NFPA® 1951

Standard on Protective Ensembles for Technical Rescue Incidents

2013 Edition

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

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NFPA® 1951

Standard on

Protective Ensembles for Technical Rescue Incidents

2013 Edition

This edition of NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*, was prepared by the Technical Committee on Special Operations Protective Clothing and Equipment, released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, and acted on by NFPA at its June Association Technical Meeting held June 11–14, 2012, in Las Vegas, NV. It was issued by the Standards Council on August 9, 2012, with an effective date of August 29, 2012, and supersedes all previous editions.

This edition of NFPA 1951 was approved as an American National Standard on August 29, 2012.

Origin and Development of NFPA 1951

The Technical Committee on Special Operations Protective Clothing and Equipment began work on the first edition of NFPA 1951, *Standard on Protective Ensembles for USAR Operations*, in 1997 to answer the need for personal protective equipment for fire and emergency services personnel operating at technical rescue incidents involving building or structural collapse, vehicle/person extrication, confined space entry, trench/cave-in rescue, rope rescue, and similar incidents. Technical rescue incidents in urban and other nonwilderness locations are complex incidents requiring specially trained personnel and special equipment.

The Technical Committee developed NFPA 1951 with the goal of establishing personal protection requirements for protective ensembles to reduce the safety risks and health risks associated with exposure of personnel to the hazards of technical rescue during search, rescue, extrication, treatment, recovery, site stabilization, and other mitigation operations at or involving urban search and rescue (USAR) incidents.

The majority of performance criteria in this standard were based on the September 1993 U.S. Fire Administration Study "Protective Clothing and Equipment Needs of Emergency Responders for Urban Search and Rescue Missions" (FA-136, Federal Emergency Management Agency), September 1993. That report documented the protective clothing and equipment needs for emergency responders engaged in technical rescue activities. Input was obtained from an emergency responder user requirements committee and resulted in proposed criteria based on a needs and risk analysis. The U.S. Fire Administration report contains survey results and test data for a number of materials.

The jurisdiction of this Technical Committee does not include the respiratory protection that is necessary for these operations; the appropriate respiratory protection needs to be addressed by emergency responder organizations.

With the second edition of NFPA 1951, the title was changed to *Standard on Protective Ensembles for Technical Rescue Incidents*, to clarify that the standard applies to all emergency services organizations that perform technical rescue incident operations, not just to USAR teams of state or federal governments. The second edition embraced the broader audience of emergency responders for whom these types of protective ensembles are developed to provide protection from the expected hazards common to such operations.

The second edition specified requirements for three different types of technical rescue ensembles:

(1) A *utility* ensemble, which provides protection from physical hazards, a basic flame resistance for the ensemble and the elements of the ensemble, and a high level of "breathability" of the ensemble to reduce heat stress for the wearers
(2) A *rescue and recovery* ensemble, which provides the physical protection of the utility ensemble and a blood-borne-pathogen barrier to protect wearers from body fluid infection from injured or deceased victims

(3) A *CBRN* ensemble, which in addition to all the protections of the rescue and recovery ensemble, provides limited protection from chemicals, biological agents, and radiological particulates during incidents involving chemical warfare agents or weapons of mass destruction

It is left to emergency services organizations to select the appropriate ensembles for the protection of their emergency responders based on the expected and anticipated technical rescue incidents to which the organizations will or could respond.

The 2013 (third) edition of NFPA 1951 includes a number of editorial changes, new definitions, and updated washing and drying procedures for whole garments, gloves, glove pouches, and CBRN materials. New sections on helmet positioning, glove test areas, and pouch construction have also been included. The man-in-simulant test (MIST) in Chapter 8 has been completely revised, and a new torque test for protective gloves has been added to the end of Chapter 8.

In Memoriam, 11 September 2001

We pay tribute to the 343 members of FDNY who gave their lives to save civilian victims on 11 September 2001, at the World Trade Center. They are true American heroes in death, but they were also American heroes in life. We will keep them in our memory and in our hearts. They are the embodiment of courage, bravery, and dedication. May they rest in peace.

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

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

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

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Standard on

Protective Ensembles for Technical Rescue Incidents

2013 Edition

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

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

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 mandatory sections of the document are given in Chapter 2 and those for extracts in 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 shall 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 the minimum design, performance, testing, and certification requirements for utility technical rescue, rescue and recovery technical rescue, and chemicals, biological agents, and radiological particulate [also known as chemical, biological, radiological, and nuclear (CBRN)] technical rescue protective ensembles for use by emergency services personnel during technical rescue incidents.

