39.3.1 Specimen size shall be the size required to cover the sweating guarded hot plate.

9.39.3.2 At least three specimens shall be tested.

9.39.3.3 Specimens shall consist of all layers in the protective garment base composite arranged in the order and orientation as worn and shall not include any reinforcement materials.

9.39.4 Apparatus. The test apparatus shall be as specified in ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate.*

9.39.5 Procedure. Testing shall be conducted in accordance with ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate*, Part C.

9.39.6 Report.

9.39.6.1 The average intrinsic thermal resistance (R_{cf}) of the sample shall be calculated, recorded, and reported.

9.39.6.2 The average apparent intrinsic evaporative resistance (AR_{ef}) of the sample shall be calculated, recorded, and reported.

9.39.6.3 The average total heat loss (Q_t) of the sample shall be calculated and reported on the product label.

9.39.7 Interpretation. 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.

9.40 Closure Penetration Resistance Test.

9.40.1 Application. This test method shall apply to dry suit closure assemblies.

9.40.1.1 Modifications to this test method for using industrial chemicals shall be as specified in 9.40.6.

9.40.1.2 Modifications to this test method for using undiluted mixtures shall be as specified in 9.40.7.

9.40.2 Specimens.

9.40.2.1 Specimens shall be the suit closure assembly, consisting of the closure in combination with the seam attaching the closure to the suit.

9.40.2.2 At least three specimens shall be tested.

9.40.2.3 The following ASTM F1001, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*, liquid chemicals at the specified concentrations shall be tested:

(1) Acetonitrile, 10 percent (w/v) in water
(2) Diethylamine, 10 percent (w/v) in water
(3) Dimethylformamide, 10 percent (w/v) in water
(4) Ethyl acetate, 8.7 percent (w/v) in water
(5) Methanol, 10 percent (w/v) in water
(6) Sodium hydroxide, 10 percent (w/v) in water
(7) Sulfuric acid, 10 percent (w/v) in water
(8) Tetrahydrofuran, 10 percent (w/v) in water

9.40.2.4 The following additional mixtures shall be tested without dilution:

(1) Paraffin oil (ASTM Oil #1), 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) Mid-octane (ISO Liquid B), specified in ISO 1817

9.40.3 Procedure. Penetration resistance testing of suit closure assemblies shall be conducted in accordance with ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, Procedure C, 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 modified to accommodate the shape of the suit closure assembly without affecting other parts of the test procedure. The Plexiglas® shield shall be omitted from the test cell.
(3) 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.
(4) An observation to determine specimen penetration shall be made at the end of the chemical contact period.

9.40.4 Report.

9.40.4.1 The pass or fail results for each chemical tested shall be recorded and reported.

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

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

9.40.6 Modifications for Using Industrial Chemicals. Specimens shall be tested for permeation resistance for a period of 60 minutes, +1 minute/–0 minute.

9.40.7 Modifications for Using Undiluted Mixtures. Specimens shall be tested for permeation resistance for a period of 10 minutes, +1 minute/–0 minute.

9.41 Chemical Permeation Resistance Test.

9.41.1 Application.

9.41.1.1 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).

9.41.1.2 Modifications to this test method for testing dry suit, hood, and attached integrated bootie materials shall be as specified in 9.41.7.

9.41.1.3 Modifications to this test method for testing dry suit, hood, attached integrated boot, and attached integrated bootie seams shall be as specified in 9.41.8.

9.41.1.4 Modifications to this test method for testing glove materials and seams shall be as specified in 9.41.9.

9.41.1.5 Modifications to this test method for testing attached integrated boot materials shall be as specified in 9.41.10.

9.41.2 Sample Preparation.

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

9.41.2.2 Samples shall be conditioned as specified in 9.1.2 after the conditioning specified in the modifications.

9.41.3 Specimens.

9.41.3.1 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*.

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

9.41.4 Procedure.

9.41.4.1 Except as noted in 9.41.4.1(1) through 9.41.4.1(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.

9.41.4.2 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

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

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

9.41.5 Report.

9.41.5.1 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.

9.41.5.1.1 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.

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

9.41.5.2.1 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.

9.41.5.2.2 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.

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

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

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

9.41.7.1 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.

9.41.7.2 Composite samples prepared as specified in 9.41.7.1 shall be tested after being subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 9.1.3.
(2) Specimens shall then be conditioned as specified in 9.1.2.

9.41.7.3 Composite samples conditioned as specified in 9.41.7.2 shall be trimmed to a sample size of 300 mm × 280 mm (12 in. × 11 in.).

9.41.7.3.1 Trimmed composite samples shall be subject to flexing conditioning as specified in 9.1.4, with the 280 mm (11 in.) direction parallel with the compression action of the machine.

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

9.41.7.4 Following flexing, samples of the barrier layer shall be removed from the flexed, trimmed composite samples and cut to the dimensions specified in 9.41.7.3, with the long dimension of the sample parallel to the 280 mm (11 in.) dimension.

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

9.41.7.6 The barrier layer samples prepared as specified in 9.41.7.4 and the other samples retained as specified in 9.41.7.5 shall be subjected to abrasion as specified in 9.1.5.

9.41.7.7 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.

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

9.41.7.9 Specimens shall be tested for permeation resistance as specified in 9.41.2 through 9.41.6.

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

9.41.8.1 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.

9.41.8.2 Composite samples prepared as described in 9.41.8.1 shall be tested after being subjected twice to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 9.1.3.
(2) Specimens shall then be conditioned as specified in 9.1.2.

9.41.8.3 Composite samples conditioned as specified in 9.41.8.2 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.

9.41.8.3.1 Trimmed composite samples shall be subject to flexing conditioning as specified in 9.1.4, with the 280 mm (11 in.) direction parallel with the compression action of the machine.

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

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

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

9.41.8.6 Specimens shall be tested for permeation resistance as specified in 9.41.2 through 9.41.6.

9.41.9 Specific Requirements for Testing Glove Materials and Seams.

9.41.9.1 This test shall apply to all types of glove configurations.

9.41.9.2 Samples for conditioning shall be whole gloves.

9.41.9.3 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 9.1.3.
(2) Specimens shall then be conditioned as specified in 9.1.2.

9.41.9.4 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.

9.41.9.5 Specimens shall be tested for permeation resistance as specified in 9.41.2 through 9.41.6.

9.41.10 Specific Requirements for Testing Dry Suit Attached Integrated Boot Materials.

9.41.10.1 This test shall not apply to footwear configurations that include attached integrated booties that are subjected to the procedures in 9.41.7.

9.41.10.2 Samples for conditioning shall be whole attached integrated boot items.

9.41.10.3 Footwear samples shall first be conditioned as specified in 9.1.2.

9.41.10.4 Samples shall be taken in areas from the footwear upper at the footwear quarter and vamp areas and cut to the dimensions specified in 9.41.7.3.

9.41.10.5 Cut samples shall then be conditioned by abrading as specified in 9.1.5 using silicon carbide, ultrafine 600 grit sandpaper as the abradant in lieu of other specified layers.

9.41.10.6 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.

9.41.10.7 Specimens shall be tested for permeation resistance as specified in 9.41.2 through 9.41.6.

Chapter 10 Contaminated Water Operations PPE Certification Requirements (NFPA 1953)

10.1 Administration.

10.1.1* Scope.

10.1.1.1* Chapter 4 and Chapters 10 through 14 of this standard shall specify the minimum design, performance, testing, and certification requirements for protective clothing and equipment items, including dry suits, 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.

10.1.1.2* Chapter 4 and Chapters 10 through 14 of this standard shall specify requirements for protective clothing and protective equipment used during operations in contaminated water dive operations.

