

NFPA®

1992

**Standard on
Liquid Splash–Protective
Ensembles and Clothing for
Hazardous Materials
Emergencies**

2018



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NFPA® 1992

Standard on

Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies

2018 Edition

This edition of NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies*, was prepared by the Technical Committee on Hazardous Materials 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 August 1, 2017, with an effective date of August 21, 2017, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 1992 was approved as an American National Standard on August 21, 2017.

Origin and Development of NFPA 1992

In 1985, the National Transportation Safety Board (NTSB) issued report I-004-5 on a hazardous material incident that occurred in Benicia, California. In that report, the NTSB recommended that standards be developed for protective clothing for protection from hazardous chemicals. The United States Department of Transportation (DOT) issued a position that requested private sector standards development to undertake the project of writing the standards on hazardous chemical protective clothing and asked other governmental agencies to assist and participate in the private sector standards development system. The DOT at that time also directly requested that NFPA develop documents on hazardous chemical protective clothing. The Environmental Protection Agency (EPA), the United States Coast Guard (USCG), the Federal Emergency Management Agency (FEMA), and the Occupational Safety and Health Administration (OSHA) either endorsed the DOT position or adopted position statements modeled after it.

During 1985, the NFPA Standards Council approved a project for development of these standards and assigned the project to the Technical Committee on Fire Service Protective Clothing and Equipment. The technical committee established a standing Subcommittee on Hazardous Chemicals Protective Clothing, which began its work in Phoenix, Arizona, in March 1986. Representatives from USCG, FEMA, and OSHA participated on the subcommittee.

At the same time, the American Society for Testing and Materials (ASTM) was developing a document on a selection of chemicals for evaluating protective clothing materials that would serve as one of several ASTM testing criteria that would be referenced in the NFPA standards.

The subcommittee met several times over a 2 ½-year period at different locations across the country and developed two standards, one for vapor-protective ensembles and one for liquid splash-protective ensembles and clothing. These standards are today known as NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents*, and NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies*.

NFPA 1992 addresses liquid splash–protective ensembles and clothing designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments during hazardous materials emergencies. Documentation is required for chemical penetration resistance of garment material against an NFPA battery of test chemicals and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. The NFPA battery of chemicals was selected from ASTM F1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Materials*. These chemicals do not include liquid chemicals with known or suspected carcinogenicity or skin toxicity because these garments deal with skin exposure and not inhalation. This criterion produces a different subset of ASTM F1001 chemicals to be certified.

This standard includes performance requirements that were established to reflect simulated-use conditions. An overall suit water penetration test is included to ensure that the suit provides full-body splash protection. Materials testing includes burst strength, tear resistance, flammability resistance testing, abrasion resistance, cold temperature performance, and flexural fatigue testing. These tests are required so that garment materials will provide adequate protection in the environment in which they will be used.

The first edition of NFPA 1992 was voted on by the Association at the 1989 Fall Meeting in Seattle, Washington, on November 15, 1989, and had an effective date of February 5, 1990.

The Subcommittee on Hazardous Chemicals Protective Clothing began an early revision (4-year cycle) of the 1990 edition of NFPA 1992 in December 1991. During 1993, the NFPA restructured the manner in which committees were organized, and all standing subcommittees were eliminated. Within the Technical Committee on Fire Service Protective Clothing and Equipment, the former standing subcommittees were reorganized as task groups to address specific technical issues, and the technical committee assumed the entire responsibility for NFPA 1992.

The 1994 edition of NFPA 1992 encompassed revised scope and purpose sections to include optional components for enhanced protection and replacement items. Test methods were updated and refined to better ensure repeatability of testing results. Extensive changes were made to the product labels to better accommodate the optional and replacement items.

The 1994 edition was acted on by the membership of the Association at the NFPA Annual Meeting in San Francisco, California, on May 18, 1994, and was issued with an effective date of August 5, 1994.

In January 1995, the entire project for fire service protective clothing and equipment was reorganized by the Standards Council. The new project had a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on Hazardous Chemicals Protective Clothing was established as the new Technical Committee on Hazardous Materials Protective Clothing and Equipment and given the responsibility for NFPA 1992.

The 2000 edition changed the title to *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies* and was a complete revision. It addressed the protection as encapsulating and non-encapsulating ensembles in addition to individual items of protective clothing. It also combined certain requirements for liquid splash protection for support function activities from the former NFPA 1993, *Standard on Support Function Protective Clothing for Hazardous Chemical Operations*, the 1994 edition, which was withdrawn on January 14, 2000. Protective clothing certified as compliant with NFPA 1993 was seldom used by hazardous materials incident responders. More practical requirements for liquid splash-protective ensembles and clothing used for response and support activities were included in that edition of NFPA 1992.

The 2000 edition was presented to the Association membership at the 1999 November Meeting in New Orleans, Louisiana, on November 17, 1999, and issued by the Standards Council with an effective date of February 11, 2000.

The 2005 edition (fourth edition) of NFPA 1992 was again a complete revision and was reformatted according to the new style for all NFPA codes and standards. Because of the new style, most of the chapter numbering, as well as paragraph numbering, was changed. While the 2005 edition's content was in a different order than in previous editions, all the material was there, and the table of contents directed users of the document to the appropriate chapters and sections. The committee included in Chapter 4 new requirements for manufacturers' quality assurance programs and for situations where hazards involving compliant products are believed to exist, including the appropriate actions in addressing these situations if there is a previously unknown threat to the users. Those requirements were applied to all fire and emergency services product standards that are the responsibility of this project. All design, performance, and testing requirements were reviewed and refined as necessary.

The 2005 edition was presented to the Association membership at the 2004 November meeting in Miami Beach, Florida on November 17, 2004, and issued by the Standards Council with an effective date of February 7, 2005.

The 2012 edition of NFPA 1992 (fifth edition) was extensively revised and included a new optional requirement on material total heat loss in Chapter 8, several new definitions, and updates to several ANSI, ISO, and ASTM standards. This edition deleted the footwear sole puncture resistance test and revised both the slip resistance test method and the flexural fatigue procedure for footwear. The 2012 edition featured changes to requirements of the manufacturers' quality assurance program in Chapter 4.

The 2012 edition was issued by the Standards Council with an effective date of January 2, 2012.

The 2018 edition of NFPA 1992 (sixth edition) has a significant change in its scope whereby it no longer states that NFPA 1992 protective clothing and ensembles are not designed for use with known or suspected carcinogens and instead establishes the standard as applying to any chemicals that are not gas or vapor-producing liquids at concentrations known to be toxic to the skin. The chemical challenges within NFPA 1992 have been changed to represent more operationally relevant chemicals, such as sodium hydroxide and sodium hypochlorite, as well as chemicals known to degrade materials, such as dimethylformamide and tetrachloroethylene. In addition, several test methods have been updated to more closely match operational parameters, and other tests have been added for assessing hand-glove insertion/reinsertion and defining a minimum field of vision. Footwear sole puncture resistance and toe impact/compression resistance requirements have been replaced by compliance with the ASTM F2413 specification for protective footwear. Footwear requirements have been broadened to offer more footwear choices for end users. Specific criteria have been added to address separate hoods and elastomeric interface materials. Evaporative resistance has been added as an optional test for reporting the breathability of ensemble garment materials. Finally, the technical data package organization and content has been standardized across the chemical protective clothing standards to provide enhanced clarity for the operator in order to make educated decisions.

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

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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 protective clothing and protective equipment, except respiratory protective equipment, that provides hand, foot, torso, limb, and head protection for fire fighters and other emergency services responders during incidents that involve hazardous materials operations. These operations involve the activities of rescue; hazardous material confinement, containment, and mitigation; and property conservation where exposure to substances that present an unusual danger to responders are present or could occur due to toxicity, chemical reactivity, decomposition, corrosiveness, or similar reactions. Additionally, this Committee shall have primary responsibility for documents on the selection, care, and maintenance of hazardous materials protective clothing and protective equipment by fire and emergency services organizations and personnel.

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NFPA 1992

Standard on

Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies

2018 Edition

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

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in the recommendations sections of this document are given in Chapter 2 and those for extracts in the informational sections are given in Annex B. 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 should be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall specify minimum requirements for the design, performance, testing, documentation, and certification for liquid splash–protective ensembles, ensemble elements, and protective clothing used by emergency response personnel during hazardous materials incidents.

Δ 1.1.2* This standard shall also specify additional *optional* criteria for liquid splash–protective ensembles *only* for *escape protection* from chemical flash fires encountered during hazardous materials incidents.

1.1.3 This standard shall specify requirements for new liquid splash–protective ensembles, new ensemble elements, and new protective clothing.

N 1.1.3.1 Ensemble elements shall include garments, gloves, footwear, and hoods.

1.1.4* This standard alone shall not specify requirements for protective ensembles or clothing for hazardous materials emergencies where the hazardous material is present as a gas or a vapor-producing liquid at vapor concentrations known to be toxic to the skin.

Δ 1.1.5* This standard alone shall not specify requirements for protection from chemical or biological terrorism agents or from chemical or biological terrorism incidents. Requirements for such protection shall be provided by protective ensembles that are certified as compliant with NFPA 1994 or ensembles that are certified as compliant with NFPA 1991.

1.1.6* This standard alone shall not specify requirements for protective clothing for any fire-fighting applications.

1.1.7* This standard alone shall not specify requirements for protection from ionizing radiation; biological, liquefied gas, or cryogenic liquid hazards; or *explosive atmospheres caused by vapors, dust, or particulates*.

1.1.8* This standard shall not specify requirements for the respiratory protection that is necessary for proper protection with the protective ensemble.

1.1.9 This standard shall not specify requirements for any accessories that could be attached to the product but are not necessary for the product to meet the requirements of this standard.

1.1.10 Certification of compliant liquid splash–protective ensembles, ensemble elements, and protective clothing to the requirements of this standard shall not preclude certification to additional appropriate standards where the ensemble, ensemble elements, or protective clothing meet all the applicable requirements of each standard.

1.1.11 This standard shall not be construed as addressing all of the safety concerns, if any, associated with its use for the designing, manufacturing, testing, or certifying of product to meet the requirements of this standard. 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 use of this standard.

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

1.2 Purpose.

1.2.1* The purpose of this standard shall be to establish a minimum level of protection for emergency response personnel against adverse liquid-splash environments during hazardous materials emergency incidents.

1.2.1.1 The purpose of this standard shall also be to establish a minimum level of *limited* chemical flash fire protection, *for escape only* in the event of a chemical flash fire, as an option for compliant liquid splash–protective ensembles, ensemble elements, and protective clothing.

1.2.1.2 The purpose of this standard shall be to provide emergency response organizations the flexibility to specify the option in 1.2.1.1 in their purchase specifications according to the anticipated exposure and expected needs of the emergency response organization.

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

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

1.3 Application.

1.3.1 This standard shall apply to the design, manufacturing, testing, and certification of new liquid splash-protective ensembles, new ensemble elements, and new protective clothing.

1.3.2 This standard alone shall not specify requirements for protective ensembles or clothing for hazardous materials emergencies where the hazardous material is present as a gas or a vapor-producing liquid at vapor concentrations known to be toxic to the skin.

1.3.3 This edition of NFPA 1992 shall not apply to liquid splash-protective ensembles, ensemble elements, and protective clothing manufactured to previous editions of this standard.

1.3.4 This standard alone shall not apply to protective clothing for any fire-fighting applications.

1.3.5 This standard alone shall not apply to protective clothing for protection from ionizing radiation, cryogenic liquid hazards, or explosive atmospheres caused by vapor, dust, or particulates.

1.3.6* This standard shall not apply to the respiratory protection that is necessary for proper protection with the liquid splash-protective ensemble or protective clothing.

Δ 1.3.7 This standard shall not apply to use requirements for liquid splash-protective ensembles or protective clothing; such requirements are specified in NFPA 1500.

1.3.8* The requirements of this standard shall not apply to any accessories that could be attached to the product but are not necessary for the product to meet the requirements of this standard.

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 are 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 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2017 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*, 2018 edition.

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*, 2018 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2018 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, 2013 edition.

NFPA 1986, *Standard on Respiratory Protection Equipment for Tactical and Technical Operations*, 2017 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents*, 2016 edition.

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

2.3 Other Publications.

Δ 2.3.1 AAFA Publications. American Apparel and Footwear Association, 1601 North Kent Street, Suite 1200, Arlington, VA 22209.

FIA Standard 1209, *Whole Shoe Flex*, 1984.

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

ANSI/ISEA Z87.1, *American National Standard for Occupational and Educational Personal Eye and Face Protection Devices*, 2015.

ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection*, 2014.

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

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension*, 2015a.

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

ASTM D747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*, 2010.

ASTM D751, *Standard Test Methods for Coated Fabrics*, 2011.

ASTM D2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheet*, 2009.

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

ASTM D5151, *Standard Test Method for Detection of Holes in Medical Gloves*, 2015.

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

ASTM F903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 2010.

ASTM F1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Durability of Protective Ensembles and Ensemble Components*, 2011.

ASTM F1301, *Standard Practice for Labeling Chemical Protective Clothing*, 2011, e1.

ASTM F1342/F1342M, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture*, 2013 e1.

ASTM F1358, *Standard Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance*, 2016.

ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin*, 2016.

ASTM F1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, 2005.

ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate*, 2014.

ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test*, 2010.

ASTM F2412, *Standard Test Methods for Foot Protection*, 2011.

ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, 2011.

ASTM F2700, *Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating*, 2013.

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*, 2011.

• **N 2.3.4 CDC Publications.** Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30329.

Statement of Standard for NIOSH CBRN APR Testing, 2004.

Statement of Standard for NIOSH CBRN PAPR Testing, 2004.

Statement of Standard for NIOSH CBRN SCBA Testing, 2004.

• **Δ 2.3.5 ISO Publications.** International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

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

ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*, 2010.

ISO 9001, *Quality Management Systems — Requirements*, 2008.

ISO 9001, *Quality Management Systems — Requirements*, 2015.

ISO 11092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*, 2014.

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

ISO 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*, 2011.

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

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

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

Title 29, Code of Federal Regulations, Part 1910.132, Subpart I, “Personal Protective Equipment.”

Δ 2.3.7 Other Publications.

American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, 2014.

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

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

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

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

3.2.5 Shall. Indicates a mandatory requirement.

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

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

activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Afterflame Time. The length of time for which a material, component, or chemical protective suit continues to burn after the simulated chemical flash fire has ended.

3.3.2 Biological Agents. Biological materials that are capable of causing disease or long-term damage to the human body.

3.3.3 Boot. See 3.3.42, Liquid Splash-Protective Footwear.

3.3.4 Care. Procedures for cleaning, decontamination, and storage of protective clothing and equipment.

3.3.5 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.

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

3.3.7 Chemical and Biological Terrorism Incidents. Situations involving the release of chemical or biological warfare agents in civilian areas by terrorists.

3.3.8* Chemical Flash Fire. The ignition of a flammable and ignitable vapor or gas that produces an outward expanding flame front as those vapors or gases burn. This burning and expanding flame front, a fireball, will release both thermal and kinetic energy to the environment.

3.3.9* Chemical-Protection Layer. The material or composite used in an ensemble or clothing for the purpose of providing protection from chemical hazards.

3.3.10 Chemical-Protective Material. Any material or composite used in liquid splash-protective ensemble or clothing for the purpose of providing protection from chemical hazards; can be a part of the “primary suit material.”

3.3.11 Clothing Items. See 3.3.40, Liquid Splash-Protective Clothing.

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

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

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

3.3.15* Cryogenic Liquid. A refrigerated liquefied gas having a boiling point below -130°F (-90°C) at atmospheric pressure.

N 3.3.16 Elastomer. A polymeric material that returns to its original length and shape after stretching.

N 3.3.17* Elastomeric Interface Material. An exposed elastomeric material that is not otherwise used as a garment material, which provides an interface between components of the ensemble or ensemble elements, other than seams, and if applicable, the interface between the respirator facepiece and the ensemble or ensemble elements.

3.3.18 Element(s). See 3.3.22, Ensemble Elements.

3.3.19 Emergency Response Personnel. Personnel assigned to organizations that have the responsibility for responding to hazardous materials emergencies.

Δ 3.3.20 Encapsulating. A type of ensemble that covers the wearer and the wearer's respirator.

3.3.21 Ensemble. See 3.3.41, Liquid Splash-Protective Ensemble.

3.3.22 Ensemble Elements. Ensemble elements including garments, gloves, footwear, and hoods.

N 3.3.22.1 Hazardous Materials and Emergencies Protective Footwear. The element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

N 3.3.22.2 Hazardous Materials and Emergencies Protective Footwear Cover. The item of the protective ensemble to be worn over standard footwear that provides a barrier and physical protection to the wearer's feet.

N 3.3.22.3 Hazardous Materials and Emergencies Protective Garment(s). The element of the protective ensemble that provides protection to the upper and lower torso, head, arms, and legs; excluding the hands and feet.

N 3.3.22.4 Hazardous Materials and Emergencies Protective Glove(s). The element of the protective ensemble that provides protection to the wearer's hands and wrists.

N 3.3.22.5 Hazardous Materials and Emergencies Protective Hood. The element of the protective ensemble that provides protection to the wearer's head and neck.

3.3.23 Exhaust Valve. One-way vent that releases exhaust to the outside environment and prevents entry of outside environment.

3.3.24* External Fittings. Any component that allows the passage of gases, liquids, or electrical current from the outside to the inside of the element or item as well as any fitting externally located on, and part of, the ensemble that is not part of the garment material, visor material, gloves, footwear, seams, or closure assembly.

3.3.25 Flammable or Explosive Atmospheres. Atmospheres containing solids, liquids, vapors, or gases at concentrations that will burn or explode if ignited.

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

3.3.27 Footwear. See 3.3.42, Liquid Splash-Protective Footwear.

3.3.28 Footwear Upper. That portion of the footwear above the sole, heel, or insole.

3.3.29 Garment. See 3.3.43, Liquid Splash-Protective Garment.

3.3.30 Garment Closure. The garment component designed and configured to allow the wearer to don (put-on) and doff (take-off) the garment.

3.3.31 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.

3.3.32 Garment Material. The principal chemical-protective material used in the construction of the liquid splash-protective suit.

3.3.33 Glove. See 3.3.44, Liquid Splash-Protective Glove.

3.3.34* Hazardous Materials. A substance (solid, liquid, or gas) that when released is capable of creating harm to people, the environment, and property.

3.3.35 Hazardous Materials Emergencies. Incidents involving the release or potential release of hazardous materials.

N 3.3.36 Hood. See 3.3.45, Liquid-Splash Protective Hood.

3.3.37* Ionizing Radiation. Extremely short-wavelength, high energy penetrating rays of alpha, beta, gamma and x-rays emitted from radioactive elements and isotopes (radionuclides).

3.3.38 Ladder Shank. Reinforcement to the shank area of protective footwear designed to provide additional support to the instep when standing on a ladder rung.

3.3.39* Liquefied Gas. A gas that, under its charged pressure, is partially liquid at 21°C (70°F).

3.3.40* Liquid Splash-Protective Clothing. Multiple items of compliant protective clothing and equipment products that provide protection from some risks, but not all risks, of hazardous materials emergency incident operations involving liquids.

3.3.41* Liquid Splash-Protective Ensemble. Multiple elements of compliant protective clothing and equipment products that when worn together provide protection from some risks, but not all risks, of hazardous materials emergency incident operations involving liquids to the torso, legs, arms, head, hands, and feet.

3.3.42* Liquid Splash-Protective Footwear. The element of the protective ensemble, or the item of protective clothing that provides liquid chemical protection and physical protection to the feet, ankles, and lower legs.

Δ 3.3.43* Liquid Splash-Protective Garment. The element of the protective ensemble or the item of protective clothing that provides liquid chemical protection to the upper and lower torso, arms and legs, excluding the head, hands, and feet.