1.1.2 This standard shall also specify the minimum requirements for the various elements of the utility technical rescue ensembles and the rescue and recovery technical rescue protective ensembles, including garments, helmets, gloves, footwear, interface, and eye and face protection devices.

1.1.3* This standard shall also specify the minimum requirements for the respiratory protection for the CBRN technical rescue protective ensembles.

1.1.4 This standard shall not specify requirements for respiratory protection equipment for utility technical rescue or rescue and recovery technical rescue protective ensembles; those requirements are specified by NIOSH in 42 CFR 84 and by OSHA in 29 CFR 1910.134.

1.1.5 This standard shall not establish criteria for water or wilderness operations.

1.1.6* This standard shall not specify requirements for any visibility markings.

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

1.1.8 This standard shall not establish criteria for protection for any fire-fighting operations or hazardous materials emergencies.

1.1.9* This standard shall not specify requirements for accessories that could be attached to any ensemble or ensemble element but are not required for the ensemble or element to meet the requirements of this standard.

1.1.10 Certification of technical rescue protective ensembles or ensemble elements to the requirements of this standard shall not preclude certification to additional applicable standards where the protective ensemble or ensemble elements meet all the applicable requirements of the other standards.

1.1.11 This standard shall not be construed as addressing all the safety concerns associated with the use of compliant protective ensembles or elements. It shall be the responsibility of the persons and organizations that use compliant protective ensembles or elements to establish safety and health practices and to determine the applicability of regulatory limitations prior to use.

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

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

1.2* Purpose.

1.2.1* The purpose of this standard shall be to establish minimum levels of protection for emergency services personnel assigned to or involved in search, rescue, treatment, decontamination, recovery, site stabilization, and similar operations at technical rescue incidents.

1.2.2 To achieve that purpose, this standard shall establish requirements for three different ensembles and their associated ensemble elements designed to provide protection to emergency response personnel during technical rescue incidents.

1.2.2.1* Utility technical rescue protective ensembles and ensemble element requirements shall establish limited protection for operational settings where exposure to physical and thermal hazards are expected.

1.2.2.2* Rescue and recovery technical rescue protective ensembles and ensemble element requirements shall establish limited protection for operational settings where exposure to physical, thermal, liquid, and body fluid–borne pathogen hazards are expected.

1.2.2.3* CBRN technical rescue protective ensemble and ensemble element requirements shall establish limited protection in operational settings where exposure to physical, thermal, liquid, and body fluid–borne pathogen hazards and CBRN agents in vapor, liquid-splash, and particulate forms are expected during terrorism incident operations.

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

1.2.4 This standard 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 utility technical rescue, rescue and recovery technical rescue, and CBRN technical rescue protective ensembles and new ensemble elements.

1.3.2 This edition of NFPA 1951 shall not apply to urban search and rescue (USAR) protective ensembles and ensemble elements manufactured and certified to previous editions of this standard.

1.3.3 This standard shall not apply to utility technical rescue, rescue and recovery technical rescue, and CBRN technical rescue protective ensembles and ensemble elements manufactured to the requirements of any other organization's standards.

1.3.4 This standard shall not apply to protective ensembles or protective ensemble elements for personnel assigned to or involved in search, rescue, recovery, or site stabilization operations that require the functional capabilities for water or wilderness incidents.

1.3.5* The requirements of this standard shall not apply to accessories that could be attached to any element of technical rescue ensembles.

1.3.6* This standard shall not apply to protection for any firefighting operations or hazardous materials emergencies.

1.3.7 This standard shall not apply to protection from ionizing radiation, protection from all chemical warfare agents, protection from all biological agents, protection from all weapons of mass destruction, or protection from all toxic industrial chemicals.

1.3.8 This standard shall not apply to the use of utility technical rescue, rescue and recovery technical rescue, and CBRN technical rescue protective ensembles and ensemble elements.

1.3.9* The requirements of this standard shall not apply to any accessories that could be attached to the product but that 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, because 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 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2013 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services,* 2007 edition.

2.3 Other Publications.

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

AATCC 42, *Water Resistance: Impact Penetration Test*, 2000.

AATCC 61, *Colorfastness to Laundering, Home and Commercial: Accelerated*, 2010.

AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*, 2004.

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

ANSI Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices*, 2010.

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

ASTM B 117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, 2003.

ASTM B 152, *Specification for Copper Sheet, Strip, Plate, and Rolled Bar*, 2000.

ASTM D 471, *Standard Test Method for Rubber Property — Effect of Liquids*, 1998.

ASTM D 747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*, 2002.

ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, 2004.

ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting*, 2003.

ASTM D 3787, *Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics — Ball Burst Testing Method.*

ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, 2001.