10.1.1.3 Chapter 4 and Chapters 10 through 14 of 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.

10.1.1.4* Chapter 4 and Chapters 10 through 14 of this standard shall not specify requirements for protective clothing and protective equipment for any other technical rescue operation, firefighting operation, or hazardous materials emergency.

10.1.1.5* Chapter 4 and Chapters 10 through 14 of this standard shall specify the 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.

10.1.1.5.1 The accessories or enhancements shall be installed or attached and tested with the protective clothing and equipment to assure the performance and function of the contaminated water dive operations protective clothing and equipment.

10.1.1.6 Chapter 4 and Chapters 10 through 14 of 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.

10.1.1.6.1 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 determine the applicability of regulatory limitations prior to use.

10.1.1.7 Chapter 4 and Chapters 10 through 14 of 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.

10.1.1.7.1 It shall be the responsibility of the persons and organizations that use this standard to establish safety and health practices and determine the applicability of regulatory limitations prior to using this standard for designing, manufacturing, and testing.

10.1.1.8 Certification of contaminated water dive operations protective clothing and equipment to the requirements in Chapter 4 and Chapters 10 through 14 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.

10.1.1.9 Nothing herein shall restrict any authority having jurisdiction or manufacturer from exceeding these minimum requirements.

10.1.2 Purpose.

10.1.2.1* The purpose of Chapter 4 and Chapters 10 through 14of 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.

10.1.2.2* Controlled laboratory tests used to determine compliance with the performance requirements in Chapter 4 and Chapters 10 through 14 of this standard shall not be deemed as establishing performance levels for all the situations to which emergency services personnel might respond.

10.1.2.3* The requirements in Chapter 4 and Chapters 10 through 14 of this standard are not intended to be detailed manufacturing or purchase specifications but shall be permitted to be referenced in purchase specifications as minimum requirements.

10.1.3 Application.

10.1.3.1 Chapter 4 and Chapters 10 through 14 of this standard shall apply to the design, manufacture, and certification of new contaminated water dive operations protective clothing and equipment.

10.1.3.2 Chapter 4 and Chapters 10 through 14 of 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.

10.1.3.3 Chapter 4 and Chapters 10 through 14 of 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 for other applications are specified by other emergency services organizations.

10.1.3.4 Chapter 4 and Chapters 10 through 14 of this standard shall apply to protective clothing and protective equipment used during contaminated water dive operations.

10.1.3.5 Chapter 4 and Chapters 10 through 14 of this standard shall not apply to protective clothing and protective equipment for operations in surface water, swift water, tidal water, surf, and ice.

10.1.3.6 Chapter 4 and Chapters 10 through 14 of this standard shall not apply to protective clothing and protective equipment for any other technical rescue operation, firefighting operation, or any hazardous materials emergency.

10.1.3.7 Chapter 4 and Chapters 10 through 14 of this standard shall not apply to protection from all biological agents or hazardous chemicals.

10.1.3.8* Chapter 4 and Chapters 10 through 14 of 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.

10.1.3.8.1 The accessories or enhancements shall be installed or attached and tested with the protective clothing and equipment to assure the performance and function of the contaminated water dive operations protective clothing and equipment.

10.1.4* Units.

10.1.4.1 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.

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

10.2 General.

10.2.1 The process of certifying contaminated water dive operations protective clothing and equipment as compliant with NFPA 1953 shall meet the requirements of Section 10.2, General, through Section 10.4, Annual Verification.

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

10.3 Inspection and Testing.

10.3.1 Testing to determine product compliance with the performance requirements specified in Chapter 13 shall be conducted by the certification organization in accordance with the specified testing requirements of Chapter 14.

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

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

10.3.2 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 as the actual final product or product component.

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

10.3.4 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.

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

10.3.6 The certification organization shall test ensemble elements with the specific ensembles with which they are to be certified.

10.3.7 Any change in the design, construction, or materials of a compliant product shall necessitate new inspection and testing to verify compliance with all the applicable requirements of this standard that the certification organization determines can be affected by such change.

10.3.7.1 Recertification shall be conducted before labeling the modified product as being compliant with this standard.

10.3.8 The manufacturer shall maintain all the design and performance inspection and test data from the certification organization used in the certification of the manufacturer's compliant product.

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

10.4 Annual Verification.

10.4.1 All products that are labeled as being compliant with this standard shall undergo verification on an annual basis.

10.4.1.1 This verification 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 10.4.1.1 on all manufacturer models and components within the following protocol:
    (a) Where a test method incorporates testing both before and after the laundering preconditioning specified in 14.1.3 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 14.1.3 and the test generates nonquantitative results, recertification 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 the required conditioning is 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.

10.4.1.2 This recertification shall include inspection and evaluation to all the design requirements and testing to all the performance requirements as required by this standard on all the manufacturer's models and components as required by 10.4.3.

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

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

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

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

10.4.4 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 for annual recertification.

10.4.5 The manufacturer shall maintain all the design, inspection, performance, and test data from the certification organization used in the recertification of manufacturer models and components.

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

Table 10.4.1.1 Recertification Schedule

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
Wet suit					
13.1.1 Overall Donning Efficiency Test	X				
13.1.2 Breaking Strength Test	X		X		
13.1.3 Puncture Propagation Tear Resistance Test	X				
13.1.4 Seam/Closure Breaking Strength Test	X	X	X	X	X
13.1.5 Liquid Absorption Resistance Test	X				
13.1.6 Retroreflectivity Test	X				
13.1.7 Zipper Strength Test	X				
13.1.8 Resistance to Twist of Pull and Slider Test	X				
13.1.9 Opening and Closing of Zippers Test	X				
13.1.10 Corrosion Resistance Test	X				
13.1.11 Label Durability and Legibility Test	X				
Ice suit					
13.3.1 Overall Liquid Integrity Test One	X				
13.3.2 Air Retention Test	X	X	X	X	X
13.3.3 Viral Penetration Resistance Test	X				
13.3.4 Overall Donning Efficiency Test	X				
13.3.5 Thermal Insulation Test	X		X		
13.3.6 Breaking Strength Test	X		X		
13.3.7 Puncture Propagation Tear Resistance Test	X		X		
13.3.8 Seam/Closure Breaking Strength Test	X	X	X	X	X
13.3.9 Liquid Absorption Resistance Test	X		X		
13.3.10 Liquid Penetration Resistance Test	X				
13.3.11 Retroreflectivity Test	X				
13.3.12 Water Penetration and Air Evacuation Test	X				
13.3.13 Buoyancy Test	X				
13.3.14 Corrosion Resistance Test	X				
13.3.15 Label Durability and Legibility Test	X				

(continues)

Table 10.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
13.3.16 Zipper Point Breaking Strength Test	X				
13.3.17 Zipper Leak Resistance Test	X	X	X	X	X
13.3.18 Opening and Closing of Zippers Test	X				
13.3.19 Zipper Opening and Closing Force Test	X				
Wet suit gloves					
13.5.1 Cut Resistance Test	X			X	
13.5.2 Puncture Resistance Test	X		X		
13.5.3 Abrasion Resistance Test Two	X			X	
13.5.4 Glove Hand Function Test	X				
13.5.5 Grip Test	X				
13.5.6 Glove Donning Test	X				
13.5.7 Corrosion Resistance Test	X				
13.5.8 Label Durability and Legibility Test	X				
Dry suit gloves					
13.6.1 Cut Resistance Test	X			X	
13.6.2 Puncture Resistance Test	X		X		
13.6.3 Abrasion Resistance Test Two	X			X	
13.6.4 Glove Hand Function Test	X				
13.6.5 Grip Test	X				
13.6.6 Glove Donning Test	X				
13.6.7 Corrosion Resistance Test	X				
13.6.8 Liquid Penetration Resistance Test	X				
13.6.9 Viral Penetration Resistance Test	X				
13.6.10 Overall Liquid Integrity Test Two	X		X		
13.6.11 Label Durability and Legibility Test	X				
PFD					
13.10.1 Buoyancy Test — SG3, SG20 of UL 1123	X				
13.10.2 Label Durability and Legibility Test	X				
13.10.3 Corrosion Resistance Test	X				
7.11.1 Water Entry Test — SG3, SG16 of UL 1123	X				