3.3.44 Liquid Splash-Protective Glove. The element of the protective ensemble, or the item of protective clothing that provides liquid chemical protection to the hands and wrists.

N 3.3.45* Liquid-Splash Protective Hood. The element of the protective ensemble or an item of protective clothing that provides liquid chemical protection and physical protection to the head and neck.

3.3.46 Maintenance. Procedures for inspection, repair, and removal from service of liquid splash-protective ensembles or clothing.

3.3.47 Manufacturer. The entity that directs and controls compliant product design, compliant product manufacturing, or compliant product quality assurance; or the entity that assumes the liability or provides the warranty for the compliant product.

N 3.3.48 Melt. A response to heat by a material resulting in evidence of flowing and dripping.

3.3.49 Model. The collective term used to identify a group of individual liquid splash-protective ensembles or protective clothing 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.

3.3.50* Nonencapsulating Ensemble. A type of ensemble that does not fully cover the wearer's respirator and relies on the facepiece of the respirator to have an interface with the garment to complete the enclosure of the wearer.

Δ 3.3.51 Outer Boot. A secondary boot worn over another footwear item that provides physical protection for the chemical-protective material in order for liquid splash-protective footwear to meet certain requirements of this standard.

3.3.52 Outer Garment. A secondary garment worn over another garment that provides physical protection for the chemical-protective material in order for liquid splash-protective garment to meet certain requirements of this standard.

3.3.53 Outer Glove. A secondary glove worn over another glove that provides physical protection for the chemical-protective material in order for the liquid splash-protective glove to meet certain requirements of this standard.

3.3.54* Particulates. Finely divided solid matter that is dispersed in air.

3.3.55 Primary Suit Materials. Liquid splash-protective ensemble and clothing materials limited to the garment material, hood material, visor material, glove material, and footwear material that provide protection from chemical and physical hazards.

3.3.56* Product Label. A label or marking affixed by the manufacturer to each compliant product, or product package. Such labels contain compliance statements, certification statements, general information, care, maintenance, or similar data.

3.3.57 Protective Clothing. See 3.3.40, Liquid Splash-Protective Clothing.

3.3.58 Protective Ensemble. See 3.3.41, Liquid Splash-Protective Ensemble.

3.3.59 Protective Footwear. See 3.3.42, Liquid Splash-Protective Footwear.

3.3.60 Protective Garment. See 3.3.43, Liquid Splash-Protective Garment.

3.3.61 Protective Gloves. See 3.3.44, Liquid Splash-Protective Glove.

3.3.62 Puncture-Resistant Device. A reinforcement to the bottom of protective footwear that is designed to provide puncture resistance.

3.3.63 Radionuclide. An isotope form of an element or radioactive element that emits radiation in excess of normal background radiation levels.

3.3.64 Recall System. The action by which a manufacturer identifies an element, provides notice to the users, withdraws an element from the marketplace and distribution sites, and returns the element to the manufacturer or other acceptable location for corrective action.

3.3.65 Respirator. A certified device that provides respiratory protection for the wearer within the limits of the certification.

3.3.66 Seam. Any permanent attachment of two or more chemical-protective clothing materials, excluding external fittings, gaskets, and suit closure assemblies, in a line formed by joining the separate material pieces.

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

N 3.3.68* Sock. An extension of the garment or suit leg or a separate item that covers the entire foot and is intended to be worn inside a protective outer boot.

3.3.69 Storage Life. The date to remove from service a liquid splash-protective ensemble, element, or clothing item that has undergone proper care and maintenance in accordance with the manufacturer's instructions but has not been used either in training or at actual incidents.

3.3.70 Suit Closure. The component that allows the wearer to enter (don) and exit (doff) the liquid splash-protective ensemble.

3.3.71* Vapor-Protective Ensemble. Multiple elements of compliant protective clothing and equipment products that when worn together provide protection from some risks, but not all risks, of hazardous materials emergency incident operations involving vapors.

3.3.72 Visor Material. The transparent chemical-protective material that allows the wearer to see outside the protective ensemble hood.

Chapter 4 Certification

4.1 General.

4.1.1 The process of certification for protective ensembles and ensemble elements as being compliant with NFPA 1992 shall meet the requirements of Section 4.1, General; Section 4.2, Certification Program; Section 4.3, Inspection and Testing; Section 4.4, Annual Verification of Product Compliance; Section 4.5, Manufacturers' Quality Assurance Program; Section 4.6, Hazards Involving Compliant Product; Section 4.7, Manufacturers' Investigation of Complaints and Returns; and Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

4.1.2 All compliant ensembles and ensemble elements that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

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

4.1.4* Manufacturers shall not claim compliance with portions or segments of the requirements of this standard and shall not use the NFPA name or the name or identification of this standard, NFPA 1992, in any statements about their respective product(s) unless the product(s) is certified as compliant to this standard.

4.1.5 All compliant protective ensembles and ensemble elements shall be labeled and listed.

4.1.6 All compliant ensembles and ensemble elements shall also have a product label that meets the requirements specified in Section 5.1, Product Label Requirements.

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

4.1.8 The certification organization shall not issue any new certifications to the 2012 edition of this standard on or after the NFPA effective date for the 2018 edition, which is August 21, 2017.

4.1.9 The certification organization shall not permit any manufacturer to continue to label any ensembles or ensemble elements that are certified as compliant with the 2012 edition of this standard on or after August 21, 2018.

4.1.10 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2012 edition of this standard from all ensembles and ensemble elements that are under the control of the manufacturer on August 21, 2018, and the certification organization shall verify this action is taken.

• 4.1.11 Liquid splash-protective ensembles or liquid splash-protective clothing items shall not be certified for chemical or specific chemical mixtures with skin notations as indicated by American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, and that have a vapor pressure greater than 5 mm Hg at 25°C (77°F).

4.2 Certification Program.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2.9.2 Sample product shall be evaluated by the certification organization to verify the *product's* continued compliance in order to assure that the materials, components, and manufac-

turing quality assurance systems are consistent with the materials, components, and manufacturing quality assurance that were inspected and tested by the certification organization during initial certification and recertification.

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

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

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

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

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

4.3 Inspection and Testing.

4.3.1 For both initial certification and recertification of protective ensembles and ensemble elements, the certification organization shall conduct both inspection and testing as specified in this section.

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

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

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

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

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

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

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

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

4.3.4 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to ensure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified to this standard are compliant, unless such sampling levels are specified herein. This information shall be included in the manufacturer's technical data package.

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

4.3.6 Inspection by the certification organization shall include an evaluation of any symbols and pictorial graphic representations used on product labels or in user information, as permitted by in 5.1.1.7, to ensure that the symbols are clearly explained in the product's user information package.

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

4.3.8 Inspection by the certification organization shall include a review of the technical data package to determine compliance with the requirements of Section 5.3, Technical Data Package.

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

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

4.3.10.1 Testing shall be performed on specimens representative of materials and components used in the actual construction of the protective ensemble and ensemble element.

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

4.3.11 The certification organization shall accept from the manufacturer, for evaluation and testing for certification, only

product or product components that are the same in every respect to the actual final product or product component.

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

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

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

4.3.15 The certification organization shall test ensemble elements with the specific ensemble(s) with which they are to be certified.

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

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

4.4 Annual Verification of Product Compliance.

4.4.1 All **ensembles and ensemble elements** that are labeled as being compliant with this standard shall undergo recertification on an annual basis. This recertification shall include inspection and evaluation to all design requirements and testing to all performance requirements as required by this standard on all manufacturer models and components as specified in 4.4.3.

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

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

4.4.2 Samples of **manufacturer's** models and components for recertification shall be acquired from the manufacturer or component supplier during random and unannounced visits as part of the follow-up inspection program. For recertification, the certification organization shall acquire at least one liquid splash-protective garment, one pair of liquid splash-protective gloves, one pair of liquid splash-protective footwear, and one complete liquid splash-protective nonencapsulating or encapsulating ensemble outfitted with all manufacturer-provided external fittings. The certification organization shall also acquire a sufficient quantity of component samples to be tested for recertification as required by 4.4.3.

4.4.3 Liquid splash-protective ensembles, ensemble elements, and ensemble components shall be inspected, evaluated, and tested for annual recertification.

4.4.3.1 Each liquid splash-protective ensemble and ensemble element shall be inspected and evaluated to each of the design requirements specified in Chapter 6.

4.4.3.2 Each liquid splash-protective ensemble specimen shall be tested for overall performance as specified in Section 7.1 using the following sequence of tests:

- (1) The liquid splash-protective ensemble specimen shall then be tested for liquidtight integrity as specified in Section 8.2, Liquidtight Integrity Test 1.
- (2) The liquid splash-protective ensemble specimen shall then be tested for overall function and integrity as specified in Section 8.3, Overall Garment Function and Integrity Test.
- (3) If certified for optional chemical flash fire protection, the liquid splash-protective ensemble shall then be tested for overall ensemble flash protection as specified in Section 8.17, Overall Ensemble Flash Test.

4.4.3.3* All garment material, visor, glove, footwear, hoods, and optional chemical flash fire protection performance requirements shall be evaluated as specified in Chapter 7, with the following modifications:

- (1) Chemical penetration resistance testing shall be limited to the testing specified in 7.1.2, 7.1.6.1, 7.1.7.1, 7.1.8.1, 7.1.9.2, 7.2.2, 7.2.7, 7.3.2, and 7.3.8, and shall be performed against the following chemicals:
 - (a) Fuel H — surrogate gasoline [42.5 percent toluene, 42.5 percent isooctane, and 15 percent denatured ethanol, volume/volume (v/v)] as defined in ASTM D471, *Standard Test Method for Rubber Property-Effect of Liquids*.
 - (b) Methyl isobutyl ketone, CAS No. 108-10-1, >95 percent, weight/weight (w/w)
 - (c) Sulfuric acid, CAS No. 7664-93-9, 93.1 percent, w/w
- (2) A total of two specimens shall be permitted for testing requirements. If the testing is specified for both directions of a material, a total of two specimens per material direction shall be permitted for testing requirements.

4.4.4 The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the recertification of manufacturer's models and components. The manufacturer shall provide such data, upon request, to the purchaser or the AHJ.

4.5 Manufacturers' Quality Assurance Program.

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

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

4.5.3* The manufacturer shall be registered to ISO 9001, *Quality Management Systems — Requirements*.

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

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

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

4.5.4* Any entity that meets the definition of *manufacturer* as specified in 3.3.47 and therefore is considered to be the "manufacturer" but does not manufacture or assemble the compliant product shall meet the requirements specified in Section 4.5.

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

4.6 Hazards Involving Compliant Product.

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

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

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

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

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

4.6.6 The certification organization's investigation shall include, but not be limited to, the extent and scope of the problem as it might apply to other compliant products 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 the manufacturer of the compliant product component if applicable, to assist the certification organization in the investigation and to conduct its own investigation as specified in Section 4.7, *Manufacturers' Investigation of Complaints and Returns*.

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

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

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

- (1) Notification of 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) Notification of parties authorized and responsible for issuing a product recall when, in the opinion of the certification organization, such a recall is necessary to protect the users
- (3) Removing the mark of certification from the product
- (4) Where a hazardous condition exists and it is not practical to implement (1), (2), or (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

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

4.6.13* 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 NFPA, and shall also submit either a public proposal for a proposed change to the next revision of the applicable standard, or a proposed Temporary Interim Amendment (TIA) to the current edition of the applicable standard.

4.7 Manufacturers' Investigation of Complaints and Returns.

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

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

4.7.3 Where the manufacturer discovers, during the review of specific returns or complaints, that a compliant product or compliant product component can constitute a potential safety

risk to end users that is possibly subject to a safety alert or product recall, the manufacturer shall immediately contact the certification organization and provide all information about their review to assist the certification organization with their investigation.

4.8 Manufacturers' Safety Alert and Product Recall Systems.

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

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

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

Chapter 5 Labeling and Information

5.1 Product Label Requirements.

5.1.1 General.

5.1.1.1* Each liquid splash-protective garment element and item shall have a product label permanently and conspicuously attached to or printed on each garment when the garment is properly assembled with all layers, components, and component parts in place.

5.1.1.2 Each liquid splash-protective glove element and item shall have a product label permanently and conspicuously attached to or printed on the top outside of the gauntlet of each glove piece when the glove is properly assembled with all layers, components, and component parts in place. In addition, each package containing one or more pairs of liquid splash-protective gloves shall have a product label attached to, printed on, or inserted in the glove package.

5.1.1.3 All liquid splash-protective footwear elements and items shall have a product label permanently and conspicuously attached to or printed on the inside of each footwear piece when the footwear is properly assembled with all layers, components, and component parts in place. In addition, each package containing one or more pairs of liquid splash-protective footwear shall have a product label attached to, printed on, or inserted in the footwear package.

5.1.1.4 Each liquid splash-protective ensemble shall have a product label permanently and conspicuously attached to or

printed on the inside of each ensemble when the ensemble is properly assembled with all layers, components, and component parts in place.

5.1.1.5* 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 entire product label shall be located adjacent to each other.

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

5.1.1.7 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s) where such symbols and other pictorial graphic representations are clearly explained in the user information.

5.1.1.8 The certification organization's label, symbol, or identifying mark shall be legibly printed on the product label. All letters shall be at least 6 mm ($\frac{1}{4}$ in.) high.

5.1.1.9 The compliance statements and information specified in 5.1.2 through 5.1.6, as applicable for the specific protective ensemble, element, or protective clothing item, shall be legibly printed on the product label. All letters shall be at least 2.5 mm ($\frac{3}{32}$ in.) high.

Δ 5.1.1.10 In addition to the compliance statements specified in 5.1.1.9, at least the following information shall also be printed legibly on the product label(s), and all letters shall be at least 1.6 mm ($\frac{1}{16}$ in.) high:

- (1) Manufacturer's name, identification, or designation
- (2) Manufacturer's address
- (3) Country of manufacture
- (4) Model, style, or serial number
- (5) Size
- (6) Garment, glove, footwear, ensemble material(s)
- (7) Visor material(s) if provided
- (8) Glove component for ensemble
- (9) Footwear component for ensemble

5.1.1.11 Where detachable components, including, but not limited to, outer garments, outer gloves, or outer boots, must be worn with a liquid splash-protective ensemble or protective clothing item in order for the ensemble or clothing item to be compliant with this standard, at least the following statement and information shall also be printed legibly on the product label. All letters shall be at least 1.6 mm ($\frac{1}{16}$ in.) high. The appropriate term — *garment*, *glove*, *footwear*, or *ensemble* — shall be inserted where indicated in the label text. The detachable component(s) shall be listed following this statement by type, identification, and how properly worn:

"FOR COMPLIANCE WITH NFPA 1992, THE FOLLOWING ADDITIONAL COMPONENTS MUST BE WORN IN CONJUNCTION WITH THIS LIQUID SPLASH-PROTECTIVE [insert the term GARMENT, GLOVE, FOOTWEAR, or ENSEMBLE here]:
[List detachable components here.]"

5.1.1.12 Detachable components specified in 5.1.1.11 shall meet the label requirements specified in ASTM F1301, *Standard Practice for Labeling Chemical Protective Clothing*. The label shall also meet the requirements of 5.1.1.1 through 5.1.1.8.

5.1.2 Garment Element and Item Compliance Statements.

5.1.2.1 Each liquid splash-protective garment shall have at least the following compliance statements and information on the product label:

"THIS LIQUID SPLASH-PROTECTIVE GARMENT MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2018 EDITION, AND FOR THE ADDITIONAL REQUIREMENTS IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR ESCAPE ONLY IN THE EVENT OF A CHEMICAL FLASH FIRE		
CLAIM OF OPTIONAL BREATHABILITY FOR GARMENT MATERIALS		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS GARMENT IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL."

5.1.2.2 Where the garment does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the garment does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

N 5.1.2.3 For garments where the integrity of the interfaces between the respirator and hood or suit, between gloves and garment sleeves, and between the footwear and garment legs has not been evaluated as specified in 7.4.1 or 7.5.1, the following warning shall be provided as part of the product label:

"WARNING
THE INTEGRITY OF THE FOLLOWING INTERFACES OF THIS GARMENT WITH THE RESPIRATOR, GLOVES, AND FOOTWEAR HAS NOT BEEN EVALUATED ACCORDING TO THE REQUIREMENTS OF NFPA 1992. USE OF THIS GARMENT IN A LIQUID EXPOSURE ENVIRONMENT MAY RESULT IN LIQUID PENETRATION THROUGH THESE INTERFACES."

N 5.1.2.4 Where the garment is represented as providing the optional breathability above the basic requirements of this standard, the YES box shall be marked. Where the garment ensemble is not represented as providing the optional breathability above the basic requirements of this standard, the NO box shall be marked.

5.1.3 Glove Element and Item Compliance Statements.

5.1.3.1 Each liquid splash-protective glove shall have at least the following compliance statements and information on the product label:

“THIS LIQUID SPLASH-PROTECTIVE GLOVE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2018 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR <i>ESCAPE ONLY</i> IN THE EVENT OF A CHEMICAL FLASH FIRE		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS GLOVE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL.”

5.1.3.2 Where the glove does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the glove does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

5.1.3.3 Each liquid splash-protective glove shall be permitted to have the labeling information specified in 5.1.3.1 and 5.1.3.2 placed on the package label, and the statement in either 5.1.3.3.1 or 5.1.3.3.2, as applicable, shall be directly printed, embossed, or attached to each glove in lettering at least 2.5 mm ($\frac{3}{32}$ in.) high.

5.1.3.3.1 Where the glove is not compliant with the optional limited chemical flash fire protection above the basic requirements of this standard, the following statement shall be used:

“MEETS NFPA 1992 (2018 ed.)”

5.1.3.3.2 Where the glove is compliant with the optional limited chemical flash fire protection above the basic requirements of this standard, the following statement shall be used:

“MEETS NFPA 1992 (2018 ed.), FLASH FIRE ESCAPE PROTECTION”

5.1.4 Footwear Element and Item Compliance Statements.

5.1.4.1 Each liquid splash-protective footwear piece shall have at least the following compliance statements and information on the product label:

“THIS LIQUID SPLASH-PROTECTIVE FOOTWEAR MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2018 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR <i>ESCAPE ONLY</i> IN THE EVENT OF A CHEMICAL FLASH FIRE		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS FOOTWEAR IS CERTIFIED. CONSULT TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL.”

5.1.4.2 Where the footwear does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the footwear does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

5.1.5 Nonencapsulating Ensemble Compliance Statements.

5.1.5.1 Each nonencapsulating liquid splash-protective ensemble shall have at least the following compliance statements and information on the product label:

“THIS NONENCAPSULATING LIQUID SPLASH-PROTECTIVE ENSEMBLE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2018 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR <i>ESCAPE ONLY</i> IN THE EVENT OF A CHEMICAL FLASH FIRE		
CLAIM OF OPTIONAL BREATHABILITY FOR GARMENT MATERIALS		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS NONENCAPSULATING ENSEMBLE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL.”

5.1.5.2 Where the nonencapsulating ensemble does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the nonencapsulating ensemble does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

N 5.1.5.3 Where the manufacturer specifies outer boot footwear element options as permitted in 6.4.4.2, the following additional language shall be provided as part of the product label:

OUTER BOOT FOOTWEAR OPTIONS WORN WITH THIS ENSEMBLE MUST MEASURE AT LEAST 200 MM (8 IN.) HIGH AND BE CERTIFIED TO NFPA 1951, 1971, 1991, 1992, or 1994.

N 5.1.5.4 Where the garment is represented as providing the optional breathability above the basic requirements of this standard, the YES box shall be marked. Where the garment ensemble is not represented as providing the optional breathability above the basic requirements of this standard, the NO box shall be marked.