(continues)

Table 10.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
7.11.1 Flotation Stability Test — SG3, SG16 of UL 1123	X				
7.11.1 Buoyancy Distribution Test — SG3, SG19 of UL 1123	X				
7.11.1 Tensile Strength — SG3, SG24 of UL 1123	X				
7.11.1 750-Pound Shoulder Tensile Test — SG3, SG10, SG24 of UL 1123	X				
7.11.1 750-Pound Harness Strength Test (without accelerated weathering) — SG9 of UL 1123	X				
7.11.1 Pamphlet Strength of Attachment Test — SG3, SG35 of UL 1123	X				
7.11.1 Pull Toggle Security of Attachment — SG7A of UL 1123	X				
Helmet					
13.4.1 Helmet Bucketing Test	X				
13.4.2 Top Impact Resistance Test (Force)	X				
13.4.3 Physical Penetration Resistance Test	X				
13.4.4 Suspension System Retention Test	X				
13.4.5 Retention System Test	X				
13.4.6 Corrosion Resistance Test	X	X	X	X	X
13.4.7 Retroreflectivity Test	X				
13.4.8 Label Durability and Legibility Test	X	X	X	X	X
13.4.9 Floatability Test	X				
13.4.10 Impact Resistance Test — Acceleration	X	X	X	X	X
13.4.11 Helmet Roll Off Test	X				
13.4.12 Helmet Water Absorption Test	X				
Dry suit					
13.2.1 Air Retention Test	X	X	X	X	X
13.2.2 Overall Liquid Integrity Test One	X				
13.2.3 Overall Donning Efficiency Test	X				
13.2.4 Water Penetration and Air Evacuation Test	X				
13.2.5 Breaking Strength Test	X		X		

(continues)

Table 10.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
13.2.6 Puncture Propagation Tear Resistance Test	X				
13.2.7 Cleaning Shrinkage Resistance Test	X		X		X
13.2.8 Seam Closure Breaking Strength Test	X	X	X	X	X
13.2.9 Liquid Absorption Resistance Test	X	3 chem	3 chem	3 chem	3 chem
13.2.10 Liquid Penetration Resistance Test	X	3 chem	3 chem	3 chem	3 chem
13.2.11 Viral Penetration Resistance Test	X				
13.2.12 Zipper Strength Test	X				
13.2.13 Resistance to Twist of Pull and Slider Test	X				
13.2.14 Opening and Closing of Zippers Test	X				
13.2.15 Zipper Point Breaking Strength Test	X				
13.2.16 Zipper Leak Resistance Test	X				
13.2.17 Zipper Opening and Closing Force Test	X				
13.2.18 Retroreflectivity Test	X				
13.2.21 Corrosion Resistance Test	X				
13.2.24 Label Durability and Legibility Test	X				
Wetsuit footwear					
13.8.1 Footwear Drainage Test	X				
13.8.2 Abrasion Resistance Test Two (Upper)	X			X	
13.8.3 Cut Resistance Test	X			X	
13.8.4 Puncture Resistance Test (Upper)	X		X		
13.8.5 Abrasion Resistance Test Two (Sole)	X			X	
13.8.6 Puncture Resistance Test (Sole)	X		X		
13.8.7 Slip Resistance Test	X				
13.8.8 Corrosion Resistance Test					
13.8.9 Label Durability and Legibility Test					
Ice suit footwear					
13.9.1 Abrasion Resistance Test Two (Upper)	X			X	

(continues)

Table 10.4.1.1 *Continued*

Product/Test	Initial Certification	Year 2	Year 3	Year 4	Year 5
13.9.2 Cut Resistance Test	X			X	
13.9.3 Puncture Resistance Test (Upper)	X		X		
13.9.4 Abrasion Resistance Test Two	X			X	
13.9.5 Puncture Resistance Test (Sole)	X		X		
13.9.6 Slip Resistance Test	X				
13.9.7 Liquid Penetration Resistance Test	X				
13.9.8 Viral Penetration Resistance Test	X				
13.9.9 Corrosion Resistance Test	X				
13.9.10 Label Durability and Legibility Test	X				
13.9.11 Thermal Insulation Test	X		X		
Dry suit footwear					
13.8.1 Footwear Drainage Test	X				
13.8.2 Abrasion Resistance Test Two (Upper)	X			X	
13.8.3 Cut Resistance Test	X			X	
13.8.4 Puncture Resistance Test (Upper)	X		X		
13.8.5 Abrasion Resistance Test Two (Sole)	X			X	
13.8.6 Puncture Resistance Test (Sole)	X		X		
13.8.7 Slip Resistance Test	X				
13.8.8 Corrosion Resistance Test	X				
13.8.9 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				

Chapter 11 Contaminated Water Operations PPE Labeling and Information (NFPA 1953)

11.1 Product Label Requirements.

11.1.1* 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.

11.1.1.1 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.

11.1.1.2 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.

11.1.1.3 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.

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

11.1.2 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.

11.1.3* 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 (1⁄4 in.) in height and shall be placed in a conspicuous location.

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

11.1.5 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.

11.1.6 The following statement shall be printed legibly on the product label:

THIS CONTAMINATED WATER DIVING OPERATIONS PROTECTIVE [*insert appropriate item term*] MEETS THE REQUIREMENTS OF NFPA 1955 (1953), [*insert edition year*] EDITION.

THIS ENSEMBLE PROVIDES PROTECTION AGAINST THE

SEVERE X

MODERATE __

LEVEL OF CONTAMINATION AS DEFINED IN NFPA 1955, [*insert edition year*] EDITION.

DO NOT REMOVE THIS LABEL!

11.1.6.1 The appropriate term for the item type (dry suit, dry suit glove, or dry suit footwear) shall be inserted in the compliance statement text where indicated.

11.1.6.2 All letters shall be at least 2.5 mm (3⁄32 in.) in height.

11.1.7 The following compliance statement shall be printed legibly on the product label of the main dry suit:

FOR COMPLIANCE WITH NFPA 1955, [*insert edition year*] EDITION, THE FOLLOWING COMPONENTS MUST BE WORN IN CONJUNCTION WITH THIS CONTAMINATED WATER DIVING OPERATIONS PROTECTIVE ENSEMBLE: [*list all detachable components*].

11.1.7.1 All letters shall be at least 2.5 mm (3⁄32 in.) in height.

11.1.8 In addition to 11.1.7, where a dry suit consists of multiple layers as described in 12.1.3, the inner suit(s) shall be labeled with the following statement:

AN OUTER GARMENT SHALL BE WORN AS PART OF THIS ENSEMBLE TO MEET THE REQUIREMENTS OF NFPA 1955, [*insert edition year*] EDITION.

11.1.8.1 All letters shall be at least 13 mm (1⁄2 in.) in height.

11.1.8.2 The label shall be attached to the outside of the inner suit(s) in a conspicuous position and be of a contrasting color to the color of the suit material to which it is attached.

11.1.9 The following information shall also be printed legibly on the product label of the main dry suit, dry suit glove, and dry suit footwear:

THIS CONTAMINATED WATER DIVING OPERATIONS PROTECTIVE ENSEMBLE ALSO MEETS THE OPTIONAL CBRN PROTECTION REQUIREMENTS OF NFPA 1955, [*insert edition year*] EDITION.

11.1.9.1 All letters shall be 1.6 mm (1⁄16 in.) in height.

11.1.10 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

11.2 User Information.

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

11.2.2 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.

11.2.3 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 manu-

facturer shall provide notice that the user information is to be removed ONLY by the end user.

11.2.4* 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 Chapter 16 of NFPA 2500
(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 12 Contaminated Water Operations PPE Design Requirements (NFPA 1953)

12.1 Contaminated Water Diving Operations Protective Dry Suit Design Requirements.

12.1.1 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 10.3, Inspection and Testing.

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

12.1.3 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.

12.1.4 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.

12.1.5* 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.

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

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

12.1.6 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.

12.1.7* 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.

12.1.8 Protective dry suits shall include footwear meeting the requirements specified in Section 12.3, Contaminated Water Diving Operations Protective Dry Suit Footwear Design Requirements.

12.1.9 Protective dry suits shall be designed to accommodate permanently attached or detachable gloves meeting the requirements specified in Section 12.2, Contaminated Water Diving Operations Protective Dry Suit Glove Design Requirements.

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

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

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

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

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

12.1.14 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.

12.1.14.1 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.

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

12.1.15 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, "Retroreflective Material for Lifesaving Equipment."
(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.).

12.1.16* 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)

12.2 Contaminated Water Diving Operations Protective Dry Suit Glove Design Requirements.

12.2.1 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 10.3, Inspection and Testing.

12.2.2 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.

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

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

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

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

12.3 Contaminated Water Diving Operations Protective Dry Suit Footwear Design Requirements.

12.3.1 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 10.3, Inspection and Testing.

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

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

Chapter 13 Contaminated Water Operations PPE Performance Requirements (NFPA 1953)

13.1 Contaminated Water Diving Operations Protective Dry Suit Ensemble Performance Requirements.

13.1.1 Protective dry suits including dry suit gloves and hoods shall be tested for air penetration resistance as specified in Section 14.2, Air Retention Test, and shall not show any sign of leakage.

13.1.2 Protective dry suit valves shall be tested for watertight integrity as specified in Section 14.3, Exhaust Valve Inward Leakage Test, and shall not show any sign of liquid leakage.

13.1.3 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 14.26, Hood to Full-Face Diving Mask Seal Test.

13.1.4 The seal between the helmet and the dry suit shall be tested for air retention and watertight integrity as specified in Section 14.27, Diving Helmet Seal Test.

13.1.5 Inlet valves shall be tested for retention as specified in Section 14.4, Inlet Valve Pull Test.

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

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

13.1.5.3 The suit shall not leak.

13.1.6 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 14.5, Burst Strength Test, and shall have a bursting strength greater than 200 N (45 lbf).

13.1.7 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 14.6, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 49N (11 lbf).

13.1.8 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 14.7, Seam Breaking Strength Test, and shall have a seam breaking strength of not less than 158N (35 lbf) for each seam type.

13.1.9 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 14.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 $\mu g/cm^2$.

13.1.10 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 14.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

13.1.11 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 14.11, Cut Resistance Test, and shall have a cut resistance distance of greater than 25 mm (1 in.).

13.1.12 Protective dry suit zippers shall be tested for strength as specified in Section 14.13, Zipper Strength Test, and shall have a minimum strength of 222 N (50 lbf).

13.1.13 Protective dry suit zippers shall be tested for resistance to twist as specified in Section 14.14, Resistance to Twist of Pull

and Slider Test, and shall have a minimum force of 0.79 N-m (7 lbf-in.).

13.1.14 Protective dry suit zippers shall be tested for operability as specified in Section 14.15, Opening and Closing of Zippers Test, and shall have a minimum force of 67 N (15 lbf).

13.1.15 Protective dry suit zippers shall be tested for point breaking strength as specified in Section 14.16, Zipper Point Breaking Strength Test, and shall have a minimum strength of 440 N (90 lbf).

13.1.16 Protective dry suit closure assemblies shall be tested for penetration resistance as specified in Section 14.28, Chemical Penetration Resistance Test, and shall show no penetration.

13.1.17 Protective dry suit exhaust valves shall be tested for liquid penetration resistance as specified in Section 14.25, Chemical Degradation Resistance Test for Exhaust Valves, and shall show no penetration.

13.1.18 Where protective dry suit visibility markings are specified, the visibility markings shall be tested for retroreflectivity as specified in Section 14.17, Retroreflectivity Test, and shall have a total coefficient of retroreflection (*Ra*) of not less than 100/lux/m^2 (100 cd/fc/ft^2).

13.1.19 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 14.18, Corrosion Resistance Test.

13.1.19.1 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.

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

13.1.20 Protective dry suit product labels shall be tested for legibility as specified in Section 14.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

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

13.1.21.1 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 14.9, 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.

13.2 Contaminated Water Diving Operations Protective Dry Suit Glove Elements.

13.2.1 Protective dry suit glove materials shall be tested for resistance to cut as specified in Section 14.11, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

13.2.2 Protective dry suit glove materials shall be tested for puncture resistance as specified in Section 14.20, Puncture Resistance Test, and shall not puncture under an applied force of 12 N (2.7 lbf).

13.2.3 Protective dry suit glove materials shall be tested for abrasion resistance as specified in Section 14.21, Abrasion Resistance Test Two, and shall not wear through.

13.2.4 Protective dry suit gloves shall be tested for hand function as specified in Section 14.22, Torque Test, and shall have an average percent of barehanded control not less than 80 percent.

13.2.5 All dry suit protective glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 14.18, 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.

13.2.6 Protective dry suit glove materials and seams shall be tested for permeation resistance after abrading as specified in Section 14.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 μg/cm^2.

13.2.7 Protective dry suit glove materials and seams shall be tested for biopenetration resistance as specified in Section 14.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

13.2.8 Dry suit protective glove product labels shall be tested for legibility as specified in Section 14.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

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

13.2.9.1 Dry suit glove materials and seams shall be tested for permeation resistance as specified in Section 14.9, 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 $\mu g/cm^2$.
(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 $\mu g/cm^2$.

13.3 Contaminated Water Diving Operations Protective Dry Suit Footwear Elements.

13.3.1 Attached Footwear.

13.3.1.1 Dry suit attached integrated boot uppers shall be tested for abrasion resistance as specified in Section 14.21, Abrasion Resistance Test Two, and shall not wear through.

13.3.1.2 Dry suit attached integrated boot uppers shall be tested for cut resistance as specified in Section 14.11, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

13.3.1.3 Dry suit attached integrated boot uppers shall be tested for puncture resistance as specified in Section 14.20, Puncture Resistance Test, and shall not puncture under an applied force of 45 N (10 lbf).

13.3.1.4 Dry suit attached integrated boot soles shall be tested for abrasion resistance as specified in Section 14.29, Abrasion Resistance Test Three, and the relative volume loss shall not be greater than 250 mm^3 (0.015 $in.^3$).

13.3.1.5 Dry suit attached integrated boot soles shall be tested for penetration (physical) resistance as specified in Section 14.20, Puncture Resistance Test, and shall not have a puncture force of less than 90 N (20 lbf).

13.3.1.6 Dry suit attached integrated boot soles shall be tested for slip resistance as specified in Section 14.23, Slip Resistance, and shall have coefficient friction of 0.40 or greater.

13.3.1.7 Protective dry suit attached integrated boot materials and seams shall be tested for permeation resistance after flexing and abrading as specified in Section 14.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 $\mu g/cm^2$.

13.3.1.8 Protective dry suit attached integrated boot metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 14.18, 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.

13.3.1.9 Protective dry suit footwear materials and seams shall be tested for biopenetration resistance as specified in Section 14.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

13.3.1.10 Dry suit attached integrated boot product labels shall be tested for legibility as specified in Section 14.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

13.3.2 Attached Integrated Bootie with Overboot.

13.3.2.1 Dry suit protective overboot shall be tested for drainage as specified in Section 14.24, Footwear Drainage Test, and shall retain less than 100 g (0.22 lb) of water.