5.1.6 Encapsulating Ensemble Compliance Statements.

5.1.6.1 Each encapsulating liquid splash-protective ensemble shall have at least the following compliance statements and information on the product label:

“THIS ENCAPSULATING LIQUID SPLASH-PROTECTIVE ENSEMBLE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2018 EDITION, AND FOR THE ADDITIONAL REQUIREMENTS IF INDICATED BELOW.

ADDITIONAL REQUIREMENTS	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR ESCAPE ONLY IN THE EVENT OF A CHEMICAL FLASH FIRE		
CLAIM OF OPTIONAL BREATHABILITY FOR GARMENT MATERIALS		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS ENCAPSULATING ENSEMBLE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL.”

5.1.6.2 Where the encapsulating ensemble does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the encapsulating ensemble does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

N 5.1.6.3 Where the manufacturer specifies outer boot footwear element options as permitted in 6.5.5.2, the following additional language shall be provided as part of the product label:

OUTER BOOT FOOTWEAR OPTIONS WORN WITH THIS ENSEMBLE MUST MEASURE AT LEAST 200 MM (8 IN.) HIGH AND BE CERTIFIED TO NFPA 1951, 1971, 1991, 1992, or 1994.

N 5.1.6.4 Where the garment is represented as providing the optional breathability above the basic requirements of this standard, the YES box shall be marked. Where the garment ensemble is not represented as providing the optional breathability above the basic requirements of this standard, the NO box shall be marked.

N 5.1.7 Hood Element and Item Compliance Statements.

N 5.1.7.1 Each liquid splash-protective hood shall have at least the following compliance statements and information on the product label:

“THIS LIQUID SPLASH-PROTECTIVE HOOD MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2018 EDITION, AND FOR THE ADDITIONAL REQUIREMENTS IF INDICATED BELOW.

ADDITIONAL REQUIREMENTS	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR ESCAPE ONLY IN THE EVENT OF A CHEMICAL FLASH FIRE		
CLAIM OF OPTIONAL BREATHABILITY FOR GARMENT MATERIALS		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS HOOD IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL.”

N 5.1.7.2 Where the garment is represented as providing the optional breathability above the basic requirements of this standard, the YES box shall be marked. Where the garment ensemble is not represented as providing the optional breathability above the basic requirements of this standard, the NO box shall be marked.

5.2* User Information.

5.2.1 The manufacturer shall provide user information including, but not limited to, warnings, information, and instructions with each individual protective clothing item or each ensemble.

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

5.2.3 The manufacturer shall provide at least the following instructions and information with each liquid splash-protective clothing item or ensemble:

- (1) Pre-use information:
 - (a) Safety considerations
 - (b) Limitations of use
 - (c) Clothing or element marking recommendations and restrictions
 - (d) A statement that most performance properties of the liquid splash-protective clothing item or ensemble cannot be tested by the user in the field
 - (e) Closure lubricants, if applicable
 - (f) Visor antifog agents or procedures, if applicable
 - (g) Recommended undergarments
 - (h) Storage life, storage conditions, and storage practices

- (i) Warranty information
- (j) Specific warning for nonencapsulated ensembles that the respiratory equipment has not been evaluated for chemical permeation resistance consistent with the other ensemble elements
- (k) Specific warning to not use tape as a means for creating interfaces between ensemble elements
- (l) Inspection frequency and details
- (2) Preparation for use:
 - (a) Sizing/adjustment
 - (b) Recommended storage practices
- (3) Inspection frequency and details
- (4) Don/doff:
 - (a) Donning and doffing procedures
 - (b) Sizing and adjustment procedures
 - (c) Interface attachment
 - (d) Specific procedures for ensuring that the interface between the respiratory equipment and liquid splash-protective suits is maintained during use, if applicable
- (5) Proper use consistent with NFPA 1500 and 29 CFR 1910.132
- (6) Maintenance and cleaning:
 - (a) Cleaning instructions and precautions with a statement advising users not to use ensembles, elements, or clothing items 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
- (7) Retirement and disposal criteria and consideration
- (8) Make and model of respirator used to achieve compliance with the requirements of this standard if a respirator is required to be worn with the ensemble or clothing item to meet the requirements of the standard
- (9) Removal and reinsertion of hand from gloves
- (10) Removal and replacement of gloves and other user-replaceable components

5.2.4 The manufacturer shall state the storage life for each liquid splash-protective ensemble, element, or clothing item.

5.3 Technical Data Package.

5.3.1* The manufacturer shall furnish a technical data package for the protective ensemble, element, or clothing item upon the request of the purchaser.

5.3.2* The technical data package shall contain all documentation required by this standard and the values obtained from the initial certification showing compliance with the requirements of Chapter 7 in the current edition of this standard, using the reporting formats provided in Table 5.3.2(a) and Table 5.3.2(b) for each ensemble, element, material, or component, as applicable.

N 5.3.2.1 The technical data package information shall indicate “Pass” for those requirements where there is no quantitative value reported and “Not applicable” for specific requirements that do not apply to the liquid splash-protective ensemble.

N 5.3.2.2 The manufacturer shall be permitted to make modifications in the tabular format to accommodate specific product

features or additional materials as applicable to the certified product.

5.3.3 In the technical data package, the manufacturer shall describe the clothing item, element, or ensemble in terms of manufacturer trade name and model number, manufacturer replaceable components, and available options.

5.3.4* Descriptions of sizes shall include the range in height and weight for persons fitting each particular size, for garments, or sizes specific in Chapter 6, Design Requirements, for gloves and footwear, and shall provide information to the wearer as to whether these sizes apply to persons wearing SCBA, hardhats, communications devices, fire-fighting protective clothing, and other similar gear.

5.3.5 Garment Material and Component Descriptions.

5.3.5.1 When specific clothing items or equipment are required for certifying the ensemble, element, or clothing item to this standard, the manufacturer shall list these clothing items or equipment in the technical data package.

5.3.5.2 The manufacturer shall provide, in the technical data package, the list and descriptions of the following ensemble materials and components, if applicable:

- (1) Garment material
- (2) Visor material
- (3) Glove material and type of attachment
- (4) Footwear material and type of attachment
- (5) Hood material
- (6) Zipper/closure type and materials
- (7) Material seam types and composition
- (8) Exhaust valve types and material(s)
- (9) External fitting types and material(s)
- (10) External gasket types and material(s)
- (11) Outer garment, glove, or boot material(s)
- (12) Type or style of head protection accommodated within the suit
- (13) Interface materials

5.3.5.3 All descriptions of material composition shall specify either the generic material names or trade names if the composition of the material is proprietary.

5.3.5.4 Descriptions of respective suit materials and components shall include the following information, if applicable:

- (1) Visor material: The availability of any permanent detachable covers and films
- (2) Gloves:
 - (a) Type of linings or surface treatments
 - (b) Available glove sizes
- (3) Footwear:
 - (a) Type of linings or surface treatments
 - (b) Type of soles or special toe reinforcements
 - (c) Available footwear sizes
- (4) Garment zipper or closure:
 - (a) The material(s) of construction for the closure (including chain, slide, pull, and tape for zippers)
 - (b) The location and the length of the completed closure assembly
 - (c) A description of any protective covers for flaps
- (5) Other clothing items (e.g., outer garments): Type and how used with protective suit

N Table 5.3.2(a) Format for Reporting Certification Test Data in Technical Data Package

Ensemble or Element	Performance Requirement	Test Method	Requirement	Result
<i>Base Requirements</i>				
Nonencapsulating Ensemble or Encapsulating Ensemble Garment (or hood)	Liquidtight integrity	ASTM F1359/F1359M with modifications (Section 8.2)	No liquid penetration	
	Overall garment function and integrity	ASTM F1154 (Section 8.3)	Complete all tasks within 15 minutes No liquid penetration Accommodates head protection devices meeting ANSI/ISEA Z89.1 (Type 1, Class G) Test subject has visual acuity of 20/35 or better through visor and facepiece lens Protective flap remains closed over closure system Test subject properly identifies 3 out of 4 numbers on NFPA 704 placard at each angle	
Garment (or hood) material	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
	Burst strength	ASTM D751 (Section 8.8)	Strength ≥ 135 N	
	Puncture propagation tear resistance	ASTM D2582 (Section 8.6)	Tear resistance ≥ 25 N	
	Cold temperature performance	ASTM D747 (Section 8.7)	Bending moment ≤ 0.057 N·m	
Garment (or hood) visor	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
Garment (or hood) seam	Visor high-mass impact resistance	ANSI Z87.1, Section 9.11 (Section 8.9)	No full-thickness cracks, holes, or fractures	
	Chemical penetration resistance test	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
	Seam breaking strength	ASTM D751 (Section 8.8)	Strength ≥ 33 N/25 mm	
Garment (or hood) closure	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
	Closure breaking strength	ASTM D751 (Section 8.8)	Strength ≥ 33 N/25 mm	
Interface material	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
	Cut resistance	ASTM F1790 (Section 8.11)	Blade travel distance ≥ 20 mm at 50 g	
	Puncture resistance	ASTM F1342/F1342M, Method A (Section 8.12)	Puncture force ≥ 7 N	
	Ultimate tensile strength	ASTM D412 (Section 8.22)	Strength ≥ 4 MPa	
Gloves	Liquidtight integrity	ASTM D5151 with modifications (Section 8.10)	No leakage	
	Gloved hand dexterity	ASTM F2010/F2010M (Section 8.13)	Percent increase over barehanded control $\leq 200\%$	

(continues)

N Table 5.3.2(a) *Continued*

Ensemble or Element	Performance Requirement	Test Method	Requirement	Result
Glove material	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
	Cut resistance	ASTM F1790 (Section 8.11)	Blade travel distance ≥ 20 mm at 50 g	
	Puncture resistance	ASTM F1342/F1342M, Method A (Section 8.12)	Puncture force ≥ 11 N	
	Cold temperature performance	ASTM D747 (Section 8.7)	Bending moment ≤ 0.057 N·m	
Glove material seams	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
Footwear	Liquidtight integrity	ASTM D5151 with modifications (Section 8.10)	No leakage	
	Toe impact and compression resistance; sole puncture resistance	ASTM F2412	Footwear meets toe	
	Slip resistance	ASTM F2913 (Section 8.16)	Coefficient ≥ 0.40	
Footwear upper materials	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
	Cut resistance	ASTM F1790 (Section 8.11)	Blade travel distance ≥ 20 mm at 350 g	
	Puncture resistance	ASTM F1342/F1342M, Method A (Section 8.12)	Puncture force ≥ 36 N	
Footwear upper material seams	Chemical penetration resistance	ASTM F903 (Section 8.4)	No penetration for at least 1 hour for each of the specified chemicals	See separate table
Footwear sole and heels	Abrasion resistance	ISO 4649, Method A (Section 8.14)	Relative volume loss ≤ 250 mm ³	
Footwear ladder shanks	Bending resistance	Section 8.15	Deflection ≤ 6 mm	
Optional Flash Fire Requirements				
Ensemble	Overall ensemble flash protection	Section 8.17	Afterflame times ≤ 2 seconds	
Garment material	Heat transfer performance	ASTM F2700 (Section 8.18)	No liquid penetration Test subject has visual acuity of 20/35 or better through visor and facepiece lens	HTP rating ≥ 12 cal/cm ²
	Flame resistance	ASTM F1358 (Section 8.19)	Afterflame time ≤ 2 seconds	
Visor material	Heat transfer performance	ASTM F2700 (Section 8.18)	Burn distance ≤ 100 mm No melting or dripping	Average HTP rating ≥ 12 cal/cm ²
	Flame resistance	ASTM F1358 (Section 8.19)	Afterflame time ≤ 2 seconds	
Glove material	Heat transfer performance	ASTM F2700 (Section 8.18)	Burn distance ≤ 100 mm No melting or dripping	Average HTP rating ≥ 12 cal/cm ²
	Flame resistance	ASTM F1358 (Section 8.19)	Afterflame time ≤ 2 seconds	
			Burn distance ≤ 100 mm	

(continues)

N Table 5.3.2(a) *Continued*

Ensemble or Element	Performance Requirement	Test Method	Requirement	Result
Footwear material	Heat transfer performance Flame resistance	ASTM F2700 (Section 8.18) ASTM F1358 (Section 8.19)	No melting or dripping Average HTP rating ≥ 12 cal/cm ² Afterflame time ≤ 2 seconds	
Interface material	Heat transfer performance Flame resistance	ASTM F2700 (Section 8.18) ASTM F1358 (Section 8.19)	Burn distance ≤ 100 mm No melting or dripping Average HTP rating ≥ 12 cal/cm ² Afterflame time ≤ 2 seconds Burn distance ≤ 100 mm No melting or dripping	
Optional Breathability Claim				
Garment (or hood) material	Total heat loss	ASTM F1868, Method C (Section 8.20)	Total heat loss (Report only)	
	Evaporative resistance	ASTM F1868, Method B (Section 8.25)	Apparent intrinsic evaporative resistance (Report only) Intrinsic thermal resistance (Report only) Evaporative resistance (Report only)	

N Table 5.3.2(b) **Format for Reporting Certification Penetration Test Data in Technical Data Package**

Chemical (concentration)	Minimum Requirement*	Garment Material	Garment Visor	Garment Seam	Garment Closure	Interface Material	Glove Material	Footwear Upper Material	Hood Material
Butyl acetate, CAS No. 123-86-4, > 95%	Pass								
Dimethylformamide, CAS No. 68-12-2, > 95%	Pass								
Fuel H (42.5% toluene, 42.5% isooctane, 15% ethanol mixture, v/v)	Pass								
Isopropyl alcohol, CAS No. 67-63-0, > 91%	Pass								
Methyl isobutyl ketone, CAS No. 108-10-1, > 95%	Pass								
Nitrobenzene, CAS No. 98-95-3, > 95%	Pass								
Sodium hydroxide, CAS No. 1310-73-2, 50%	Pass								
Sodium hypochlorite, 10%	Pass								
Sulfuric acid, CAS No. 7664-93-9, 93.1%	Pass								
Tetrachloroethylene, CAS No. 127-18-4, > 95%	Pass								

Note: Shaded areas indicate no requirement for testing.

*A pass result indicates no liquid penetration through the tested specimens after a 1-hour exposure with 1-minute of the exposure at 7.8 kPa hydrostatic pressure.

5.3.5.5 The manufacturer shall describe, in the technical data package, the type of seams or methods of attachment for the following garment material and component combinations, if applicable:

- (1) Garment material–garment material
- (2) Garment material–visor
- (3) Garment material–glove
- (4) Garment material–footwear
- (5) Garment material–garment closure
- (6) Outer cover–outer cover
- (7) Hood material–visor material
- (8) Hood material–hood material
- (9) Hood material–garment materials
- (10) Sock material–garment material (if the sock material is different from the garment material)

Chapter 6 Design Requirements

6.1 Protective Garment Elements and Items Design Requirements.

6.1.1 Liquid splash–protective garments shall be designed and configured to protect the wearer's torso, arms, and legs.

Δ 6.1.2 Where used, an attached hood shall be designed and configured to protect the wearer's head and neck, but shall be permitted to exclude the face.

6.1.3 Where used, socks shall be designed as an extension of the garment leg or as a separate item and shall cover the entire foot and ankle.

6.1.4 Liquid splash–protective garments shall be offered in at least four unique and different sizes.

6.1.5 All external fittings shall be free of rough spots, burrs, or sharp edges that could tear primary materials.

6.1.6* Where the manufacturer designates a suit as “breathable,” the garment and hood (if applicable) composite(s) total heat loss shall be measured as specified in Section 8.20, Total Heat Loss Test, the garment and hood (if applicable) composite(s)'s evaporative resistance shall be measured as specified in Section 8.23, Evaporative Resistance Test, the results for total heat loss and evaporative resistance shall be provided in the technical data package, and the additional language regarding suit breathability shall be printed on the product label as required by 5.1.2.3, 5.1.5.3, and 5.1.6.3.

6.2 Protective Glove Elements and Items Design Requirements.

6.2.1 Liquid splash–protective gloves shall be designed and configured to protect the wearer's hands and wrists.

Δ 6.2.2 Gloves shall provide protection to at least 12 in. from the fingertips.

Δ 6.2.3 To label or otherwise represent a glove that meets the requirements of this standard, the manufacturer shall provide gloves in not less than five separate and distinct sizes.

6.2.4 Where ensemble gloves are designed for removal, the interface of the glove to the liquid splash–protective garment sleeve shall be designed to permit removal and replacement of the gloves attached to each sleeve within a 30-minute period.

6.2.5 All external hardware and fittings shall be free of rough spots, burrs, or sharp edges that could tear materials.

6.3 Protective Footwear Elements and Items Design Requirements.

6.3.1 Protective footwear shall be designed and configured to provide protection to the feet, ankles, and lower legs.

6.3.2 Footwear shall provide protection not less than 200 mm (8 in.) in height when measured from the plane of the sole bottom.

6.3.3 Protective footwear shall be constructed using primary material that shall provide the protection from chemical and physical hazards.

6.3.3.1 The primary material shall include the chemical-protective layer that can be configured as a separate layer or as a composite.

6.3.3.2 The chemical-protective layer shall be designed to provide penetration resistance to liquid chemical splash.

6.3.3.3 The chemical-protective layer shall be considered as primary material and shall be permitted to be configured as a separate layer or as a composite with other primary materials.

6.3.3.4 The chemical-protective layer shall be permitted to depend on the other primary material to provide the physical protection.

6.3.4 Protective footwear shall be permitted to be constructed using an outer boot designed to be worn over the primary footwear or sock where such additional footwear components are necessary to meet the footwear requirements of this standard.

Δ 6.3.5 Socks shall cover the entire foot and ankle and shall provide protection when worn in conjunction with an outer boot.

6.3.6 Heel breast shall not be less than 13 mm (½ in.) nor be more than 25 mm (1 in.).

6.3.7 Protective footwear shall be offered in at least six unique and different sizes.

6.3.8 All external hardware and fittings shall be free of rough spots, burrs, or sharp edges that could tear materials.

6.3.9 Metal parts shall not penetrate from the outside into the lining or insole at any point.

6.3.10 No metal parts, including but not limited to nails or screws, shall be present or utilized in the construction or attachment of the sole (with heel) to the puncture-resistant device, insole, or upper.

6.4 Nonencapsulating Ensemble Design Requirements.

6.4.1 Nonencapsulating protective ensembles shall be designed and configured to protect the wearer's torso, head, arms, legs, hands, and feet and shall completely enclose the wearer but shall not completely enclose the wearer's respirator.

Δ 6.4.1.1 Nonencapsulating ensembles shall be designed to accommodate the respirator(s) specified by the manufacturer for the specific ensemble.

Δ 6.4.1.2 All respirators specified by the ensemble manufacturer shall be certified by the National Institute for Occupational Safety and Health (NIOSH) as compliant with the *Statement of*

Standard for NIOSH CBRN SCBA Testing, the Statement of Standard for NIOSH CBRN APR Testing, or the Statement of Standard for NIOSH CBRN PAPR Testing.

- N 6.4.1.3*** The interface and integration of the selected respirator with the protective ensemble shall not invalidate the NIOSH certification of the respirator.

6.4.2 Garment elements of nonencapsulating ensembles shall meet the design requirements specified in Section 6.1, Protective Garment Elements and Items Design Requirements.

6.4.3 Glove elements of nonencapsulating ensembles shall meet the design requirements specified in Section 6.2, Protective Glove Elements and Items Design Requirements.

6.4.3.1 Where inner gloves are used as part of the nonencapsulating protective ensemble, the manufacturer shall specify types of compliant outer gloves that provide the performance requirements for gloves specified in 7.2.3, 7.2.4, and 7.2.5.

6.4.4 Footwear elements of nonencapsulating ensembles shall meet the design requirements specified in Section 6.3, Protective Footwear Elements and Items Design Requirements.

6.4.4.1 Where socks are used as part of a nonencapsulating protective ensemble, the manufacturer shall specify types of compliant outer footwear that provide the performance requirements for footwear specified in 7.3.3 through 7.3.7, and 7.3.9.

- N 6.4.4.2** Where socks are used as part of a nonencapsulating protective ensemble, the manufacturer shall permit the use of any NFPA 1992 footwear element, or any outer boot of the footwear element that is certified to NFPA 1951, NFPA 1971, NFPA 1991, or NFPA 1994, that also meets the minimum height requirement specified in 6.3.2.

- N 6.4.4.3** If the manufacturer chooses to provide open choices of footwear as permitted in 6.4.4.2, then the product label shall have an additional warning as stipulated in 5.1.5.3.

- N 6.4.5*** The application of separate tape shall not be permitted in the design of ensemble interfaces with the exception of tape that is permanently applied in the creation of the ensemble.

6.5 Encapsulating Ensemble Design Requirements.

6.5.1 Encapsulating protective ensembles shall be designed and configured to protect the wearer's torso, head, arms, legs, hands, feet, and SCBA and shall completely enclose the wearer and the wearer's SCBA.

6.5.2 Garment elements of encapsulating ensembles shall meet the design requirements specified in Section 6.1, Protective Garment Elements and Items Design Requirements.

6.5.3 Encapsulating ensembles shall include an integral hood with visor and shall include attached gloves and attached footwear or footwear consisting of an attached sock and separate outer boot.

6.5.4 Glove elements of encapsulating ensembles shall meet the design requirements specified in Section 6.2, Protective Glove Elements and Items Design Requirements.

6.5.4.1 Attached gloves shall be permitted to be inner gloves.

6.5.4.2 Where inner gloves are used as part of the encapsulating protective ensemble, the manufacturer shall specify types of

compliant outer gloves that provide the performance requirements for gloves specified in 7.2.3, 7.2.4, and 7.2.5.

6.5.5 Footwear elements of encapsulating ensembles shall meet the design requirements specified in Section 6.3, Protective Footwear Elements and Items Design Requirements.

6.5.5.1 Where socks are used as part of an encapsulating protective ensemble, the manufacturer shall permit the use of any NFPA 1992 footwear element, or any outer boot of the footwear element that is certified to NFPA 1951, NFPA 1971, NFPA 1991, or NFPA 1994, that also meets the minimum height requirement specified in 6.3.2.

6.5.5.2 If the manufacturer chooses to provide open choices of footwear as permitted in 6.5.5.1, then the product label shall have an additional warning as stipulated in 5.1.6.3.

- N 6.5.6*** The application of separate tape shall not be permitted in the design of ensemble interfaces with the exception of tape that is permanently applied in the creation of the ensemble.

6.6 Optional Chemical Flash Fire Protection Design Requirements.

- N 6.6.1** Where liquid splash-protective ensembles or elements rely on external clothing items or multiple layers to meet the performance requirements in Section 7.6, Optional Chemical Flash Fire Protection Performance Requirements, the ensemble or elements shall be designed so that all layers or separate parts are securely attached and provided as a single and integrated unit.

- N 6.6.2** Liquid splash-protective ensembles shall be tested with the glove and footwear elements specified by the manufacturer, which are also listed on the product label as required in 5.1.1.11.

N 6.7 Protective Hood Elements and Item Design Requirements.

- N 6.7.1** Liquid splash-protective hoods shall be designed and configured to protect the wearer's head and neck.

- N 6.7.1.1** Liquid splash-protective hoods shall be permitted to include a visor.

- N 6.7.1.2** Liquid splash-protective hoods shall be permitted to have a face opening that provides an interface with a specific respirator facepiece.

- N 6.7.1.2.1** Liquid splash-protective hoods that include a respirator interface shall be designed to accommodate the respirator(s) specified by the manufacturer for the specific hood.

- N 6.7.1.2.2** All respirators specified by the hood manufacturer shall be certified by the National Institute for Occupational Safety and Health (NIOSH) as compliant with the *Statement of Standard for NIOSH CBRN SCBA Testing*, the *Statement of Standard for NIOSH CBRN APR Testing*, or the *Statement of Standard for NIOSH CBRN PAPR Testing*.

- N 6.7.1.2.3** All respirators shall cover the eyes, nose, and mouth at a minimum.

- N 6.7.1.3** The interface and integration of the selected respirator with the protective hood shall not invalidate the NIOSH certification of the respirator.

- N 6.7.2*** Where loose-fitting facepiece powered air-purifying respirators (PAPR) are used as part of a nonencapsulating

ensemble as specified by the manufacturer, the hood portion of the PAPR shall be considered a hood under this standard.

N 6.7.2.1 The hood portion of the PAPR shall be subject to the performance criteria specified in Section 7.7.

N 6.7.2.2 The PAPR shall be certified by the National Institute for Occupational Safety and Health (NIOSH) as compliant with the *Statement of Standard for NIOSH CBRN PAPR Testing*.

N 6.7.3 All external fittings shall be free of rough spots, burrs, or sharp edges that could tear primary materials.

Chapter 7 Performance Requirements

7.1 Protective Garment Elements and Items Performance Requirements.

7.1.1 Garments shall be tested for overall function and integrity as specified in Section 8.3, Overall Garment Function and Integrity Test, and shall allow the test subject to complete all tasks within 15 minutes, and shall allow no liquid penetration in subsequent liquidtight integrity testing as specified in Section 8.2, Liquidtight Integrity Test 1, and the garment closure shall remain engaged during the entire garment function testing.

7.1.1.1 Where hoods are provided, garments shall accommodate head protection devices meeting the dimensional requirements for Type I, Class G helmets of ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection*.

7.1.1.2 Where hoods with visors are provided, garments shall permit the test subject to see with a visual acuity of 20/35 or better through the combination of both the hood visor and the respirator facepiece lens.

7.1.1.3 Where a protective flap is used over the closure system, it shall remain closed for the duration of the overall garment function test.

N 7.1.1.4 Where an encapsulated design is used, it shall permit the test subject to remove and reinsert his or her hand into the glove system 5 times sequentially within 2.5 minutes or less.

N 7.1.1.5 Where the garment includes a hood with a visor that covers the respirator facepiece, the garment shall permit the test subject to properly identify 3 out of 4 numbers on an NFPA 704-based placard at each of the following angles: upward 36°, downward 30°, and right and left 60°.

Δ 7.1.2 Garment materials shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

7.1.3 Garment materials shall be tested for bursting strength as specified in Section 8.5, Burst Strength Test, and shall have a bursting strength of not less than 135 N (30 lbf).

7.1.4 Garment materials shall be tested for puncture propagation tear resistance as specified in Section 8.6, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 25 N (5.6 lbf).

7.1.5 Garment materials shall be tested for cold weather performance as specified in Section 8.7, Cold Temperature

Performance Test 1, and shall have a bending moment of not greater than 0.057 N·m (0.50 in.·lbf) at an angular deflection of 60 degrees and -25°C (-13°F).

7.1.6 Garment Visor Requirements.

7.1.6.1 Where provided, visor materials shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and for each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

7.1.6.2 Where provided, visor materials shall be tested for high-mass impact resistance as specified in Section 8.9, Visor High-Mass Impact Resistance Test, and shall not have full-thickness cracks, holes, or fractures.

7.1.7 Garment Seam Requirements.

7.1.7.1 Garment seams, and other seams to the garment where present, shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

7.1.7.2 Garment seams, and other seams to the garment where present, shall be tested for seam strength as specified in Section 8.8, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 33 N/25 mm (7.5 lbf/1 in.).

7.1.8 Garment Closure Assembly Requirements.

7.1.8.1 Where garment closures are not fully covered by a protective flap that is constructed of the same material as the garment, garment closure assemblies shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

7.1.8.2 Garment closure assemblies shall be tested for closure strength as specified in Section 8.8, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 33 N/25 mm (7.5 lbf/1 in.).

N 7.1.9 Elastomeric Interface Material Requirements.

N 7.1.9.1* Elastomeric interface materials shall have an elongation at rupture of not less than 125 percent when tested according to Section 8.21, Ultimate Tensile Strength Test.

N 7.1.9.2 Where the garment includes elastomeric interface materials, each elastomeric interface material shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

N 7.1.9.3 Where the garment includes elastomeric interface materials, each elastomeric interface material shall be tested for cut resistance as specified in Section 8.11, Cut Resistance Test, and shall have a blade travel distance of not less than 20 mm (0.8 in.).

N 7.1.9.4 Where the garment includes elastomeric interface materials, each elastomeric interface material shall be tested for puncture resistance as specified in Section 8.12, Puncture Resistance Test 1, and shall have a puncture resistance of not less than 7 N (1.6 lbf).

N 7.1.9.5 Where the garment includes elastomeric interface materials, each exposed elastomeric interface material shall be tested for ultimate tensile strength as specified in Section 8.21, Ultimate Tensile Strength Test, and shall have an ultimate tensile strength of not less than 4 MPa (580 psi).

N 7.1.9.6 Where the garment includes elastomeric interface materials, each elastomeric interface material shall be tested for cold weather performance as specified in Section 8.7, Cold Temperature Performance Test 1, and shall have a bending moment of not greater than 0.057 N·m (0.50 in·lbf) at an angular deflection of 60 degrees and -25°C (-13°F).

7.2 Protective Glove Elements and Items Performance Requirements.

7.2.1 Gloves shall be tested for liquidtight integrity as specified in Section 8.10, Liquidtight Integrity Test 2, and shall show no leakage.

Δ 7.2.2 Glove materials shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the glove.

7.2.3 Glove materials shall be tested for cut resistance as specified in Section 8.11, Cut Resistance Test, and shall have a blade travel distance of not less than 20 mm (0.8 in.).

7.2.4 Glove materials shall be tested for puncture resistance as specified in Section 8.12, Puncture Resistance Test 1, and shall have a puncture resistance of not less than 11 N (2.5 lbf).

7.2.5 Glove materials shall be tested for cold weather performance as specified in Section 8.7, Cold Temperature Performance Test 1, and shall have a bending moment of not greater than 0.057 N·m (0.50 in·lbf) at an angular deflection of 60 degrees and -25°C (-13°F).

7.2.6 Glove specimens shall be tested for hand function as specified in Section 8.13, Gloved Hand Dexterity Test, and shall have an average percent increase over barehanded control less than 200 percent.

7.2.7 Glove seams, if present, shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

7.3 Protective Footwear Elements and Items Performance Requirements.

7.3.1 Footwear shall be tested for liquidtight integrity as specified in Section 8.10, Liquidtight Integrity Test 2, and shall show no leakage.

Δ 7.3.2 Footwear upper materials shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and shall exhibit no

penetration for at least 1 hour for each additional chemical or specific chemical mixture for which the manufacturer is certifying the footwear.

7.3.3 Footwear upper materials shall be tested for cut resistance as specified in Section 8.11, Cut Resistance Test, and shall have a blade travel distance of not less than 20 mm (0.8 in.).

7.3.4 Footwear upper materials shall be tested for puncture resistance as specified in Section 8.12, Puncture Resistance Test 1, and shall have a puncture resistance of not less than 36 N (8 lbf).

7.3.5 Footwear sole and heels shall be tested for abrasion resistance as specified in Section 8.14, Abrasion Resistance Test, and the relative volume loss shall not be greater than 250 mm³.

7.3.6 Footwear ladder shanks shall be tested for bending resistance as specified in Section 8.15, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (¼ in.).

7.3.7 Footwear shall be tested for slip resistance as specified in Section 8.16, Slip Resistance Test, and shall have a coefficient of friction of 0.40 or greater.

7.3.8 Footwear upper seams, if present, shall be tested for penetration resistance as specified in Section 8.4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the specified chemicals and each additional chemical or specific chemical mixture for which the manufacturer is certifying the footwear.

N 7.3.9 Footwear shall meet the performance requirements specified in ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact, compression, and puncture-resistant footwear with the exception that flex resistance to cracking shall not be evaluated. Testing shall be performed as specified in ASTM F2412, *Standard Test Methods for Foot Protection*.

7.4 Nonencapsulating Protective Ensemble Performance Requirements.

Δ 7.4.1 Liquid splash-protective ensembles shall be tested for liquidtight integrity as specified by Section 8.2, Liquidtight Integrity Test 1, and shall allow no liquid penetration.

7.4.2 Garment elements of nonencapsulating ensembles shall meet the performance requirements specified in Section 7.1, Protective Garment Elements and Items Performance Requirements.

7.4.3 Glove elements of nonencapsulating ensembles shall meet the performance requirements specified in Section 7.2, Protective Glove Elements and Items Performance Requirements.

7.4.4 Footwear elements of nonencapsulating ensembles shall meet the performance requirements specified in Section 7.3, Protective Footwear Elements and Items Performance Requirements.

N 7.4.4.1 Where socks are used as part of a nonencapsulating protective ensemble and the manufacturer permits the use of any outer boot of the footwear element that is certified to NFPA 1951, NFPA 1971, NFPA 1991, or NFPA 1994, the outer boot of the footwear element shall meet the minimum height requirement specified in 6.3.2.

N 7.4.5 Where the ensemble includes installed external fittings, each type of external fitting shall be tested for pull-out strength as specified in Section 8.24, Fitting Pull-Out Strength Test, and shall not have a failure force of less than 1000 N (225 lbf).

N 7.4.6 Where the ensemble includes one or more exhaust valves, the exhaust valve shall be tested for mounting strength as specified in Section 8.25, Exhaust Valve Mounting Strength Test, and shall have a failure force greater than 135 N (30 lbf).

7.5 Encapsulating Protective Ensemble Performance Requirements.

7.5.1 Encapsulating liquid splash-protective ensembles, hoods with visors, gloves, and footwear shall be tested for liquidtight integrity as specified by Section 8.2, Liquidtight Integrity Test 1, and shall allow no liquid penetration.

7.5.2 Garment elements of encapsulating ensembles shall meet the performance requirements specified in Section 7.1, Protective Garment Elements and Items Performance Requirements.

7.5.3 Glove elements of encapsulating ensembles shall meet the performance requirements specified in Section 7.2, Protective Glove Elements and Items Performance Requirements.

7.5.4 Footwear elements of encapsulating ensembles shall meet the performance requirements specified in Section 7.3, Protective Footwear Elements and Items Performance Requirements.

N 7.5.4.1 Where socks are used as part of an encapsulating protective ensemble and the manufacturer permits the use of any outer boot of the footwear element that is certified to NFPA 1951, NFPA 1971, NFPA 1991, or NFPA 1994, the outer boot of the footwear element shall meet the minimum height requirement specified in 6.3.2.

N 7.5.5 Where the ensemble includes installed external fittings, each type of external fitting shall be tested for pull-out strength as specified in Section 8.24, Fitting Pull-Out Strength Test, and shall not have a failure force of less than 1000 N (225 lbf).

N 7.5.6 Where the ensemble includes one or more exhaust valves, the exhaust valve shall be tested for mounting strength as specified in Section 8.25, Exhaust Valve Mounting Strength Test, and shall have a failure force greater than 135 N (30 lbf).

7.6 Optional Chemical Flash Fire Escape Protection Performance Requirements.

7.6.1 Liquid splash-protective ensembles and ensemble elements shall also meet the applicable requirements specified in Sections 7.1 through 7.5.

Δ 7.6.2 Liquid splash-protective ensembles or elements shall be tested for overall flash protection as specified by Section 8.17, Overall Ensemble Flash Test, and shall show afterflame times no longer than 2 seconds; in subsequent testing of the ensemble shall allow no liquid penetration; and where a hood with visor is provided shall allow test subjects to have a visual acuity of 20/100.

7.6.3 Garment materials and, where applicable, visor, glove, footwear, and elastomeric interface materials shall be tested for heat transfer performance (HTP) as specified in Section 8.18, Heat Transfer Performance Test, and shall have an average HTP rating of not less than 12 cal/cm².

N 7.6.4 Garment materials and, where applicable, visor, glove, footwear, and elastomeric interface materials shall be tested for resistance to flame impingement as specified in Section 8.19, Flammability Resistance Test, and shall not burn a distance of greater than 100 mm (4 in.), shall not sustain burning for more than 2 seconds, and shall not melt and drip.

N 7.7 Protective Hood Elements and Item Performance Requirements.

N 7.7.1 Where a protective hood is provided as a separate element and is not attached to the garment, the protective hood shall meet all of the applicable requirements specified in Section 7.1.

Chapter 8 Test Methods

8.1 Sample Preparation Procedures.

8.1.1 Application.

8.1.1.1 The sample preparation procedures contained in Section 8.1 shall apply to each test method in this chapter, as specifically referenced in the sample section of each test method.

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

8.1.2 Room Temperature Conditioning Procedure.

8.1.2.1 Samples shall be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and a relative humidity of 65 percent, ±5 percent until equilibrium is reached or for at least 24 hours, whichever is shortest.

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

8.1.3 Flexural Fatigue Procedure for Garment Materials. Samples shall be subjected to flexural fatigue in accordance with ASTM F392, *Standard Practice for Conditioning of Flexible Barrier Materials for Flex Durability*, with the following modifications:

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

8.1.4 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 (3.5 lb) head weight shall be used.
- (3) The abradant shall be silicone carbide, ultrafine, 600 grit.
- (4) The sample shall be abraded for 25 continuous cycles.

8.1.5 Flexural Fatigue Procedure for Gloves. Sample gloves shall be subjected to one full cycle of dexterity testing in accordance with the procedures specified in Section 8.13, Gloved Hand Dexterity Test, of this standard.

8.1.6 Flexural Fatigue Procedure for Footwear. Sample footwear shall be subjected to 100,000 flexes in accordance with Appendix B of FIA Standard 1209, *Whole Shoe Flex*, with the following modifications:

- (1) Water shall not be used.
- (2) The flex speed shall be 60 cycles, ± 2 cycles per minute.
- (3) Alternative flexing equipment shall be permitted to be used when the flexing equipment meets the following parameters:
 - (a) Is capable of providing the angle of flex as described in FIA 1209
 - (b) Is capable of a flex speed of 60 cycles, ± 2 cycles per minute
 - (c) Provides a means of securing the footwear during flexing

8.1.7 Fatigue Procedure for Suit Closure Assemblies. Sample suit closure assemblies shall be exercised a total of 50 openings and 50 closings.

8.1.8 Dry Environment Conditioning Procedure for Garment and Glove Materials.

8.1.8.1 Samples shall be conditioned at a temperature of 24°C, $\pm 3^\circ\text{C}$ (75°F, $\pm 5^\circ\text{F}$) and a relative humidity of 45 percent ± 5 percent until equilibrium is reached, or for at least 24 hours, whichever is shortest.

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

8.2 Liquidtight Integrity Test 1.

8.2.1 Application.

8.2.1.1 This test method shall apply to garment elements, nonencapsulating ensembles, and encapsulating ensembles.

8.2.1.2 Modifications to this test method for testing nonencapsulating ensembles shall be as specified in 8.2.8.

8.2.1.3 Modifications to this test method for testing encapsulating ensembles shall be as specified in 8.2.9.

8.2.2 Samples.

8.2.2.1 Samples shall be complete garment elements or complete ensembles.

8.2.2.2 Samples shall be conditioned as specified in 8.1.2.

8.2.3 Specimens.

8.2.3.1 Specimens shall be complete garment elements or complete ensembles with all layers assembled that are required to be compliant.

8.2.3.2 At least three specimens shall be tested.

8.2.3.3 The size of the garment or ensemble comprising the specimens shall be chosen to conform with the dimensions of the manikin for proper fit of the specimen on the manikin in accordance with the manufacturer's sizing system. The size of the garments comprising the specimens or ensembles shall be the same as the manikin in terms of chest circumference, waist circumference, and inseam length.