13.3.2.2 Dry suit protective overboot uppers shall be tested for abrasion resistance as specified in Section 14.21, Abrasion Resistance Test Two, and shall not wear through.

13.3.2.3 Dry suit protective overboot uppers shall be tested for cut resistance as specified in Section 14.11, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (¾ in.).

13.3.2.4 Dry suit protective overboot uppers shall be tested for puncture resistance as specified in Section 14.20, Puncture Resistance Test, and shall not puncture under an applied force of 45 N (10 lbf).

13.3.2.5 Dry suit protective overboot soles shall be tested for abrasion resistance as specified in Section 14.29, Abrasion Resistance Test Three, and the relative volume loss shall not be greater than 250 mm^3 (0.015 $inches^3$).

13.3.2.6 Dry suit protective overboot soles shall be tested for penetration (physical) resistance as specified in Section 14.20, Puncture Resistance Test, and shall not have a puncture force of less than 90 N (20 lbf).

13.3.2.7 Dry suit protective overboot soles shall be tested for slip resistance as specified in Section 14.23, Slip Resistance, and shall have coefficient friction of 0.40 or greater.

13.3.2.8 Dry suit protective overboot metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 14.18, 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.

13.3.2.9 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 14.8, Chemical Permeation Resistance Test, and the average cumulative permeation shall not exceed 6 $\mu g/cm^2$.

13.3.2.10 Where the bootie material is different from the suit material, it shall be tested for biopenetration resistance as specified in Section 14.10, Viral Penetration Resistance Test, and shall not show any viral penetration.

13.3.2.11 Dry suit protective footwear product labels shall be tested for legibility as specified in Section 14.19, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

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

13.3.2.12.1 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 14.8.10 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 14 Contaminated Water Operations PPE Test Methods (NFPA 1953)

14.1 Sample Preparation Procedures.

14.1.1 Application.

14.1.1.1 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.

14.1.1.2 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.

14.1.2 Room Temperature Conditioning Procedure.

14.1.2.1 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.

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

14.1.3 Washing and Drying Procedure.

14.1.3.1 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.

14.1.3.2 A front-loading washer/extractor shall be used.

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

14.1.3.4 The wash cycle procedure in Table 14.1.3.4 shall be followed.

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

14.1.4 Flexural Fatigue Procedure.

14.1.4.1 Samples shall be subjected to flexural fatigue in accordance with ASTM F392/F392M, *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.

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

14.1.5 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 14.1.5.
(5) The specimen shall be abraded for 25 continuous cycles.

14.1.6 Wet Conditioning Procedure for Whole Gloves.

14.1.6.1 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.

14.1.6.2 The test subject shall don the test specimen gloves.

Table 14.1.3.4 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				

14.1.6.3 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.

14.1.6.4 The glove specimens shall be tested within 1 minute.

14.1.7 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.

14.2 Air Retention Test.

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

14.2.2 Samples.

14.2.2.1 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.

14.2.2.2 Samples shall be conditioned as specified in 14.1.2 and 14.1.3.

14.2.3 Specimens. A minimum of three specimens shall be tested.

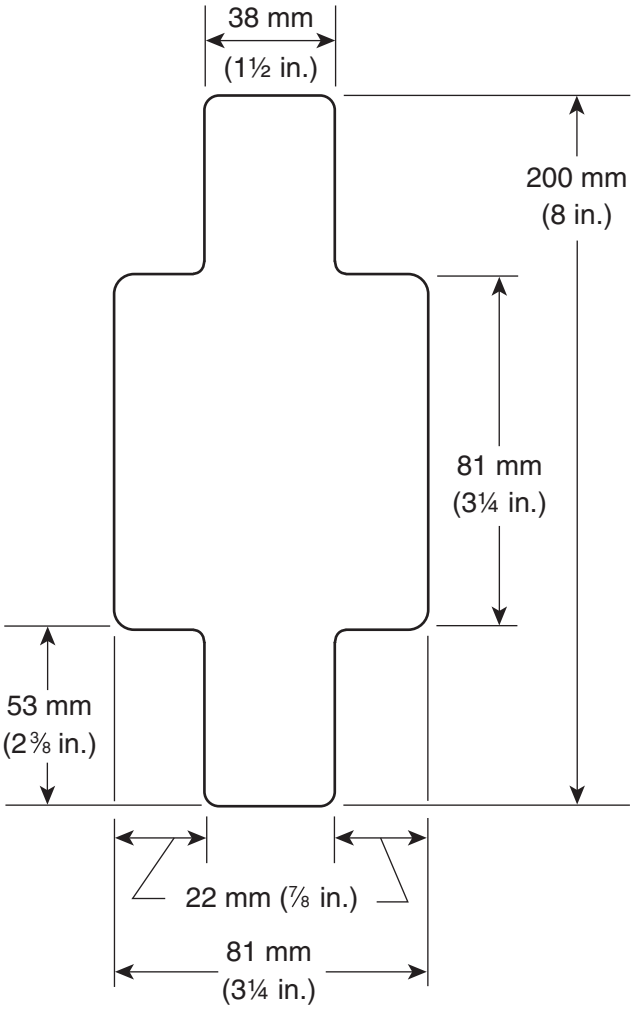


FIGURE 14.1.5 Specimen Configuration.

14.2.4 Procedure. Air retention performance testing shall be performed in accordance with UL 1197, *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.

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

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

14.3 Exhaust Valve Inward Leakage Test.

14.3.1 Application. This application shall apply to exhaust valves.

14.3.2 Sample Preparation.

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

14.3.2.2 Samples shall be conditioned as specified in 14.1.2.

14.3.3 Specimens.

14.3.3.1 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 14.3.4.

14.3.3.2 A minimum of three specimens shall be tested.

14.3.4 Test Apparatus.

14.3.4.1 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.

14.3.5 Procedure.

14.3.5.1 The specimen shall be placed and sealed in the test cell described in 14.25.4.1, such that the normal exterior side of the exhaust valve is oriented towards the liquid reservoir.

14.3.5.2 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

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

14.3.6 Report.

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

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

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

14.4 Inlet Valve Pull Test.

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

14.4.2 Sample Preparation. Samples shall be conditioned as specified in 14.1.3 followed by the conditioning specified in 14.1.2.

14.4.3 Specimens. A minimum of three specimens shall be tested.

14.4.4 Procedure.

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

14.4.4.2 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.

14.4.4.3 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.

14.4.4.4 The suit and the inlet valve shall be visually inspected and tested for leakage in accordance with Section 14.2, Air Retention Test.

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

14.4.6 Interpretation. Any leakage or signs of damage shall constitute failure.

14.5 Burst Strength Test.

14.5.1 Application.

14.5.1.1 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.

14.5.1.2 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.

14.5.2 Sample Preparation.

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

14.5.2.2 One set of samples shall be conditioned as specified in 14.1.3 followed by the conditioning specified in 14.1.2. A second set of samples shall be conditioned as specified in 14.1.5 followed by the conditioning specified in 14.1.2.

14.5.3 Specimens.

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

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

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

14.5.4 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.

14.5.5 Report.

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

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

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

14.6 Puncture Propagation Tear Resistance Test.

14.6.1 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.

14.6.2 Samples.

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

14.6.2.2 Samples shall be conditioned as specified in 14.1.3 followed by the conditioning specified in 14.1.2.

14.6.3 Specimens.

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

14.6.3.2 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.

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

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

14.6.5 Report.

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

14.6.5.2 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.

14.6.6 Interpretation.

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

14.6.6.2 Failure in any one direction constitutes failure for the material.

14.7 Seam Breaking Strength Test.

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

14.7.2 Samples.

14.7.2.1 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.