Δ 8.2.4 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*.

Δ 8.2.5 Procedure. Liquidtight integrity testing of garments shall be conducted in accordance with Procedure A of 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)* No provisions for garments with a partial barrier layer shall be allowed.
- (2) The method used for mounting the manikin in the spray chamber shall not interfere with the water spray.
- (3) The suited manikin shall be exposed to the liquid spray for a total of 20 minutes, 5 minutes in each of the four specified manikin orientations.

8.2.6 Report. A diagram shall be prepared for each test that records and reports the locations of any liquid leakage as detected on the liquid-absorptive garment or visible within the garment.

8.2.7 Interpretation.

Δ 8.2.7.1 Evidence of liquid on the interior of ensembles or garment elements or on the liquid-absorptive garment as determined by visual, tactile, or absorbent toweling, shall constitute failure.

8.2.7.2 For glove and footwear parts of ensembles that consist of multiple separable layers, accumulation of liquid between any layers shall constitute failure.

8.2.8 Specific Requirements for Testing Nonencapsulating Ensembles.

8.2.8.1 Nonencapsulating ensembles shall be evaluated with each type of respirator for which the ensemble is certified.

8.2.8.2 Where encapsulating ensembles are tested, all areas of the manikin body shall be evaluated for liquidtight integrity.

8.2.8.3 The left arm of the manikin shall be positioned with the upper arm against the side of the manikin and the lower arm bent at the elbow upward at a 135-degree angle throughout the test duration.

N 8.2.8.4 The configuration and placement of the glove and sleeve interface shall be the same on both arms.

N 8.2.8.5 If outer gloves are worn in conjunction with gloves attached to the totally encapsulating ensemble or if outer boots are worn in conjunction with garment socks to meet foot protection requirements, these elements shall not collect liquid.

N 8.2.8.6 Where socks are used as part of the nonencapsulating protective ensemble, it shall be permitted that testing be performed on only one representative outer boot style for the evaluation of the ensemble.

N 8.2.9 Specific Requirements for Testing Encapsulating Ensembles.

N 8.2.9.1 Where encapsulating ensembles are tested, all areas of the manikin body shall be evaluated for liquidtight integrity.

N 8.2.9.2 The left arm of the manikin shall be positioned with the upper arm against the side of the manikin and the lower arm bent at the elbow upward at a 135-degree angle throughout the test duration.

N 8.2.9.3 The configuration and placement of the glove and sleeve interface shall be the same on both arms.

N 8.2.9.4 If outer gloves are worn in conjunction with gloves attached to the totally encapsulating ensemble or if outer boots are worn in conjunction with garment socks to meet foot protection requirements, these elements shall not collect liquid.

N 8.2.9.5 Where socks are used as part of the encapsulating protective ensemble, it shall be permitted that testing be performed on only one representative outer boot style for the evaluation of the ensemble.

8.3 Overall Garment Function and Integrity Test.

8.3.1 Application.

8.3.1.1 This test method shall apply to garments, hoods, nonencapsulating ensembles, and encapsulating ensembles.

N 8.3.1.2 Modifications for testing separate hood items shall be as specified in 8.3.8.

8.3.2 Samples.

8.3.2.1 Samples shall be complete garments or ensembles, including all outerwear and other items required to be compliant.

8.3.2.2 Samples shall be conditioned as specified in 8.1.2.

8.3.3 Specimens.

8.3.3.1 Specimens shall be complete garments or ensembles, including all outerwear and other items required to be compliant.

8.3.3.2 At least three specimens shall be tested.

N 8.3.3.3 Nonencapsulating ensembles or hoods that integrate with the facepiece of the respirator shall be tested with each type and model of the respirator specified by the manufacturer.

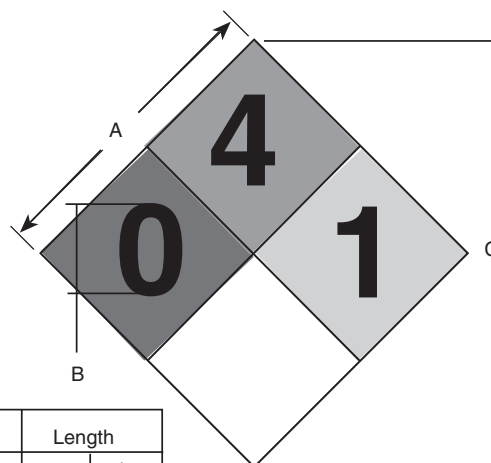
N 8.3.4 Apparatus. The equipment and supplies specified in ASTM F1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical Protective Suit Ensembles*, shall be used along with the following additional items:

- (1) A Snellen eye chart for a 6 m (20 ft) distance
- (2) A stopwatch or other timing device
- (3) A protractor or other device to measure the angle of the placard relative to the test subject
- (4) An NFPA 704-based placard as seen in Figure 8.3.4

8.3.5 Procedure.

Δ 8.3.5.1 Overall function and integrity shall be measured in accordance with ASTM F1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Durability of Protective Ensembles and Ensemble Components*, with the following parameters:

- (1) Both Exercise Procedures A and B, specified in ASTM F1154, shall be used.
- (2) Specimens to be tested shall meet the sizing range of the test subjects as determined in 5.3.4.
- (3) Specimens shall be donned in accordance with the manufacturer's instructions.
- (4) Testing shall be conducted at 25°C, ±6°C (77°F, ±10°F) and relative humidity of 50 percent, ±20 percent.
- (5) Liquidtight integrity shall be measured as specified in Section 8.2 after the exercise procedures are completed.



Measurement	Length	
	mm	in.
A	64	2.5
B	25	1
C	90	3.5

FIGURE 8.3.4 NFPA 704 Placard.

- (6) Where hoods are part of the garment or ensemble, or are evaluated as separate items, test subjects shall wear head protection devices meeting the dimensional requirements of Type 1, Class G helmets of ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection*, while performing exercise procedures.
- (7) Test subjects shall wear a full-body coverall and shall wear underclothing in accordance with the manufacturer's recommendation.
- (8) Where encapsulating ensembles are evaluated or the respirator is not otherwise specified, test subjects shall wear respirators that are certified as compliant with NFPA 1981 or NFPA 1986.
- (9) Where nonencapsulating ensembles are evaluated or hoods integrate with the facepiece of the respirator, test subjects shall wear the respirators specified by the manufacturer.

8.3.5.2 Where hoods with visors are provided as part of a garment or ensemble, or are evaluated as separate items, visual acuity testing shall be conducted using a standard 6.1 m (20 ft) eye chart with a normal lighting range of 100–150 ft-candles at the chart and with the test subject positioned at a distance of 6.1 m (20 ft) from the chart.

8.3.5.2.1 Test subjects shall have a minimum visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses or glasses, as determined in a visual acuity test or doctor's examination.

8.3.5.2.2 Test subjects shall then read the standard eye chart from within the ensemble through the combination of both the hood visor and the respirator facepiece lens to determine the test subject's visual acuity.

N 8.3.5.3 The field of vision for the test subject shall be assessed for the up, down, left, and right orientation angles used with the NFPA 704-based placard with random numbers between 0 and 4 in each of the quadrants. The placard shall be 2 m (6 ft) / +0/–0.1 m (0.3 ft) away from the eye of the test subject

and perpendicular to the field of view or line of sight being measured.

N 8.3.5.4 Where encapsulating ensembles are evaluated, at the end of testing the test subject shall be instructed to remove his or her hands from each of the gloves while still wearing the ensemble, touch the bypass valve of the SCBA, and then reinsert his or her hands into the gloves.

N 8.3.5.4.1 The test subject shall perform this action in accordance with the manufacturer's instructions. This action shall be sequentially repeated a total of five times.

N 8.3.5.4.2 The time for completing this action shall be timed using a stopwatch or other suitable timing device.

8.3.5.5 Where a protective flap is used over the closure system, the flap shall be observed to determine whether the flap remains over the closure during Exercise Procedures A and B.

8.3.5.5.1 Where closures are covered by a protective flap, the flap shall be inspected upon completion of the exercise procedures and before the specimen is doffed to determine if any portion of the flap has become disengaged.

8.3.5.5.2 The closures shall be inspected upon completion of the exercise procedures and before the specimen is doffed to determine if any portion of the closures has become disengaged.

8.3.6 Report.

8.3.6.1 A diagram shall be prepared for each test that records and reports the locations of any liquid leakage detected on the liquid-absorptive garment or on the inside of the specimens.

8.3.6.2 The length of time it takes for the test subjects to satisfactorily complete both exercise procedures shall be recorded and reported.

N 8.3.6.3 Where garments include hoods or separate hoods are evaluated, the ability of the test subject to wear head protection meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Protection*, shall be recorded and reported.

8.3.6.4 Where garments or hoods with visors are provided, the visual acuity of the test subject when in and out of the suit shall be recorded and reported.

N 8.3.6.5 Where garments or hoods with visors are provided, the angular degree for the up, down, left, and right defining the field of vision shall be measured and reported. The average angular degree for each direction for all test subjects shall be calculated and reported.

N 8.3.6.6 Where encapsulating ensembles are evaluated, the time for each test subject to repeatedly remove and reinsert his or her hands completely in the gloves five times sequentially shall be recorded and reported. The average time for all test subjects shall be calculated and reported.

8.3.6.7 Where closures are covered by a protective flap, any disengagement of the protective flap observed during the exercise procedures shall be recorded and reported.

8.3.6.8 Any disengagement of the closures observed after the exercise procedures shall be recorded and reported.

8.3.7 Interpretation.

8.3.7.1 Evidence of liquid on the absorbent manikin garment or inside the specimen as determined by visual, tactile, or absorbent toweling shall constitute failure.

8.3.7.1.1 Where encapsulating and nonencapsulating ensembles are tested, all areas of the manikin body shall be evaluated for liquidtight integrity.

8.3.7.1.2 Where garments or nonencapsulating ensembles are tested, those portions of the body not covered by the specimen shall not be evaluated for liquidtight integrity.

8.3.7.2 The inability of the test subjects to satisfactorily complete both exercise procedures within 15 minutes shall constitute failure.

N 8.3.7.3 Where garments include hoods or separate hoods are evaluated, the inability of the test subject to wear head protection meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Protection*, shall constitute failure.

8.3.7.4 Where hoods with visors are provided, the test subjects' inability to demonstrate visual acuity of 20/35 or better through the combination of both the hood visor and the respirator facepiece lens shall constitute failure.

N 8.3.7.5 Where garments or hoods with visors are provided, the average angular field of vision shall be used to determine pass or fail performance.

N 8.3.7.6 Where encapsulating ensembles are evaluated, the average time for all test subjects to repeatedly remove and reinsert their hands completely in the gloves five times sequentially shall be used to determine pass or fail performance.

8.3.7.7 Where closures are covered by a protective flap, any disengagement of the closure of the protective flap after the exercise sequences shall constitute failure.

8.3.7.8 Any disengagement of the closures after the exercise sequences shall constitute failure.

N 8.3.8 Specific Requirements for Testing Hoods.

N 8.3.8.1 Where hoods are evaluated as separate items and do not include a visor, the hoods shall only be evaluated for liquidtight integrity and their accommodation of head protection meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Protection*, without being worn as part of the Exercise Procedures A and B, specified in 8.3.5.1.

N 8.3.8.2 Where hoods are evaluated as separate items and include a visor, the hoods shall be evaluated for the following assessments without being worn as part of the Exercise Procedures A and B, as specified in 8.3.5:

- (1) Liquidtight integrity
- (2) Accommodation of head protection meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Protection*
- (3) Visual acuity
- (4) Field of vision

8.4 Chemical Penetration Resistance Test.

8.4.1 Application.

8.4.1.1 This test method shall apply to garment materials, garment seams, visor materials, glove materials, footwear materials, garment closure assemblies, hood materials, and elastomeric interface materials.

8.4.1.2 Modifications to this test method for testing visor materials without abrading or flexing shall be as specified in 8.4.7.

8.4.1.3 Modifications to this test method for testing garment materials after flexing and abrading shall be as specified in 8.4.8.

Δ 8.4.1.4 Modifications to this test method for testing glove materials after abrading shall be as specified in 8.4.9.

Δ 8.4.1.5 Modifications to this test method for testing footwear materials after abrading shall be as specified in 8.4.10.

8.4.1.6 Modifications to this test method for testing seams without flexing and abrading shall be as specified in 8.4.11.

N 8.4.1.7 Modifications to this test method for testing closure assemblies with fatigue shall be as specified in 8.4.12.

N 8.4.1.8 Modifications to this test method for testing hood materials after flexing and abrading shall be as specified in 8.4.13.

N 8.4.1.9 Modifications to this test method for testing elastomeric interface materials shall be as specified in 8.4.14.

8.4.2 Samples.

8.4.2.1* Samples shall be the chemical protection layer of the size specified in the modifications and any exterior layers if the exterior layers are integrated.

8.4.2.2 Samples shall be conditioned as specified in 8.1.2 after the conditioning specified in the modifications.

8.4.3 Specimens.

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

8.4.3.2 At least three specimens shall be tested per chemical.

8.4.4 Procedure.

Δ 8.4.4.1* Penetration testing shall be conducted against the following liquid chemicals with chemical abstract service (CAS) numbers, at the specified concentrations:

- (1) Butyl acetate, CAS No. 123-86-4, >95 percent, w/w
- (2) Dimethylformamide, CAS No. 68-12-2, >95 percent, w/w
- (3) Fuel H — surrogate gasoline (42.5 percent toluene, 42.5 percent isooctane, and 15 percent denatured ethanol, v/v), as defined in ASTM D471, *Standard Test Method for Rubber Property-Effect of Liquids*
- (4) Isopropyl alcohol, CAS No. 67-63-0, >91 percent, w/w
- (5) Methyl isobutyl ketone, CAS No. 108-10-1, >95 percent, w/w
- (6) Nitrobenzene, CAS No. 98-95-3, >95 percent, w/w
- (7) Sodium hydroxide, CAS No. 1310-73-2, 50 percent, w/w
- (8) Sodium hypochlorite, 10 percent (made within 72 hours of use), w/w

- (9) Sulfuric acid, CAS No. 7664-93-9, 93.1 percent, w/w
- (10) Tetrachloroethylene, CAS No. 127-18-4, >95 percent, w/w

8.4.4.2 Penetration resistance shall be measured in accordance with ASTM F903, *Standard Test Method for Resistance of Protective Clothing Materials 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) 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. 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 60-minute chemical contact period.

8.4.5 Report. The pass or fail results for each chemical tested and identification of location where penetration occurs, if discernible, shall be recorded and reported.

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

8.4.7 Specific Requirements for Testing Visor Materials. Samples for conditioning shall be visor material(s).

8.4.8 Specific Requirements for Testing Garment Materials After Flexing and Abrading.

8.4.8.1 Samples for conditioning shall be 200 mm × 280 mm (8 in. × 11 in.) rectangles.

8.4.8.2 Samples shall first be conditioned by flexing as specified in 8.1.3.

8.4.8.3 Following flexing, three samples for abrasion conditioning, each measuring 75 mm × 230 mm (3 in. × 9 in.), shall be cut from the center of the flexed sample.

8.4.8.4 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.

8.4.8.5 The new samples shall then be conditioned by abrading as specified in 8.1.4.

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

8.4.8.7 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.

8.4.9 Specific Requirements for Testing Glove Materials After Abrading.

8.4.9.1 Samples for conditioning shall be whole gloves or glove materials representative of glove construction.

8.4.9.2 A new sample shall be cut from the whole glove or glove material sample that measures 75 mm × 230 mm (3 in. × 9 in.). The new sample shall provide homogeneity across the entire area.

8.4.9.3 The new samples shall then be conditioned by abrading as specified in 8.1.4.

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

8.4.9.5 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.

8.4.10 Specific Requirements for Testing Footwear Materials After Abrading.

8.4.10.1 This test shall apply to all types of footwear configurations. If the footwear incorporates a sock constructed of garment material, the garment material penetration resistance test shall be permitted to be substituted for this test.

8.4.10.2 Samples for conditioning shall be whole footwear items or footwear materials representative of the footwear upper construction.

8.4.10.3 New samples shall be taken in areas from the footwear or footwear material measuring 75 mm × 230 mm (3 in. × 9 in.). An attempt shall be made to choose new samples from areas that are homogeneous.

8.4.10.4 The new samples shall then be conditioned by abrading as specified in 8.1.4.

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

8.4.10.6 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.

8.4.11 Specific Requirements for Testing Seams of Garments, Hoods, Gloves, or Footwear.

8.4.11.1 Samples for conditioning shall be 610 mm (24 in.) lengths of prepared seam or cut from ensembles or elements.

8.4.11.2 Seam specimens shall be prepared from seam samples that have a minimum of 75 mm (3 in.) of material on each side of the seam center.

8.4.11.3 Penetration test specimens shall be cut such that the exact seam center divides the specimen in half.

8.4.11.4 Seam specimens shall be prepared representative of the actual garment or hood construction or shall be taken from each different type of seam found in the garment or hood.

8.4.11.5* Glove seam specimens shall be prepared representative of the actual glove construction or shall be taken from each different type of seam found in the glove. Only the barrier layer(s) shall be included in the test.

8.4.11.6* Footwear seam specimens shall be prepared representative of the actual footwear construction or shall be taken from each different type of seam found in the footwear. Only the barrier layer(s) shall be included in the test.

N 8.4.11.7 Sample seams shall be evaluated against a subset of the chemicals specified in 8.4.4.1 that shall include the following:

- (1) Fuel H — surrogate gasoline (42.5 percent toluene, 42.5 percent isooctane, and 15 percent denatured ethanol, v/v), as defined in ASTM D471, *Standard Test Method for Rubber Property-Effect of Liquids*
- (2) Methyl isobutyl ketone, CAS No. 108-10-1, >95 percent, w/w
- (3) Sulfuric acid, CAS No. 7664-93-9, 93.1 percent, w/w

N 8.4.12 Specific Requirements for Testing Garment Closure Assemblies After Fatigue.

N 8.4.12.1 Samples for conditioning shall include 150 mm (6 in.) of material on either side of the closure.

N 8.4.12.2 Specimens shall be conditioned as specified in 8.1.7.

N 8.4.12.3 Sample seams shall be evaluated against a subset of the chemicals specified in 8.4.4.1 that shall include the following:

- (1) Fuel H — surrogate gasoline (42.5 percent toluene, 42.5 percent isooctane, and 15 percent denatured ethanol, v/v), as defined in ASTM D471, *Standard Test Method for Rubber Property-Effect of Liquids*
- (2) Methyl isobutyl ketone, CAS No. 108-10-1, >95 percent, w/w
- (3) Sulfuric acid, CAS No. 7664-93-9, 93.1 percent, w/w

N 8.4.13 Specific Requirements for Testing Hood Materials After Flexing and Abrading.

N 8.4.13.1 Samples for conditioning shall be 200 mm × 280 mm (8 in. × 11 in.) rectangles.

N 8.4.13.2 Samples shall first be conditioned by flexing as specified in 8.1.3.

N 8.4.13.3 Following flexing, three samples for abrasion conditioning, each measuring 75 mm × 230 mm (3 in. × 9 in.), shall be cut from the center of the flexed sample.

N 8.4.13.4 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.

N 8.4.13.5 The new samples shall then be conditioned by abrading as specified in 8.1.4.

N 8.4.13.6 Following abrasion, only one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion.

N 8.4.13.7 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.

N 8.4.14 Specific Requirements for Testing Elastomeric Interface Materials. Specimens shall be taken from elastomeric interface sheet material or formed elastomeric interfaces that are representative of the material nominal thickness and composition.

8.5 Burst Strength Test.

8.5.1 Application.

8.5.1.1 This test shall apply to garment and hood materials.

△ 8.5.1.2 Where the garment or hood is constructed of several separable layers, all layers shall be assembled in the order in which they appear in the garment or visor, and shall be tested as a composite.

8.5.2 Samples.

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

8.5.2.2 Samples shall be conditioned as specified in 8.1.2.

8.5.3 Specimens.

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

8.5.3.2 At least 10 specimens shall be tested.

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

8.5.5 Report.

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

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

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

8.6 Puncture Propagation Tear Resistance Test.

8.6.1 Application.

8.6.1.1 This test shall apply to garment and hood materials.

△ 8.6.1.2 Where the protective garment or hood is constructed of several layers, all layers shall be assembled in the order in which they appear in the garment or hood and shall be tested as a composite.

8.6.2 Samples.

8.6.2.1 Samples shall be at least 1 m (1 yd) squares of material.

8.6.2.2 Samples shall be conditioned as specified in 8.1.2.

8.6.3 Specimens.

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

8.6.3.2 At least five specimens in each of the machine direction and the cross-machine direction, shall be tested.

8.6.3.3 If the material is isotropic, then at least 10 specimens shall be tested.

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

8.6.5 Report.

8.6.5.1 The puncture propagation tear resistance of each specimen shall be recorded and reported to the nearest 0.445 N (0.1 lbf).

8.6.5.2 An average puncture propagation tear resistance shall be calculated, recorded, and reported for each direction tested.

8.6.6 Interpretation.

8.6.6.1 Pass/fail performance shall be based on the average puncture propagation tear resistance in each direction tested.

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

8.7 Cold Temperature Performance Test 1.

8.7.1 Application. This test method shall apply to garment, hood, elastomeric interface, and glove materials.

8.7.2 Samples.

8.7.2.1 Samples shall be at least 1 m (1 yd) squares of material.

8.7.2.2 Samples shall be conditioned as specified in 8.1.2.

8.7.3 Specimens.

8.7.3.1 Specimens shall be the size specified in ASTM D747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*.

△ 8.7.3.2 At least five specimens in each of the, machine direction and the cross-machine direction shall be tested.

8.7.3.3 If the material is isotropic, then at least 10 specimens shall be tested.

8.7.4 Procedure. Specimens shall be tested in accordance with ASTM D747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*, with the following modifications:

- (1) The test temperature shall be -25°C (-13°F).
- (2) The bending moment shall be that applied when the specimen is bent to a 60-degree angular deflection and shall be calculated in inch-pounds as follows:

N

[8.7.4]

$$\text{Bending moment} = \frac{\text{load scale reading} \times \text{moment weight}}{100}$$

$$\text{Bending moment (Nm)} = \text{bending moment, in.-lb} \times 0.113$$

- (3) Values shall be permitted to be obtained for materials that are too flexible to measure with this apparatus by laminating to a stiffening material that yields a valid test value and subtracting out the stiffening materials bending moment when tested alone. Permitted lamination techniques shall include fastening of one or both ends of the specimens.

8.7.5 Report. Cold temperature performance results shall be recorded and reported as the average for each material direction.

8.7.6 Interpretation. Failure of the material in any direction shall constitute failing performance.

8.8 Seam/Closure Breaking Strength Test.

8.8.1 Application.

8.8.1.1 This test shall be applied to all types of garment seams as well as the garment closure assembly used in the construction of the garment and hood.

8.8.1.2 Where the garment consists of multiple separable layers, then the test shall be applied to the seams and closure assemblies of each separable layer.

8.8.1.3 Modifications to this test method for testing seams shall be as specified in 8.8.7.

8.8.1.4 Modifications to this test method for testing closure assemblies shall be as specified in 8.8.8.

8.8.2 Samples.

8.8.2.1 Samples shall be 610 mm (24 in.) lengths of seam or closure assembly.

8.8.2.2 Samples shall be cut from the finished garment or ensemble.

8.8.2.3 Lengths of seam shall be permitted to be prepared by representatively joining two pieces of the garment material instead of being cut from the garment.

8.8.2.4 Samples shall be conditioned as specified in 8.1.2.

N 8.8.2.5 Closure samples shall be permitted to be individual samples cut to the specimen width.

N 8.8.2.6 Samples shall be conditioned as specified in 8.1.2.

8.8.3 Specimens.

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

8.8.3.2 At least five specimens shall be tested for each seam and closure assembly type.

N 8.8.3.3 Closure sample specimen width shall be permitted to be 25 mm \pm 6 mm (1 in. \pm 1/4 in.) larger than the required specimen size. The specimen edges at the closure shall be permitted to be secured by stitching or tacking.

8.8.4 **Procedure.** All seams and closure assemblies shall be tested in accordance with ASTM D751, *Standard Test Methods for Coated Fabrics*.

8.8.5 Report.

8.8.5.1 The breaking strength for each seam or closure assembly specimen shall be recorded and reported.

8.8.5.2 The average breaking strength for each seam or closure assembly type shall also be calculated, recorded, and reported.

8.8.5.3 The types of seams and closure assemblies tested shall be recorded and reported as to whether the specimens were cut from the finished garment or prepared from fabric samples.

Δ 8.8.6 **Interpretation.** The average breaking strength for each seam and closure assembly type shall be used to determine the pass or fail performance.

8.8.7 **Specific Procedures for Testing Seams.** Samples for conditioning shall include 150 mm (6 in.) of material on either side of the seam.

8.8.8 Specific Procedures for Testing Closure Assemblies.

8.8.8.1 Samples for conditioning shall include 150 mm (6 in.) of material on either side of the closure.

8.8.8.2 Specimens shall be conditioned as specified in 8.1.7.

8.9 Visor High-Mass Impact Resistance Test.

8.9.1 Application.

N 8.9.1.1 This test method shall apply to visor materials.

N 8.9.1.2 Where the visor is constructed of several layers, all layers shall be assembled in the order in which they appear in the suit, and shall be tested as a composite.

8.9.2 Samples.

8.9.2.1 Samples shall be at least 305 mm (12 in.) squares of visor material.

8.9.2.2 Samples shall be conditioned as specified in 8.1.2.

8.9.3 Specimens.

8.9.3.1 Specimens shall be 450 mm x 305 mm.

8.9.3.2 At least five specimens shall be tested.

8.9.4 **Procedure.** Specimens shall be tested in accordance with Section 9.11 of ANSI Z87.1, *American National Standard for Occupational and Educational Personal Eye and Face Protective Devices*, with the following modifications:

- (1) Visor material shall be securely mounted to the test fixture.
- (2) The sample number shall be indicated.
- (3) The impact location shall be in the center apex of the visor between the frame members.
- (4) Testing shall be performed on samples conditioned for a minimum of 4 hours at -25°C (-13°F).
- (5) Testing shall commence between 60 and 90 sec.
- (6) The sample shall not be allowed to move greater than 6 mm (0.25 in.).

Δ 8.9.5 **Report.** Visible penetration or full-thickness cracks shall be recorded and reported.

8.9.6 **Interpretation.** Penetration or full-thickness cracking on any specimen shall constitute failing performance.

8.10 Liquidtight Integrity Test 2.

8.10.1 Application.

8.10.1.1 This test method shall apply to gloves and footwear.

8.10.1.2 Modifications to this test method for testing gloves shall be as specified in 8.10.7.

8.10.1.3 Modifications to this test method for testing footwear shall be as specified in 8.10.8.

8.10.2 Samples.

8.10.2.1 Samples shall be whole gloves or footwear with all layers assembled that are required for the element to be compliant.

8.10.2.2 Samples shall be conditioned as specified in 8.1.2 after the conditioning specified in the modifications.

8.10.3 Specimens.

8.10.3.1 Specimens shall be whole gloves or footwear with all layers assembled that are required for the element to be compliant.

8.10.3.2 At least 10 specimens shall be tested.

8.10.4 Procedure. Liquidtight integrity testing of gloves and footwear shall be conducted in accordance with ASTM D5151, *Standard Test Method for Detection of Holes in Medical Gloves*, with the following modifications:

- (1) The surface tension of the water used in testing shall be 32 dynes/cm, ± 2 dynes/cm (32 N/m, ± 2 N/m).
- (2) The surfactant-treated water shall remain in the specimen for a period of 1 hour, $\pm 5/-0$ minutes.
- (3) Observations for leakage shall be performed at the end of the test period.
- (4) Blotting paper shall be permitted to be used for assisting in the determination that liquid leakage has occurred.

8.10.5 Report. Observations of water leakage shall be recorded and reported by specific area on the test specimen.

8.10.6 Interpretation. Any evidence of water leakage, as determined by visual, tactile, or absorbent blotting, shall constitute failure of the specimen.

8.10.7 Specific Requirements for Testing Gloves.

8.10.7.1 Specimens shall be conditioned as specified in 8.1.5.

8.10.7.2 A sufficient amount of surfactant-treated water shall be added to the specimen so that the water is within 25 mm (1 in.) of the edge of the glove opening.

8.10.8 Specific Requirements for Testing Footwear.

8.10.8.1 Specimens shall be conditioned as specified in 8.1.6.

8.10.8.2 A sufficient amount of surfactant-treated water shall be added to the specimen so that the water is within 25 mm (1 in.) of the edge of the footwear opening, measured downward from the lowest point where the protective barrier materials terminate.

8.11 Cut Resistance Test.

8.11.1 Application.

8.11.1.1 This test method shall apply to glove, footwear upper, and elastomeric interface materials.

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

8.11.1.3 Modifications to this test method for evaluation of footwear upper materials shall be as specified in 8.11.8.

8.11.1.4 Modifications to this test method for evaluation of elastomeric interface materials shall be as specified in 8.11.9.

8.11.2 Samples.

8.11.2.1 Samples shall be whole gloves, footwear uppers, or elastomeric interface materials consisting of all layers.

8.11.2.2 Samples shall be conditioned as specified in 8.1.2 after the conditioning specified in the modifications.

8.11.3 Specimens.

8.11.3.1 Specimens shall be the size specified in ASTM F1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*.

8.11.3.2 At least three specimens of glove material or footwear upper material shall be tested.

8.11.4 Procedure. Specimens shall be evaluated in accordance with ASTM F1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, with the modification that specimens shall be tested to a specific load with the measurement of distance of blade travel.

8.11.5 Report.

8.11.5.1 The distance of blade travel shall be recorded and reported to the nearest 1 mm ($\frac{1}{32}$ in.) for each sample specimen.

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

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

8.11.7 Specific Requirements for Testing Glove Materials.

8.11.7.1 Specimens shall be taken from the glove and shall not include seams.

8.11.7.1.1 Specimens shall consist of each composite of the glove used in the actual suit glove configuration, with layers arranged in proper order.

8.11.7.1.2 Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

8.11.7.2 Cut resistance testing shall be performed under a load of 50 g (1.75 oz).

8.11.8 Specific Requirements for Testing Footwear Upper Materials.

8.11.8.1 Specimens shall be taken from the footwear upper and shall not include seams.

8.11.8.1.1 Specimens shall consist of each composite of the footwear upper used in the actual suit glove configuration, with layers arranged in proper order.

8.11.8.1.2 Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

8.11.8.2 Cut resistance testing shall be performed under a load of 350 g (12.5 oz).

8.11.9 Specific Requirements for Testing Elastomeric Interface Materials.

8.11.9.1 Specimens shall be taken from elastomeric interface sheet material or formed interface material that is representative of the interface material nominal thickness.

8.11.9.2 Cut resistance shall be performed under a load of 50 g (1.75 oz).

8.12 Puncture Resistance Test 1.

8.12.1 Application.

8.12.1.1 This test shall be applied to glove, footwear upper, and elastomeric interface materials.

8.12.1.2 Modifications to this test method for testing glove materials shall be as specified in 8.12.7.

8.12.1.3 Modifications to this test method for testing footwear upper material shall be as specified in 8.12.8.

N 8.12.1.4 Modifications to this test method for evaluation of elastomeric interface materials shall be as specified in 8.12.9.

8.12.2 Samples.

8.12.2.1 Samples shall be complete gloves or footwear uppers consisting of all layers.

8.12.2.2 Samples shall be conditioned as specified in 8.1.2 after the conditioning specified in the modifications.

8.12.3 Specimens.

8.12.3.1 Specimens shall be at least 150 mm (6 in.) squares.

8.12.3.2 At least three specimens of glove material or footwear upper material shall be tested.

Δ 8.12.4 **Procedure.** Specimens shall be tested in accordance with ASTM F1342, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture*, Method A.

8.12.5 Report.

8.12.5.1 The puncture force shall be recorded and reported for each specimen to the nearest 0.5 N (0.125 lbf) of force.

8.12.5.2 The average puncture force shall be reported for all specimens tested.

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

8.12.7 Specific Requirements for Testing Glove Materials.

8.12.7.1 Specimens shall be taken from the glove and shall not include seams.

N 8.12.7.1.1 Specimens shall consist of each composite of the glove used in actual suit glove configuration, with layers arranged in the proper order.

N 8.12.7.1.2 When a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

8.12.8 Specific Requirements for Testing Footwear Upper Materials.

8.12.8.1 Specimens shall be taken from the footwear upper and shall not include seams.

N 8.12.8.1.1 Specimens shall consist of each composite of the footwear upper used in the actual suit footwear configuration, with layers arranged in proper order.

N 8.12.8.1.2 Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

N 8.12.9 **Specific Requirements for Testing Exposed Interface Materials.** Specimens shall be taken from interface sheet material or formed interfaces that are representative of the interface material nominal thickness and composition.

8.13 Gloved Hand Dexterity Test.

8.13.1 **Application.** This test shall apply to gloves.

8.13.2 Samples.

8.13.2.1 Samples for conditioning shall be whole glove pairs.

8.13.2.2 Samples shall be conditioned as specified in 8.1.2.

8.13.2.3 Samples shall not receive special softening treatments prior to testing.

8.13.3 Specimens.

8.13.3.1 Specimens shall be whole glove pairs in the new, as distributed, condition.

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

8.13.4 **Apparatus.** The test apparatus shall be as specified in ASTM F2010, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test*.

8.13.5 **Procedures.** Testing shall be conducted in accordance with ASTM F2010, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test*.

8.13.6 **Report.** The average percent of barehanded control shall be recorded and reported for each test subject. The average percent of barehanded control for all test subjects shall be calculated, recorded, and reported for each size.

8.13.7 **Interpretation.** The average percent of barehanded control for size small and size large gloves shall be used to determine the pass or fail performance. Failure of either size shall constitute failure of the test.

8.14 Abrasion Resistance Test.

8.14.1 **Application.** This test method shall apply to footwear soles with heels.

8.14.2 Samples.

8.14.2.1 Samples for conditioning shall be uniform cylinders of footwear soles and heel material.

8.14.2.2 Samples shall be conditioned as specified in 8.1.2.

8.14.3 Specimens.

8.14.3.1 A minimum of three specimens of the footwear soles and heel materials shall be tested.

8.14.4 **Procedure.** Abrasion resistance tests shall be performed in accordance with ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical device*, Method A, with a vertical force of 10 N over an abrasion distance of 40 m.

8.14.5 **Report.** The relative volume loss of each specimen shall be recorded and reported.

8.14.6 **Interpretation.** One or more footwear specimens failing this test shall constitute failing performance.

8.15 Ladder Shank Bend Resistance Test.

8.15.1 Application. This test method shall apply to footwear ladder shanks.

8.15.2 Samples.

8.15.2.1 Samples shall be footwear ladder shanks.

8.15.2.2 Samples shall be conditioned as specified in 8.1.2.

8.15.3 Specimens.

8.15.3.1 Specimens shall be footwear ladder shanks.

8.15.3.2 At least three specimens shall be tested.

8.15.4 Apparatus.

8.15.4.1 The apparatus shall consist of an Instron tensile testing machine or equivalent that challenges a specimen with a simulated ladder rung.

8.15.4.2 A 32 mm diameter × 50 mm long (1¼ in. diameter × 2 in. long) noncompressible probe shall be mounted on the movable arm.

8.15.4.3 The specimen support assembly shall consist of two 50 mm × 25 mm × 25 mm (2 in. × 1 in. × 1 in.) noncompressible blocks placed 50 mm (2 in.) apart as shown in Figure 8.15.4.3.

8.15.5 Procedure. The ladder shank shall be placed on mounting blocks as it would be oriented toward the ladder when affixed into the protective footwear and subjected to force on its center with the test probe operated at 50 mm/min (2 in./min).

8.15.6 Report.

8.15.6.1 Deflection at 182 kg (400 lb) shall be recorded and reported to the nearest 1 mm ($\frac{3}{64}$ in.).

8.15.6.2 The average deflection shall be calculated, recorded, and reported to the nearest 1 mm ($\frac{3}{64}$ in.).

8.15.7 Interpretation. The average deflection for all specimens tested shall be used to determine the pass or fail performance.

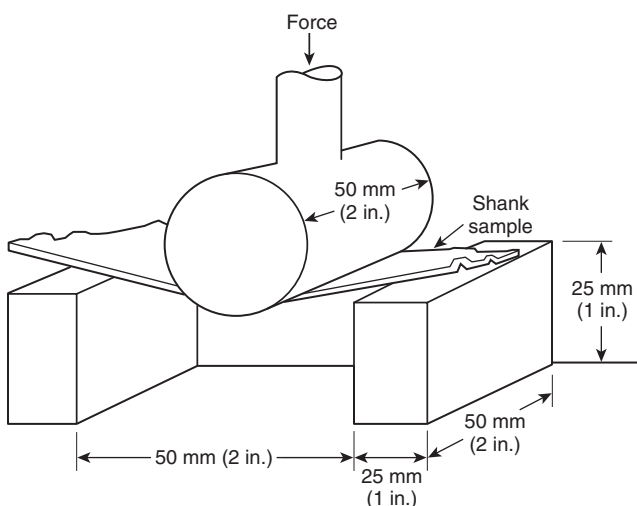


FIGURE 8.15.4.3 Ladder Shank Bend Test Set-Up.

8.16 Slip Resistance Test.

8.16.1 Application. This test method shall apply to footwear.

8.16.2 Samples.

8.16.2.1 Samples shall be complete footwear elements in men's size 9D, medium width.

8.16.2.2 Samples shall be conditioned as specified in ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance and Test Surfaces/Flooring Using a Whole Shoe Tester*.

8.16.3 Specimens.

8.16.3.1 Specimens shall be complete footwear elements in men's size 9D, medium width.

8.16.3.2 At least three specimens shall be tested.

8.16.4 Procedure. Slip resistance testing shall be performed in accordance with ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester*, in the following configurations — references to any other flooring and/or contaminate within ASTM F2913 shall not apply:

- (1) Footwear shall be tested both in the forepart and 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.

8.16.5 Report.

8.16.5.1 The coefficient of friction of each specimen shall be recorded and reported.

8.16.5.2 The average coefficient of friction of all specimens for each configuration shall be calculated, recorded, and reported.

8.16.6 Interpretation. The average coefficient of friction for each configuration shall be used to determine pass/fail performance.

8.17 Overall Ensemble Flash Test.

8.17.1 Application. This test method shall apply to complete liquid splash-protective ensembles, garments, gloves, and footwear.

8.17.2 Samples.

8.17.2.1 Samples shall be complete liquid splash-protective ensembles, full garments, gloves, or footwear.

8.17.2.2 Samples shall be conditioned as specified in 8.1.2.

8.17.3 Specimens.

8.17.3.1 Specimens shall be complete liquid splash-protective ensembles, full garments, gloves, or footwear.

8.17.3.2 At least three specimens shall be tested.

8.17.3.3 Additional protective clothing components and equipment that are necessary to provide flash protection to the wearer shall be tested in conjunction with the liquid splash-protective clothing or ensemble.