14.7.2.2 Samples shall be conditioned as specified in 14.1.3 followed by the conditioning specified in 14.1.2.

14.7.3 Specimens.

14.7.3.1 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.

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

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

14.7.4 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).

14.7.5 Report.

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

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

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

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

14.8 Chemical Permeation Resistance Test.

14.8.1 Application.

14.8.1.1 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).

14.8.1.2 Modifications to this test method for testing dry suit, hood, and attached integrated bootie materials shall be as specified in 14.8.7.

14.8.1.3 Modifications to this test method for testing dry suit, hood, attached integrated boot, and attached integrated bootie seams shall be as specified in 14.8.8.

14.8.1.4 Modifications to this test method for testing glove materials and seams shall be as specified in 14.8.9.

14.8.1.5 Modifications to this test method for testing attached integrated boot materials shall be as specified in 14.8.10.

14.8.2 Sample Preparation.

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

14.8.2.2 Samples shall be conditioned as specified in 14.1.2, after the conditioning specified in the modifications.

14.8.3 Specimens.

14.8.3.1 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*.

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

14.8.4 Procedure.

14.8.4.1 Except as noted in 14.8.4.1(1) through 14.8.4.1(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.

14.8.4.2* 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

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

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

14.8.5 Report.

14.8.5.1 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.

14.8.5.1.1 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.

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

14.8.5.2.1 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.

14.8.5.2.2 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.

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

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

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

14.8.7.1 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.

14.8.7.2 Composite samples prepared as specified in 14.8.7.1 shall be tested after being subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 14.1.3.
(2) Specimens shall then be conditioned as specified in 14.1.2.

14.8.7.3 Composite samples conditioned as specified in 14.8.7.2 shall be trimmed to a sample size of 300 mm × 280 mm (12 in. × 11 in.).

14.8.7.3.1 Trimmed composite samples shall be subject to flexing conditioning as specified in 14.1.4, with the 280 mm (11 in.) direction parallel with the compression action of the machine.

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

14.8.7.4 Following flexing, samples of the barrier layer shall be removed from the flexed, trimmed composite samples and cut to the dimensions specified in 14.8.7.3, with the long dimension of the sample parallel to the 280 mm (11 in.) dimension.

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

14.8.7.6 The barrier layer samples prepared as specified in 14.8.7.4 and the other samples retained as specified in 14.8.7.5 shall be subjected to abrasion as specified in 14.1.5.

14.8.7.7 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.

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

14.8.7.9 Specimens shall be tested for permeation resistance as specified in 14.8.2 through 14.8.6.

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

14.8.8.1 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.

14.8.8.2 Composite samples prepared as described in 14.8.8.1 shall be tested after being subjected twice to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 14.1.3.
(2) Specimens shall then be conditioned as specified in 14.1.2.

14.8.8.3 Composite samples conditioned as specified in 14.8.8.2 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.

14.8.8.3.1 Trimmed composite samples shall be subject to flexing conditioning as specified in 14.1.4, with the 280 mm (11 in.) direction parallel with the compression action of the machine.

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

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

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

14.8.8.6 Specimens shall be tested for permeation resistance as specified in 14.8.2 through 14.8.6.

14.8.9 Specific Requirements for Testing Dry Suit Glove Materials and Seams.

14.8.9.1 This test shall apply to all types of glove configurations.

14.8.9.2 Samples for conditioning shall be whole gloves.

14.8.9.3 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 14.1.3.
(2) Specimens shall then be conditioned as specified in 14.1.2.

14.8.9.4 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.

14.8.9.5 Specimens shall be tested for permeation resistance as specified in 14.8.2 through 14.8.6.

14.8.10 Specific Requirements for Testing Dry Suit Attached Integrated Boot Materials.

14.8.10.1 This test shall not apply to footwear configurations that include attached integrated booties that are subjected to the procedures in 14.8.7.

14.8.10.2 Samples for conditioning shall be whole attached integrated boot items.

14.8.10.3 Footwear samples shall first be conditioned as specified in 14.1.2.

14.8.10.4 Samples shall be taken in areas from the footwear upper at the footwear quarter and vamp areas and cut to the dimensions specified in 14.8.7.3.

14.8.10.5 Cut samples shall then be conditioned by abrading as specified in 14.1.5 using silicon carbide, ultrafine, 600 grit sandpaper as the abradant in lieu of other specified layers.

14.8.10.6 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.

14.8.10.7 Specimens shall be tested for permeation resistance as specified in 14.8.2 through 14.8.6.

14.9 CBRN Permeation Resistance Test.

14.9.1 Application.

14.9.1.1 This method shall only define the modifications to Section 14.8, Chemical Permeation Resistance Test, and the additional information required to perform the optional CBRN permeation resistance tests.

14.9.1.2 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 14.8.1.

14.9.2 Conditioning of Samples and Specimens.

14.9.2.1 The conditioning described in 14.1.2 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.

14.9.3 Apparatus.

14.9.3.1 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.

14.9.3.2 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 14.9.3.2(a) and individual part detail shown in Figure 14.9.3.2(b) through Figure 14.9.3.2(f).

14.9.3.3 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.

14.9.3.4 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.

14.9.3.5 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.

14.9.3.6 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.

14.9.4 Supplies.

14.9.4.1 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.

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

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

14.9.4.2.2 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.

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

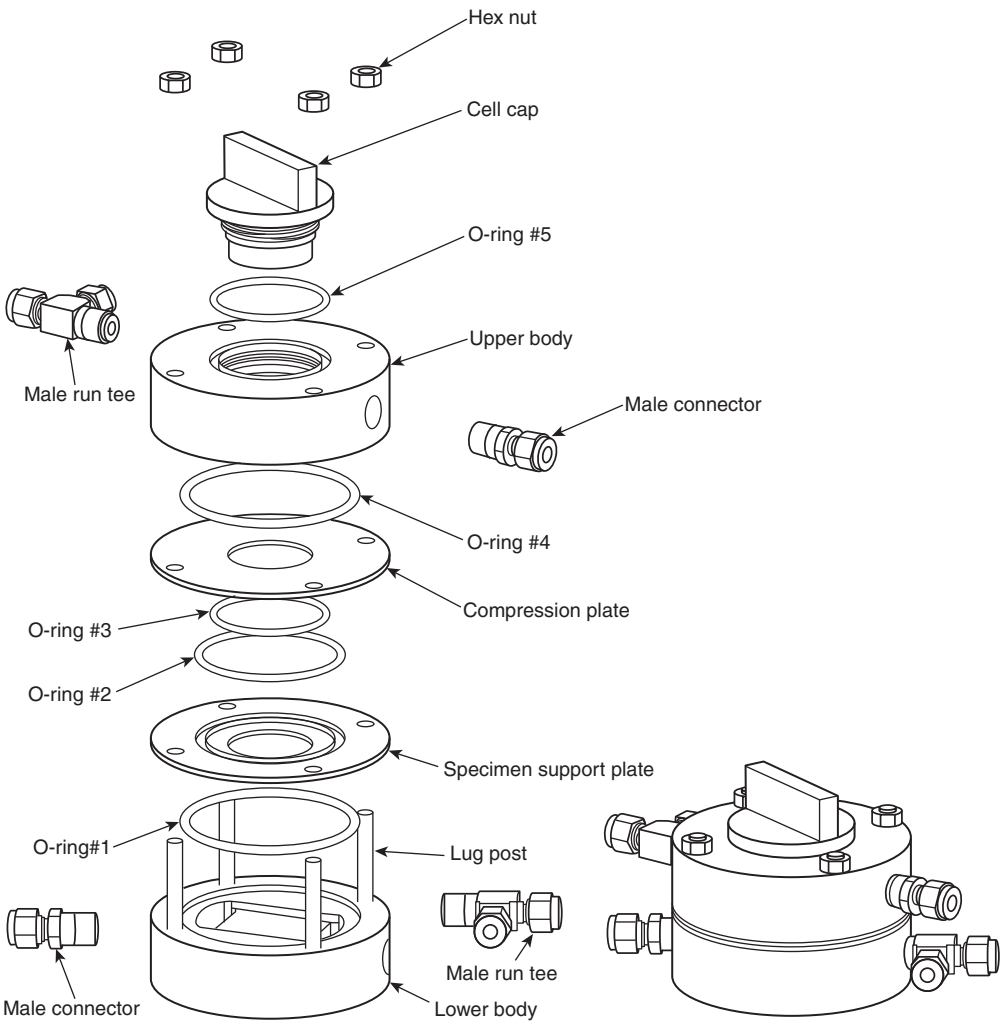


FIGURE 14.9.3.2(a) Diffusion Test Cell Assembly (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)

14.9.5 Chemicals.

14.9.5.1 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)

14.9.5.2 Process for Determining the Mass of Liquid Chemical Challenge Applied.

14.9.5.2.1 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 14.9.5.2.2 to 14.9.5.2.4.