8.17.4 Apparatus.

8.17.4.1 A human form **manikin** shall be used to support the protective suit during chemical flash fire testing.

8.17.4.2 The **manikin** shall be coated with a suitable flame-retardant coating.

8.17.4.3 A one-piece flame-resistant coverall shall be placed over the **manikin**.

8.17.4.4 The garment, gloves, and footwear to be tested shall be placed on the **manikin**, over the flame-resistant clothing, in accordance with the manufacturer's instructions.

Δ 8.17.4.5 A flash chamber shall be constructed as illustrated in Figure 8.17.4.5 and shall include the following:

- (1) The chamber shall have an internal width and depth of 2 m, ± 100 mm (6 $\frac{1}{2}$ ft, ± 4 in.) and a height of 2.5 m, ± 200 mm (8 ft, ± 8 in.).
- (2) The chamber shall be constructed of 50 mm \times 100 mm (2 in. \times 4 in.) framing lumber or other suitable structural material. A fire wall, 20 mm ($\frac{3}{4}$ in.), or other suitable flame-resistant paneling shall be used on the chamber walls. A piece of 13 mm ($\frac{1}{2}$ in.) heat-tempered safety glass of sufficient size shall be used on opposite chamber walls for multiple viewing points during testing.
- (3) The chamber shall be sealed with a suitable flame-resistant material to provide a gastight seal when the door is closed.
- (4) The chamber shall have a port for filling the chamber with propane gas located as shown in Figure 8.17.4.5 and that meets both of the following:
 - (a) The port shall allow isolation of the propane source through a valve.
 - (b) The port shall be leak-free with respect to the outside environment
- (5) The chamber shall have a minimum of two ports for electric igniters located on one wall of the chamber and meet both of the following:
 - (a) The ports shall be positioned at heights on the chamber wall such that the propane will ignite immediately once triggered.
 - (b) The ports shall be leak-free with respect to the outside environment.
- (6) The chamber shall have a top that allows containment of propane gas within the chamber during filling and venting of flash pressure after ignition.
- (7) A suitable stand shall be constructed that allows the **manikin** to be positioned 305 mm, ± 25 mm (12 in., ± 1 in.) above the chamber floor.
- (8) The flash fire chamber shall be located so that testing is performed at a temperature of 24°C, $\pm 11^\circ\text{C}$ (75°F, $\pm 20^\circ\text{F}$) and a relative humidity of 70 percent, ± 25 percent. Tests shall not be conducted outdoors during precipitation.

N 8.17.5 Verification of Flash Exposure.

N 8.17.5.1 Prior to testing each day, thermocouples shall be placed in the empty chamber so that temperature measurements are taken at the following heights from the floor: 30 cm (12 in.), 76 cm (3 in.), 122 cm (48 in.), 168 cm (66 in.), and 213 cm (84 in.). All heights are ± 2.5 cm (± 1 in.).

N 8.17.5.2 A data acquisition system shall be used to collect the temperature readings during the burn exposure and shall be

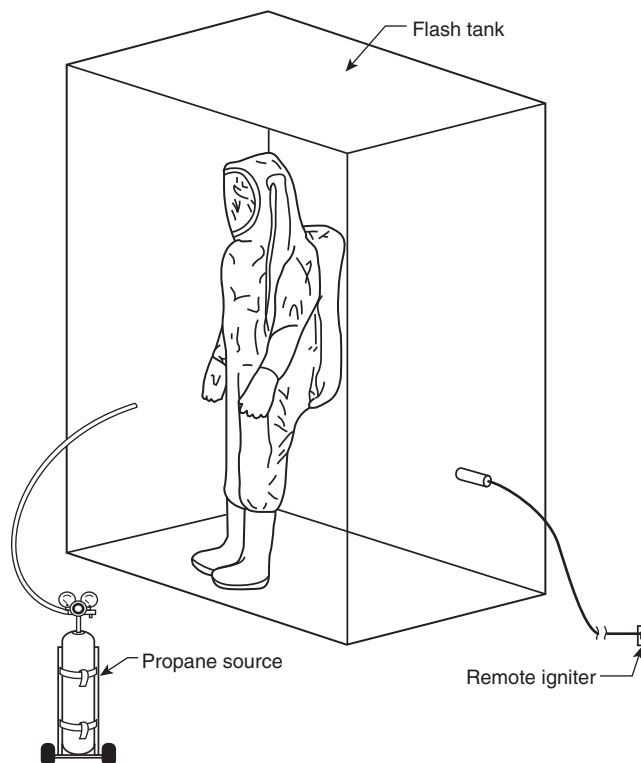


FIGURE 8.17.4.5 Overall Ensemble Chemical Flash Chamber.

sufficient to provide at least 1 temperature reading per second for each thermocouple used.

N 8.17.5.3 Propane gas, at 99 percent purity or better, shall be metered into the chamber at a delivery pressure of 172.3 kPa, ± 13.8 kPa (25 psi, ± 2 psi) and rate of 0.16 m³/min, ± 0.01 m³/min (5 $\frac{1}{2}$ ft³/min, $\pm \frac{1}{2}$ ft³/min) for 2 minutes, ± 1 minute to produce a visible chemical flash fire lasting 7 seconds, ± 1 second.

N 8.17.5.3.1 The exact time that it takes to produce a visible chemical flash fire lasting 7 seconds, ± 1 second shall be recorded.

N 8.17.5.3.2 The concentration of the propane shall be permitted to be checked by a combustible gas meter or similar detector.

N 8.17.5.4 After determination of the adequate time to create a 7-second, ± 1 second, flash fire exposure, the data collected from the thermocouples shall be evaluated to determine the maximum temperatures reached during the exposure at each height location. The maximum average temperature of all locations shall be within a temperature range of 650°C to 1150°C (1202°F to 2102°F).

8.17.6 Procedure.

8.17.6.1 The suited **manikin** shall be placed on the stand in the center of the flash chamber in an upright stationary position.

8.17.6.2 Propane gas at 99 percent purity or better shall be metered into the chamber at a delivery pressure of 172.3 kPa, ± 13.8 kPa (25 psi, ± 2 psi) and rate of 0.16 m³/min, ± 0.01 m³/min (5.5 ft³/min, ± 0.5 ft³/min).

8.17.6.2.1 The concentration of propane within the chamber shall be sufficient to produce a visible chemical flash fire lasting 7 seconds, ± 1 second.

8.17.6.2.2 The concentration of the propane shall be permitted to be checked by a combustible gas meter or similar detector.

8.17.6.3 The flash chamber shall be viewed at both vantage points, front and back, throughout the test. Video documentation shall also be conducted from the front vantage point.

8.17.6.4 The chamber atmosphere shall be remotely ignited at 30 seconds, ± 5 seconds after the chamber has been filled with propane gas.

8.17.6.5 The suited manikin shall not be removed until all surfaces have cooled to ambient temperature.

8.17.6.6 The protective clothing or ensemble shall be removed from the manikin and examined visually for signs of physical damage from thermal exposure.

8.17.6.7 A liquidtight integrity test shall be performed on the protective clothing or ensemble in accordance with Section 8.2 after the chemical flash fire exposure.

N 8.17.6.7.1 Testing shall be performed with the suited manikin exposed to the liquid spray for a total of 4 minutes, 1 minute in each of the manikin orientations.

8.17.6.8 Following liquidtight integrity testing, if the suit contains a visor, then the suit shall be donned by a test subject and evaluated as follows:

- (1) The test subject shall have a minimum visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses, as determined in a visual acuity test or doctor's examination.
- (2) Visual acuity testing within the suit shall be conducted using a standard 6.1 m (20 ft) eye chart with a normal lighting range of 100 to 150 ft-candles at the chart and with the test subject positioned at a distance of 6.1 m (20 ft) from the chart.
- (3) The test subject shall then read the standard eye chart through the lens of the SCBA facepiece and suit visor to determine his or her visual acuity.

8.17.7 Report.

8.17.7.1 The post-flash exposure liquidtight integrity test result, afterflame time, and visor clarity shall be reported and recorded for each test specimen.

Δ 8.17.7.2 An illustration of the protective clothing or ensemble as shown in Figure 8.17.7.2 shall be prepared, and the location of any damage shall be recorded on the illustration and reported.

N 8.17.7.2.1 Separate illustrations shall be prepared for over covers if tested with the protective suit.

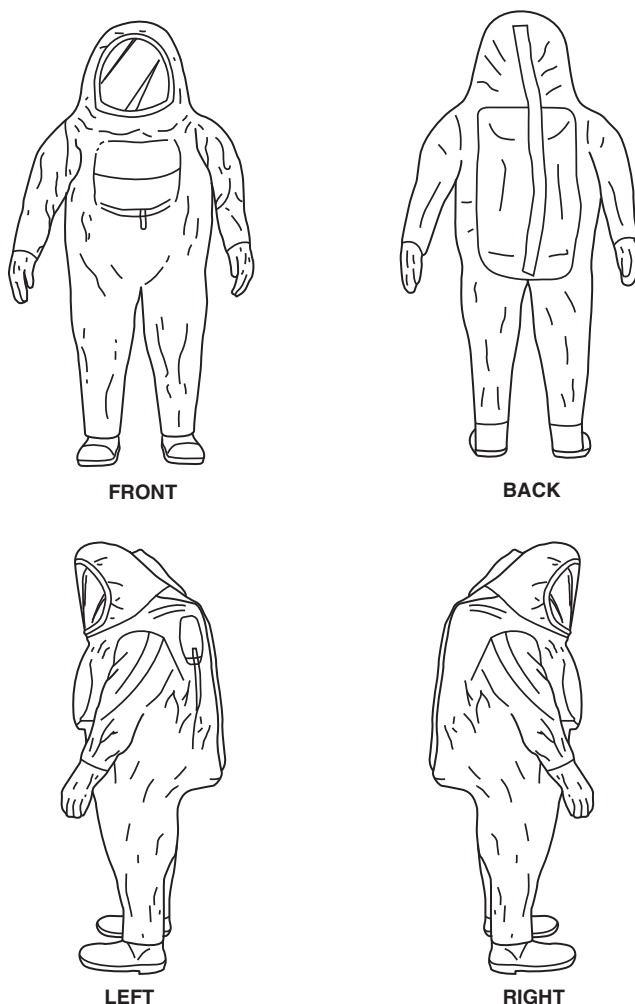


FIGURE 8.17.7.2 Suit Diagram (for noting damage locations).

N 8.17.7.2.2 The damage to be reported shall include, but not be limited to, the following:

- (1) Charring
- (2) Blistering
- (3) Evidence of material melting
- (4) Delamination
- (5) Destruction of any suit components

N 8.17.7.3 The verification burn, visible chemical flash fire time shall be recorded and reported.

N 8.17.7.4 The verification burn, maximum average temperature of all locations shall be recorded and reported.

8.17.8 Interpretation.

8.17.8.1 Any specimen with an afterflame time greater than 2 seconds shall constitute failing performance.

8.17.8.2 Liquid found on the inner liquid-absorptive garment following liquidtight integrity testing shall constitute failing performance.

8.17.8.3 The visual acuity of the test subject inside the suit shall be used for determining the pass or fail performance.

8.17.9 Specific Requirements for Testing Garments, Gloves, and Footwear. Where garments, gloves, and footwear that do not cover the entire manikin are tested, items of clothing constructed of flame-resistant materials shall be used to cover those exposed portions of the manikin body in a manner that does not cover the item being evaluated.

8.18 Heat Transfer Performance Test.

8.18.1 Application. This test method shall apply to protective garment materials, visor materials, glove materials, footwear upper materials, and hood materials. Test methods shall also apply to elastomeric interface materials in direct contact with the wearer's skin and excludes interface materials where used between the hood and respirator.

8.18.2 Samples.

8.18.2.1 Samples for conditioning shall be 150 mm × 150 mm, ±5 mm (6 in. × 6 in., ±¼ in.) and shall consist of all layers representative of the element materials to be tested, excluding any areas with special reinforcements or seams.

8.18.2.2 Samples shall be conditioned as specified in 8.1.2.

8.18.3 Specimens.

8.18.3.1 Specimens shall be 150 mm × 150 mm, ±5 mm (6 in. × 6 in., ±¼ in.) and shall consist of all layers representative of the element materials to be tested, excluding any areas with special reinforcements or seams.

8.18.3.2 At least three specimens shall be tested.

8.18.4 Apparatus. The test apparatus specified in ASTM F2700, *Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating*, shall be used.

8.18.5 Procedure. Radiant protective performance testing shall be performed in accordance with ASTM F2700, *Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating*, with the following modifications:

- (1) The optional spacer shall not be used for testing of all material specimens.
- (2) The heat transfer performance value shall be used with calculations made using the heat flux in calories per square centimeter per second and reported as the HTP rating.

8.18.6 Report. The individual test HTP rating of each specimen shall be recorded and reported. The average HTP rating shall be calculated, recorded, and reported.

8.18.7 Interpretation.

8.18.7.1 Pass or fail performance determinations shall be separately based on the average reported HTP rating of all specimens.

8.18.7.2 Where an individual result from any test set varies more than ±10 percent from the average result, the results

from the test set shall be discarded and another set of specimens shall be tested.

8.19 Flammability Resistance Test.

8.19.1 Application. This test method shall apply to garment materials, visor materials, glove materials, footwear upper materials, hood materials, and elastomeric interface materials.

8.19.2 Samples.

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

8.19.2.2 Samples shall be conditioned as specified in 8.1.2.

8.19.3 Specimens.

8.19.3.1 Specimens shall be the size specified in ASTM F1358, *Standard Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance*.

8.19.3.2 Five specimens in each warp direction (machine or coarse) and each filling direction (cross-machine or wale) shall be tested.

8.19.3.3 If the material is isotropic, then 10 specimens shall be tested.

8.19.4 Procedure. Flame resistance testing shall be conducted in accordance with ASTM F1358, *Standard Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance*, with the following modifications:

- (1) Each specimen shall only be exposed to the flame for a 12-second period.
- (2) Specimens shall be observed for the combination of both melting and dripping.

8.19.5 Report.

8.19.5.1 Afterflame times and burn distances results shall be recorded and reported for each specimen and as the average for each material direction.

8.19.5.2 The burning behavior observations of each specimen shall be recorded and reported.

8.19.6 Interpretation.

8.19.6.1 Failure of the material in any direction shall constitute failing performance.

8.19.6.2 Any specimen exhibiting melting as evidenced by dripping or flowing shall constitute failing performance.

8.20 Total Heat Loss Test.

8.20.1 Application. This test method shall apply to the base garment composite designated as breathable.

8.20.2 Samples.

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

8.20.2.2 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.

8.20.3 Specimens.

8.20.3.1 Specimen size shall be the size required to cover the sweating guarded hot plate.

8.20.3.2 At least three specimens shall be tested.

8.20.3.3 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.

8.20.4 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*.

8.20.5* 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 C, with the following modifications:

- (1) The specimen shall be placed on the test plate with the side normally facing the human body facing the test plate.
- (2) For multiple layers, the layers shall be arranged in the order and orientation as worn.
- (3) Each layer shall be smoothed by hand to eliminate wrinkles or bubbles in each layer.
- (4) Once the test is started, no further adjustments to the specimen shall be made.

8.20.6 Report.

8.20.6.1 The average intrinsic thermal resistance (R_{ct}) of the sample shall be recorded.

Δ 8.20.6.2 The average intrinsic evaporative resistance (R_{et}) of the sample shall be recorded.

8.20.6.3 The average total heat loss (Q_t) of the sample shall be calculated and reported in the technical data package.

8.20.7 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.

8.21 Ultimate Tensile Strength Test.

8.21.1 Application. This method shall apply to elastomeric interface materials.

8.21.2 Samples.

8.21.2.1 Samples for conditioning shall be the same size as the test specimens taken from either elastomeric interface sheet material or formed interfaces that are representative of the interface material nominal thickness and composition.

8.21.2.2 Samples shall be conditioned as specified in 8.1.2.

8.21.3 Specimens.

8.21.3.1 Specimens shall be the size required by ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*.

8.21.3.2 At least 10 specimens shall be tested.

8.21.4 Procedure. Specimens shall be tested in accordance with ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*, Method A.

8.21.5 Report.

8.21.5.1 The ultimate tensile strength before and after heat aging shall be recorded and reported for each specimen to the nearest 10 kPa (2 psi).

8.21.5.2 The average ultimate tensile strength before and after heat aging shall be calculated and reported for all specimens tested.

8.21.5.3 The average elongation at rupture before and after heat aging shall be individually used to qualify the elastomeric character of the interface material.

8.21.6 Interpretation.

8.21.6.1 The average ultimate tensile strength both before and after heat aging shall be individually used to determine pass/fail performance.

8.21.6.2 An elongation at rupture of less than 125 percent shall qualify an interface material for consideration as a garment material.

8.22 Puncture Resistance Test Two.

8.22.1 Application. This test method shall apply to the puncture-resistant device of liquid splash-protective footwear.

8.22.2 Samples.

8.22.2.1 Samples shall be footwear puncture resistance devices.

8.22.2.2 Samples shall be conditioned as specified in 8.1.2.

8.22.3 Specimens.

8.22.3.1 Specimens shall be footwear puncture resistance devices.

8.22.3.2 At least three specimens shall be tested.

8.22.4 Procedure.

8.22.4.1 Puncture resistance shall be performed in accordance with Section 5 of ASTM F2412, *Standard Test Methods for Footwear Protection*.

8.22.4.2 The test shall be performed under an applied force of 1200 N (270 lbf).

8.22.4.3 The penetration of the test pin tip shall be viewed at a 90-degree angle to determine if the tip penetrates the puncture-resistant device.

8.22.4.4 The observation shall be made if the test pin tip penetrates the puncture-resistant device.

8.22.5 Report. The observation of whether the test pin tip is observed or not shall be reported for each specimen.

8.22.6 Interpretation. One or more footwear specimens showing penetration of the test pin tip shall constitute failing performance.

8.23 Evaporative Resistance Test.

8.23.1 Application. This test method shall apply to the suit based composite designated as breathable.

N 8.23.2 Samples.

N 8.23.2.1 Samples shall be conditioned at a temperature of $25^{\circ}\text{C} \pm 7^{\circ}\text{C}$ ($77^{\circ}\text{F} \pm 13^{\circ}\text{F}$) and a relative humidity of 65 percent ± 5 percent for at least 4 hours.

N 8.23.2.2 The minimum sample size shall be 51 cm \times 51 cm (20 in. \times 20 in.).

N 8.23.3 Specimens.

N 8.23.3.1 Specimen size shall be the size required to cover the sweating guarded hot plate.

N 8.23.3.2 Evaporative resistance testing shall be conducted on at least three specimens.

N 8.23.3.3 Specimens shall consist of all layers in the protective garment composite, arranged in the order and orientation as worn, and shall not include any reinforcement materials.

N 8.23.4 Apparatus.

N 8.23.4.1 The test apparatus shall be as specified in ISO 11092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*.

N 8.23.4.2 The dimensions for the sweating guarded hot plate shall be a 25.4 cm (10 in.) test plate with a 12.7 cm (5 in.) guard surrounding the test plate.

N 8.23.5 Procedure. Testing shall be conducted in accordance with ISO 11092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*, with the following modifications:

- (1) The specimen shall be placed on the test plate with the side normally facing the human body toward the test plate.
- (2) For multiple layers the layers shall be arranged in the order and orientation as worn.
- (3) Each layer shall be smoothed by hand to eliminate wrinkles or bubbles in each layer and, if necessary, secure the edges.
- (4) Once the test is started, no further adjustments to the specimen shall be made.

N 8.23.6 Report.

N 8.23.6.1 The total evaporative resistance (R_{et}) of each sample shall be recorded and reported.

N 8.23.6.2 The average total evaporative resistance (R_{et}) of all tested samples shall be recorded and reported in the technical data package.

N 8.23.7 Interpretation. A garment material shall be considered breathable when it has a R_{et} value that is 30 Pa m^2/W or less.