14.9.5.2.2 The challenge chemical shall be applied to an inert impermeable surrogate specimen in the pattern described in 14.9.7.4.

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

14.9.5.2.4 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 14.9.5.2.5 to 14.9.5.2.8.

14.9.5.2.5 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.

14.9.5.2.6 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.

14.9.5.2.7 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).

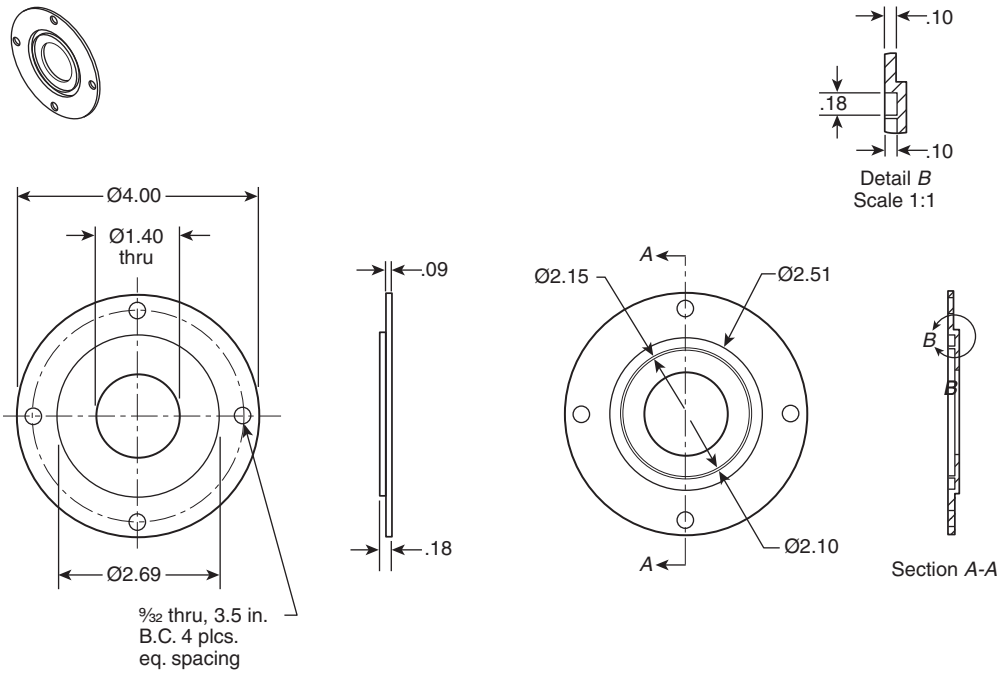


FIGURE 14.9.3.2(b) Sample Support Plate (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)

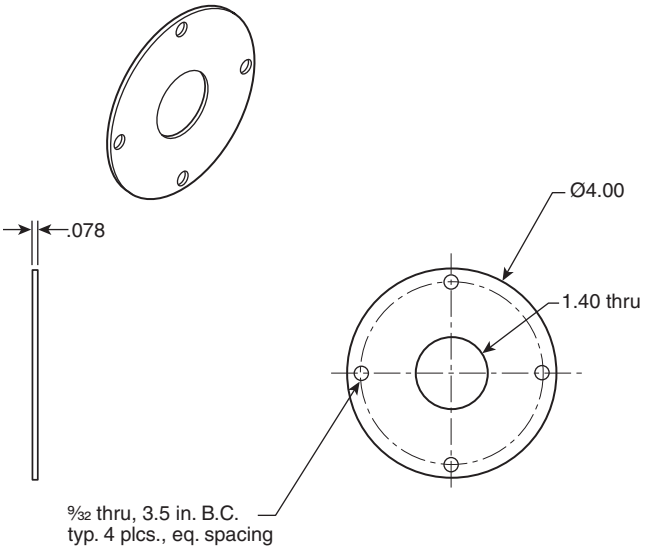


FIGURE 14.9.3.2(c) Compression Plate (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)

14.9.5.2.8 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.

14.9.5.3 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)

14.9.6 Procedures.

14.9.6.1 Preconditioning.

14.9.6.1.1 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.

14.9.6.2 Test Cell Assembly.

14.9.6.2.1 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.

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

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

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

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

14.9.6.2.6 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.

14.9.6.2.7 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 (collectionside) of the test cell.

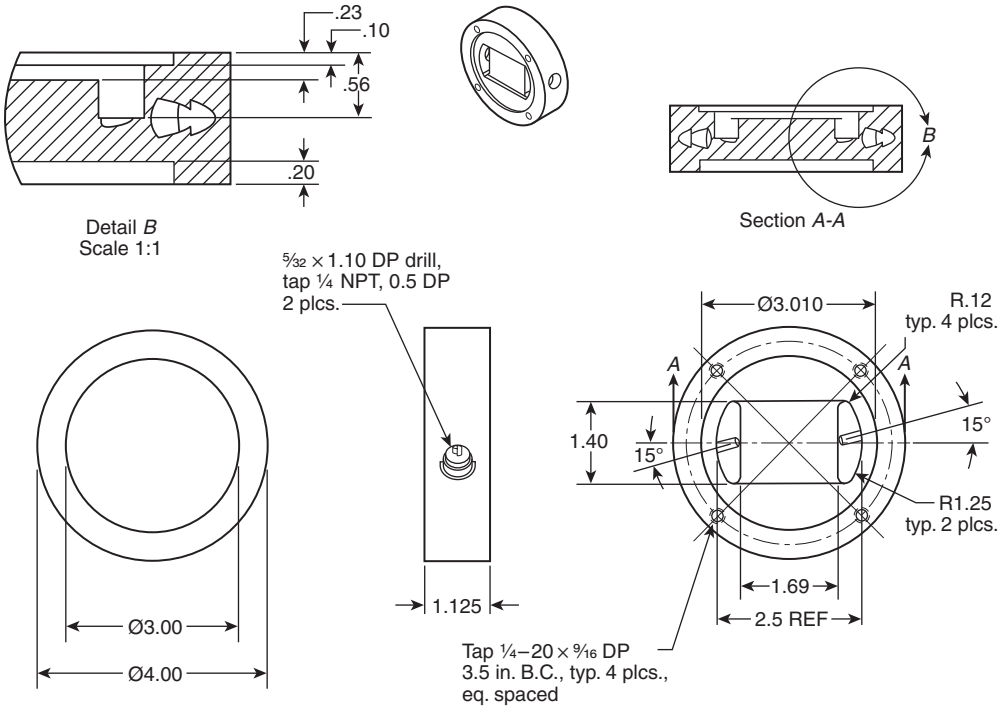


FIGURE 14.9.3.2(d) Lower Body (Collection Side) (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)

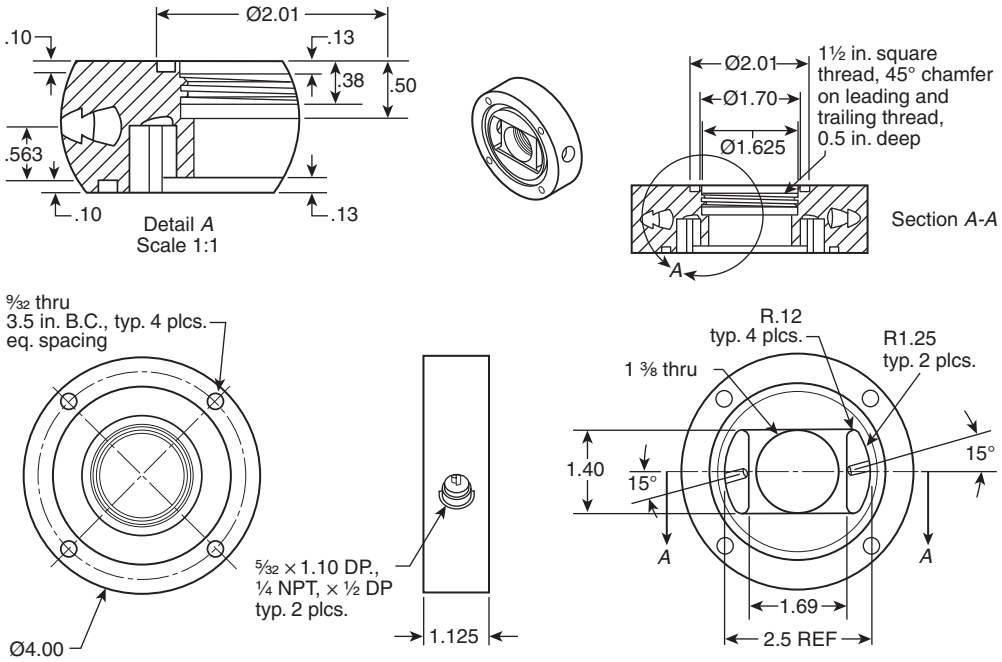


FIGURE 14.9.3.2(e) Upper Body (Challenge Side) (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)

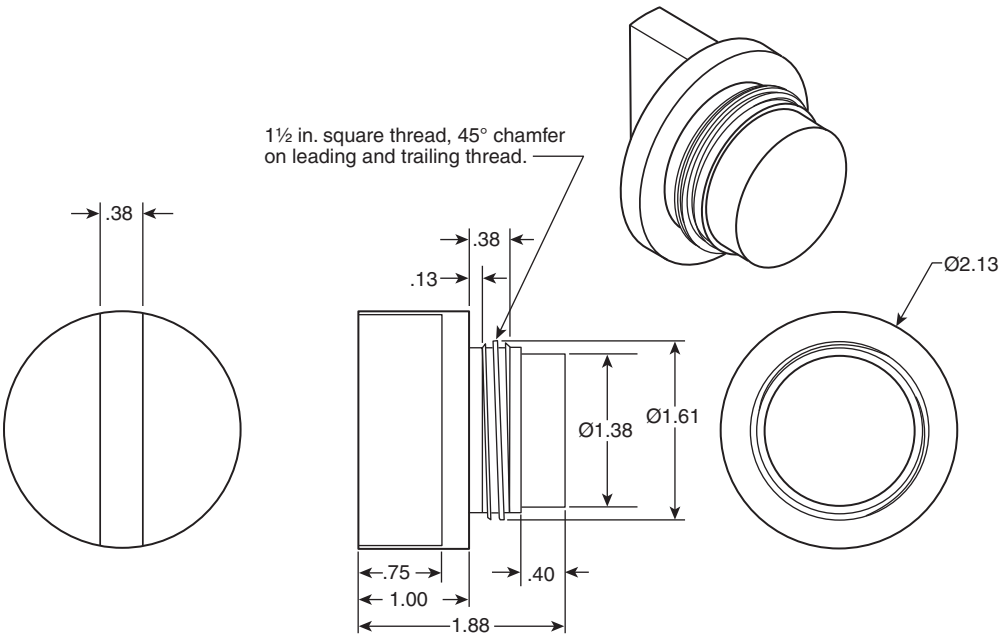


FIGURE 14.9.3.2(f) Top Cap (Copyright ©2006 W.L. Gore & Associates, Inc. Used by permission.)

14.9.6.2.8 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.

14.9.6.2.9 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.

14.9.6.2.10 The integrity of the test cell assembly shall be verified using the procedure in 14.9.6.3.

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

14.9.6.3 Verification of Test Cell Integrity.

14.9.6.3.1 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.

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

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

14.9.6.3.4 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.

14.9.6.3.5 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 NFPA 1990.

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

14.9.6.4 Determination of Procedure for Applying Liquid Challenge Chemicals.

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

14.9.6.4.2 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.

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

14.9.6.4.4 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 14.12.5.2.

14.9.6.5 Procedure for Liquid Chemical Challenge.

14.9.6.5.1 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.

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

14.9.6.5.3 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.

14.9.6.5.4 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.

14.9.6.5.5 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.

14.9.6.5.6 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 14.9.6.4.

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

14.9.6.5.7.1 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.

14.9.6.5.7.2 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.

14.9.6.5.8 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.

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

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

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

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

14.9.6.6 Procedure for Gas or Vapor Challenge Chemicals.

14.9.6.6.1 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.

14.9.6.6.2 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.

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

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

14.9.6.6.4.1 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.

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

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

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

14.9.6.6.5 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.

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

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

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

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

14.9.7 Test Conclusion, Test Cell Cleaned, and Specimen Disposal.

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

14.9.7.2 Each cell shall be disassembled one at a time.

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

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

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

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

14.9.8 Report.

14.9.8.1 The cumulative permeation in 1 hour shall be calculated, recorded, and reported in µg/cm^2 for each specimen for each challenge chemical.

14.9.8.1.1 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.

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

14.9.8.1.3 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.

14.9.8.1.4 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.

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

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

14.10 Viral Penetration Resistance Test.

14.10.1 Application.

14.10.1.1 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.

14.10.1.2 Modifications to this test method for testing glove materials shall be as specified in 14.10.8.

14.10.1.3 Modifications to this test method for testing attached integrated boots shall be as specified in 14.10.9.

14.10.2 Samples. Samples shall be conditioned as specified in 14.1.3 followed by the conditioning specified in 14.1.2.

14.10.2.1 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.

14.10.3 Specimens.

14.10.3.1 Specimens shall be as specified in 14.10.7, 14.10.8, or 14.10.9.

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

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

14.10.4 Procedure.

14.10.4.1 Biopenetration resistance testing shall be conducted in accordance with 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.*

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

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

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

14.10.7 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.

14.10.8 Specific Requirements for Testing Glove Materials.

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

14.10.8.2 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.

14.10.8.2.1 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.

14.10.8.3 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.

14.10.8.4 Specimens for testing shall be the barrier layer only.

14.10.9 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 14.1.2 prior to testing.

14.11 Cut Resistance Test.

14.11.1 Application.

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

14.11.1.2 Modifications to this test method for evaluation of dry suit bootie materials shall be as specified in 14.11.8.

14.11.1.3 Modifications to this test method for evaluation of glove materials shall be as specified in 14.11.7.

14.11.1.4 Modifications to this test method for evaluation of attached integrated boots shall be as specified in 14.11.8.

14.11.2 Samples. Samples shall be conditioned as specified in 14.1.3 followed by the conditioning specified in 14.1.2.

14.11.3 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.

14.11.4 Procedure. Specimens shall be evaluated in accordance with ASTM F1790/F1790M, *Standard Test Method for Measuring 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.