N 8.24 Fitting Pull-Out Strength Test.

N 8.24.1 Application. This test method shall apply to each type of external fitting mounted on ensembles.

N 8.24.2 Samples.

N 8.24.2.1 Samples for conditioning shall be external fitting assemblies mounted into the ensemble material using the means of mounting and the fabrication methods used to install the external fitting into the actual ensemble.

N 8.24.2.2 Samples shall be conditioned as specified in 8.1.2.

N 8.24.3 Specimens.

N 8.24.3.1 Specimens shall be external fitting assemblies mounted into the ensemble material using the means of mounting and the fabrication methods used to install the external fitting into the actual ensemble.

N 8.24.3.2 At least three specimens shall be tested.

N 8.24.4 Apparatus.

N 8.24.4.1 A specimen mounting ring shall be used for clamping the specimen.

N 8.24.4.1.1 The mounting ring shall have an inner diameter of 150 mm (6 in.).

N 8.24.4.1.2 The mounting ring shall have a means for tightly clamping the specimen along the circumference of the ring and shall hold the specimen perpendicular to the motion of the pushing force.

N 8.24.4.1.3 The mounting ring shall be designed such that a means is provided for affixing it to the fixed (bottom) arm of a tensile testing machine.

N 8.24.4.2 A set of tensile machine jaws shall be used to pull the external fitting perpendicular to the surface of the garment material in which the external fitting is mounted.

N 8.24.4.3 The tensile testing machine shall meet the following criteria:

- (1) It shall be capable of holding the specimen mounting ring securely in the fixed lower arm.
- (2) It shall be capable of holding the flat plate pushing device securely in the movable upper arm.
- (3) It shall have a calibrated dial, scale, or chart to indicate the applied load and elongation.
- (4) The error of the machine shall not exceed 2 percent of any reading within its load range.
- (5) It shall be outfitted with a compression cell.
- (6) The testing machine shall be configured with the compression cell on either the lower or upper arm.

N 8.24.5 Procedure.

N 8.24.5.1 Specimens shall be clamped into the specimen mounting ring and attached to the fixed arm of a tensile testing machine.

N 8.24.5.2 The jaws of the movable arm of a tensile testing machine shall be clamped onto the body of the external fitting.

N 8.24.5.3 The tensile testing machine shall be set in operation but stopped when the external fitting assembly either breaks through the material or when the material breaks along the specimen mounting ring.

N 8.24.5.4 The tensile testing machine jaws shall have a velocity of 508 mm/min (20 in./min) under load conditions and shall be uniform at all times.

N 8.24.5.5 The maximum force registered by the indicating device of the tensile testing machine shall be recorded for each determination.

8.24.6 Report.

8.24.6.1 The pull-out strength of each specimen shall be recorded and reported to the nearest 1 N (¼ lbf).

8.24.6.2 The average pull-out strength shall be calculated, recorded, and reported to the nearest 1 N (¼ lbf).

8.24.7 Interpretation. The average pull-out strength shall be used to determine pass or fail performance.

8.25 Exhaust Valve Mounting Strength Test.

8.25.1 Application. This test method shall apply to exhaust valves mounted on ensembles.

8.25.2 Samples.

8.25.2.1 Samples shall be an exhaust valve mounted into a piece of garment material having a minimum diameter of 200 mm (8 in.). The means of mounting the exhaust valve shall be representative of the construction practices used in the ensemble.

8.25.2.2 Samples shall be conditioned as specified in 8.1.2.

8.25.3 Specimens.

8.25.3.1 Specimens shall be complete exhaust valve assemblies mounted into a piece of ensemble material.

8.25.3.2 At least three specimens shall be tested.

8.25.4 Apparatus.

8.25.4.1 A specimen mounting ring shall be used for clamping the sample.

8.25.4.1.1 The mounting ring shall have an inner diameter of 150 mm (6 in.).

8.25.4.1.2 The mounting ring shall have a means for tightly clamping the specimen along the circumference of the ring and shall hold the specimen perpendicular to the motion of the pushing force.

8.25.4.1.3 The mounting ring shall be designed such that a means is provided for affixing it to the fixed (bottom) arm of a tensile testing machine and that a minimum 50 mm (2 in.) unobstructed space is provided under the specimen.

8.25.4.2 A flat plate pushing device shall be 50 mm (2 in.) in diameter and shall have a means for being attached to the movable (upper) arm of a tensile testing machine. The flat plate shall be oriented perpendicular to the motion of the pushing force.

8.25.4.3 The tensile testing machine shall meet the following criteria:

- (1) The machine shall be capable of holding the specimen mounting ring securely in the fixed lower arm.
- (2) The machine shall be capable of holding the flat plate pushing device securely in the movable upper arm.
- (3) The machine shall have a calibrated dial, scale, or chart to indicate the applied load and elongation.
- (4) The error of the machine shall not exceed 2 percent of any reading within its loading range.
- (5) The machine shall be outfitted with a compression cell.
- (6) The testing machine shall be configured with the compression cell on either the lower or upper arm.

8.25.5 Procedure.

8.25.5.1 Specimens shall be clamped into the specimen mounting ring and attached to the fixed arm of a tensile testing machine.

8.25.5.2 The flat plate pushing device shall be attached to the movable arm of a tensile testing machine.

8.25.5.3 The tensile testing machine shall be set in operation but stopped when the exhaust valve either breaks through the material or when the material breaks along the specimen mounting ring.

8.25.5.4 The flat plate pushing device shall have a velocity of 305 mm/min (12 in./min) under load conditions and shall be uniform at all times.

8.25.5.5 The maximum force registered by the indicating device of the tensile testing machine shall be recorded for each determination.

8.25.6 Report.

8.25.6.1 The mounting strength of each specimen shall be reported to the nearest 1 N (¼ lbf).

8.25.6.2 The average mounting strength shall be calculated and reported to the nearest 1 N (¼ lbf).

8.25.7 Interpretation. The average mounting strength shall be used to determine pass/fail performance.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 The requirements of this standard were developed taking into consideration the needs of emergency response personnel for hazardous materials emergencies. This application can entail a variety of chemical, physical, and other hazards. Other protection needs should warrant a thorough review of the requirements in this standard, such as routine industrial operations to determine their applicability.

There are no requirements in this standard that address reuse or multiple wearings of liquid splash-protective ensembles. Users are cautioned that exposure of liquid splash-protective ensembles to chemicals could require disposal, particularly if the effectiveness of decontamination cannot be assessed.

A.1.1.2 The flash fire option should be only applied to ensembles.

A.1.1.4 Organizations responsible for specialized hazardous materials response functions including ionizing radiation, biological, liquefied gas, or cryogenic liquid hazards, explosive atmospheres, or fire-fighting applications should use protective clothing and equipment specifically designed for protection for those operations.

A.1.1.5 See A.1.1.4.

A.1.1.6 See A.1.1.4.

A.1.1.7 See A.1.1.4.

N A.1.1.8 Separate standards are established for the certification of suitable respirators that include 42 CFR 84, NFPA 1981, and NFPA 1986. The choice of appropriate respiratory protective equipment for use with NFPA 1992 protective garments and ensembles should be based on an assessment of the anticipated respiratory hazards encountered during hazardous materials emergencies. The certification of nonencapsulating ensembles where there is an interface between the respirator facepiece and the protective garment requires that the manufacturer specify each type of respirator that is worn with the ensemble and the evaluation of each combination of respirator and garment to the requirements of this standard.

A.1.2.1 This standard does not include any specific design or performance requirement or test method that demonstrates protection from particulates such as radiological particulates or particulate toxins.

A.1.2.2 The testing requirements in Chapter 7 of this standard are not intended to establish the limitations of the working environment for hazardous materials emergencies but are intended to establish material performance.

Users should be advised that if unusual conditions prevail, or if there are signs of abuse or mutilation of the protective ensemble or any element or component thereof, or if modifications or replacements are made or accessories are added without authorization of the protective ensemble element manufacturer, the margin of protection might be reduced.

Users should be advised that the protective properties in new liquid splash-protective ensembles, as required by this standard, can diminish as the product is worn and ages.

It is strongly recommended that purchasers of liquid splash-protective ensembles consider the following:

- (1) Emergency response personnel must wear many items of protective clothing and equipment. Any interference by one item with another item's use might result in inefficient operations or unsafe situations.
- (2) Different breathing apparatus, communications systems, cooling devices, and other protective equipment might not be equally accommodated by each liquid splash-protective suit.
- (3) Specification of additional reinforcement in high-wear or load-bearing areas, such as the knees, elbows, shoulders, and back, can be necessary. Reinforcing materials should be the same as the garment material. Purchasers are cautioned that additional weight caused by excessive reinforcement could lead to fatigue or injury to the wearer and change or shorten the life of the garment.

N A.1.3.6 See A.1.1.8.

A.1.3.8 Emergency response organizations are cautioned that accessories are not part of the certified product but could be attached to a certified product by a means not engineered, manufactured, or authorized by the certified product manufacturer.

Emergency response organizations are cautioned that if an accessory or its means of attachment causes the structural integrity of the certified product to be compromised, the certified product might not be compliant with the standard to which it was originally certified as compliant. Additionally, if an accessory or the accessory's means of attachment are not designed and manufactured from suitable materials for the

hazardous environments of emergency incidents, the failure of the accessory, or its means of attachment, could cause injury to the emergency responder.

Because the aftermarket for accessories for certified product is so broad, emergency response organizations are advised to contact both the accessory manufacturer and the manufacturer of the certified product and verify that the accessory and its means of attachment are suitable for use in the intended emergency response environment. Emergency response organizations should seek and receive written documentation to validate the following information from the accessory manufacturer:

- (1) Accessories for certified product, and the means of attachment, will not degrade the designed protection or performance of the certified product below the requirements of this standard to which it was designed, manufactured, tested, and certified.
- (2) The accessory, when properly attached to the certified product, will not interfere with form, fit, or function of any of the certified product or with the form, fit, and function of any of the certified product's component parts.

Users are also cautioned that the means of attachment for accessories that fail to safely and securely attach the accessory to a certified product can allow the accessory to become inadvertently dislodged from the certified product and could cause a risk to emergency response personnel in the vicinity.

A.1.4 Metric units are used throughout this document with approximate U.S. units provided in parentheses. The metric units are the requirements.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.8 Chemical Flash Fire. The Technical Committee on Hazardous Materials Protective Clothing and Equipment realized that a policy of wearing protective clothing is needed that recognizes the significant threat to fire fighters who can be exposed to flash fires in either structural fire-fighting or hazardous materials environments. It is hoped that fire fighters utilize awareness training on burn injuries caused by the ignition of the environment. There is a distinct difference between chemical flash fires and flashovers occurring in structural fire-fighting environments.

Flashover is a phenomenon that requires heat and generates temperatures in the range of 650°C to 815°C (1200°F to 1500°F). A chemical flash fire requires an ignition source and a chemical atmosphere that contains a concentration above the lower explosive limit of the chemical. Chemical flash fires generate heat from 540°C to 1040°C (1000°F to 1900°F). A structural fire flashover as a rule is confined to a designated area with walls as a boundary. A chemical flash fire depends on the size of the gas or vapor cloud and when ignited, the flame front expands outward in the form of a fireball. The resulting effect of the fireball's energy with respect to radiant heat significantly enlarges the hazard areas around the gas released.

A.3.3.9 Chemical-Protection Layer. The chemical-protection layer is considered as "primary material" and can be configured as a separate layer or as a composite with other primary materials. The chemical-protection layer can depend on the other primary material to provide the physical protection.

A.3.3.13 Component(s). Components include items required for the design and construction of the product and are evaluated and tested individually, or are evaluated and tested as a part of the whole product.

A.3.3.15 Cryogenic Liquid. Examples of cryogenic liquids include helium, nitrogen, and oxygen. This is not an inclusive list of cryogenic liquids.

A.3.3.17 Elastomeric Interface Material. Examples of elastomeric interface material could include garment hood to respirator facepiece, garment sleeve to glove, and garment leg to boot. The materials used in these interfaces can be different from the other garment materials, with unique properties that should be evaluated as part of the compliance testing.

A.3.3.24 External Fittings. Airline, cooling device, and communications system connections or pass-throughs, and glove and boot interface materials are examples of external fittings.

A.3.3.34 Hazardous Materials. Hazardous materials are any solid, particulate, liquid, gas, aerosol, or mixture thereof that can cause harm to the human body through respiration, ingestion, skin absorption, injection, or contact.

A.3.3.37 Ionizing Radiation. Ionizing radiation includes alpha particles, beta particles, x-rays, and gamma rays. Ionizing radiation derives its name from its ability to "ionize" atoms and molecules with which it interacts. In other words, ionizing particles and energy waves possess enough energy to literally

knock apart the atomic structure of the material and break chemical bonds. This rearrangement of the atomic structure of a material results in a release of a great deal of energy in a very small area. When this occurs in living tissue, the tissue can be severely damaged or destroyed. Additionally, the atomic particles knocked loose by the radiation can themselves ionize other atoms, propagating the damage.

A.3.3.39 Liquefied Gas. Examples of liquefied gases include ammonia, 1,2-butadiene, chlorine, ethylene oxide, hydrogen chloride, liquefied petroleum gas, and methyl chloride. This is not an inclusive list of liquefied gases.

A.3.3.40 Liquid Splash-Protective Clothing. Liquid splash-protective clothing includes, but is not limited to, garments, gloves, and footwear.

A.3.3.41 Liquid Splash-Protective Ensemble. Liquid splash-protective ensemble elements include, but are not limited to, the garments, gloves, and footwear.

A.3.3.42 Liquid Splash-Protective Footwear. Liquid splash-protective footwear includes boots, or outer boots in conjunction with socks.

A.3.3.43 Liquid Splash-Protective Garment. Liquid splash-protective garments include coveralls, multipiece splash suits, encapsulating ensembles, and nonencapsulating ensembles.

A.3.3.45 Liquid-Splash Protective Hood. Hoods used for liquid-splash protection during hazardous materials emergencies can have several different configurations that include, but are not limited to, the following:

- (1) The hood can be a separate item of protective clothing that covers the head and neck of the wearer and includes a face opening for a respirator to provide complete head and neck protection.
- (2) The hood can be a separate item of protective clothing that includes a visor, with a respirator worn under the hood.
- (3) The hood can be a loose-fitting facepiece powered air-purifying respirator (PAPR) that includes a hood or other materials that enclose the wearer's head and neck while also providing respiratory protection. In this configuration, the PAPR is certified by the National Institute for Occupational Safety and Health (NIOSH) for respiratory protection; however, the hood is addressed in this standard as a separate item of clothing or as an element of an ensemble and is subject to separate labeling, design, and performance requirements.

A.3.3.50 Nonencapsulating Ensemble. Criteria are provided in this standard to permit the certification of either an encapsulating protective ensemble, which fully encloses the individual wearer and their respirator, or a nonencapsulating ensemble, where the respirator (primarily the full facepiece) completes the enclosure of the individual wearer in conjunction with garments, gloves, and footwear. Certification of nonencapsulating ensembles requires that the manufacturer specify each type of respirator. Each combination of nonencapsulating liquid splash-protective ensemble and respiratory must be evaluated for the relevant design and performance criteria of this standard.

In addition, the self-contained breathing apparatus (SCBA) is not evaluated to the chemical penetration resistance requirements that are applied to primary materials of the liquid

splash-protective ensemble. Organizations specifying and using nonencapsulating, liquid splash-protective ensembles should take into consideration the absence of these performance criteria where performing a hazard and risk assessment for determining the appropriate use of hazardous chemical protective ensembles.

A.3.3.54 Particulates. For the purpose of this standard, particulates do not include aerosols or suspended liquid droplets in air. Aerosols are considered liquids.

A.3.3.56 Product Label. The product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark can be attached to it or be part of the product label.

A.3.3.67 Self-Contained Breathing Apparatus (SCBA). For the purposes of this standard, where the term is used without a qualifier, it indicates only open-circuit self-contained breathing apparatus or combination SCBA/SARs. See also the definitions for *Atmosphere-Supplying Respirator*, *Combination SCBA/SAR*, and *Supplied Air Respirator*.

NA.3.3.68 Sock. For the purposes of this standard, a sock is always worn inside external footwear. Other common terms used to describe footwear include shoe covers, socks, and boots. A shoe cover is always worn outside of the footwear. A sock can be worn either inside or outside the footwear per the manufacturer's instructions. A boot provides physical protection of the internal chemical protective sock.

A.3.3.71 Vapor-Protective Ensemble. The vapor-protective ensemble elements include, but are not limited to, the suit, gloves, and footwear.

ΔA.4.1.4 The compliance of liquid splash-protective ensembles in meeting this standard is determined by the NFPA battery of chemicals. Each liquid splash-protective ensemble, or element of a liquid splash-protective ensemble, meeting the requirements of this standard will have a list of chemicals or chemical mixtures associated with it.

Vapor-protective ensembles meeting the requirements of NFPA 1991 provide additional levels of protection not required for protective ensembles compliant with this standard.

A.4.1.7 The National Fire Protection Association (NFPA), from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment might be carrying labels falsely identifying them as compliant with an NFPA standard. The requirement for placing the certification organization's mark on or next to the product label is to help ensure that the purchaser can readily determine compliance of the respective product through independent third-party certification.

A.4.2.1 The certification organization should have a sufficient breadth of interest and activity so that the loss or award of a specific business contract would not be a determining factor in the financial well-being of the agency.

A.4.2.5 The contractual provisions covering a certification program should contain clauses advising the manufacturer that if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently listed products.

Without the clauses, certifiers would not be able to move quickly to protect their name, marks, or reputation. A product safety certification program would be deficient without these contractual provisions and the administrative means to back them up.

A.4.2.6 Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the agency before any major testing is undertaken.

A.4.2.7.1 For further information and guidance on recall programs, see 21 CFR 7, Subpart C.

A.4.2.9 Such inspections should include, in most instances, witnessing of production tests. With certain products the certification organization inspectors should select samples from the production line and submit them to the main laboratory for countercheck testing. With other products, it could be desirable to purchase samples in the open market for test purposes.

A.4.3.16 Manufacturers are not limited in their approaches for designing liquid splash-protective ensembles compliant with this standard. If the ensemble design uses combinations of materials or components to meet one part of the standard, then the same combinations must be assessed for all parts of the standard. For example, if a two-part visor is used such that the visor materials meet the chemical resistance requirement, the outer visor cannot be removed to meet the visor clarity requirement. The same configuration must be used for all performance requirements.

NA.4.4.3.3 A subset of the chemicals has been chosen from the full battery of 10 chemicals that are specified in 8.4.4.1 to represent those chemical challenges deemed representative for periodically assessing material performance and the barrier characteristics of seams and closures. Fuel H was selected to represent a hydrocarbon mixture that simulates gasoline and potentially affects adhesives that might be used in seams and closures; methyl isobutyl ketone provides a low surface tension chemical that has some degradation effects on materials; and sulfuric acid is a representative strong inorganic acid and corrosive liquid.

NA.4.5.3 In September of 2015, a revised edition of ISO 9001, *Quality Management Systems — Requirements*, was issued. Both the 2008 and 2015 editions of the standard are being referenced in this revision of NFPA 1992 to allow manufacturers time to transition their quality management systems registration to the new edition.

A.4.5.4 For example, this situation exists when a product is wholly manufactured and assembled by another entity or entities for a separate entity that puts its name and label on the product (frequently called "private labeling") and markets and sells the product as its own product.

A.4.5.5 Subcontractors include, but are not limited to, a person or persons, company, firm, corporation, partnership, or other organization having an agreement with or under contract with the compliant product manufacturer to supply or assemble the compliant product or portions of the compliant product.

ΔA.4.6.1 ISO Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*, is a component of accreditation of certification organizations specified in 4.1.4 and 4.2.3 of this standard. Those paragraphs