ASTM D 3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*, 2004.

ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*, 1983.

ASTM D 4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, 2002.

ASTM D 4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics*, 1998.

ASTM D 5034, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Grab Method)*, 2001.

ASTM D 5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*, 2003.

ASTM D 5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners*, 1998 (2010).

ASTM D 5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners*, 1998 (2010).

ASTM D 5587, *Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure,* 2005.

ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, 2008.

ASTM F 392, *Standard Test Method for Flex Durability of Flexible Barrier Materials,* 2004.

ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 2003.

ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact,* 2005.

ASTM F 1342, *Standard Test Method for Protective Clothing Material Resistance to Puncture,* 2005.

ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin,* 1999.

ASTM F 1671, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage as a Test System*, 2003.

ASTM F 1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, 2004.

ASTM F 1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials using a Sweating Hot Plate*, 2002.

ASTM F 2010, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test*, 2000.

ASTM F 2412, *Standard Test Methods for Foot Protection*, 2005.

ASTM F 2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear*, 2011.

ASTM F 2700, *Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating*, 2008.

2.3.4 FIA Publications. Footwear Industries of America, 1420 K Street, NW, Suite 600, Washington, DC 20005.

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

2.3.5 ISO Publications. International Organization for Standardization, 1, rue de Varembé, Case Postale 56, CH-1211 Geneve 20, 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 Guide 62, *General requirements for bodies operating assessment and certification/registration of quality systems,* 1983.

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

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

ISO 9001, *Quality Management Systems — Requirements*, 2000.

ISO 13287, *Personal Protective Equipment — Footwear — Test Method for Slip Resistance*, 2006.

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

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

ISO 17025, *General requirements for the competence of calibration and testing laboratories*, 1999.

2.3.6 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J211, *Instrumentation for Impact Test.*

2.3.7 U.S. Department of Defense Publications. Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

A-A-55126, *Commercial Item Description: Fastener Tapes, Hook and Pile, Synthetic*, 1999.

A-A-55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic*, 2006.

A-A-55634, *Commercial Item Description: Zippers (Fasteners, Slide Interlocking)*, 2004.

MIL-F-10884G, *Fastener, Snap*, 16 June 1995.

2.3.8 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910.132, "Personal Protective Equipment: General Requirements."

Title 29, Code of Federal Regulations, Part 1910.134, "Personal Protective Equipment: Respiratory Protection."

Title 42, Code of Federal Regulations, Part 84, "Approval of Respiratory Protective Devices," 2004.

Statement of Standard for NIOSH CBRN PAPR Testing, 2003.

Statement of Standard for NIOSH CBRN SCBA Testing, 2008.

2.3.9 Other Publications.

Assessment of the U.S. Army Chemical and Biological Defense Command Report 1: Technical Assessment of the Man-In-Simulant Test (MIST) Program, National Research Council Report, 1997.

The Technical Cooperation Program, Chemical Biological Defence Technical Panel 11 on Low Burden, Integrated Protective Clothing, "Final Report: Development of a Standard Vapour Systems Test to Assess the Protection Capability of NBC Individual Protective Ensembles," Appendix G, Defence Research Establishment Suffield Report, April 1997, UNCLASSIFIED.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2008 edition.

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. An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

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

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

3.2.5 Shall. Indicates a mandatory requirement.

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

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

3.3 General Definitions.

3.3.1 Arch. The bottom curve of the foot, from the heel to the ball.

3.3.2 Barrier Layer. The component of the ensemble that is intended to provide protection from hazardous liquids.

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

3.3.4 Biological Terrorism Agents. Liquid or particulate agents that can consist of biologically derived toxins or pathogens to inflict lethal or incapacitating casualties.

3.3.5 Body Fluid–Borne Pathogen. An infectious bacterium or virus carried in human, animal, or clinical body fluids, organs, or tissue.

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

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

3.3.8 Cargo Pockets. Pockets located on the protective garment exterior.

3.3.9 CBRN. An abbreviation for chemicals, biological agents, and radiological particulate hazards. *(See also 3.3.18, CBRN Terrorism Agents.)*

3.3.10* CBRN Barrier Layer. The component of the ensemble that provides protection against CBRN terrorism agents.

3.3.11 CBRN Technical Rescue Protective Ensemble. Multiple elements of compliant protective clothing and protective equipment designed and configured as an ensemble to provide limited protection in operational settings where exposure to physical, thermal, liquid, and body fluid–borne pathogen hazards, and CBRN agents in vapor, liquid-splash, and particulate forms are expected.

3.3.12 CBRN Technical Rescue Protective Ensemble Elements. The parts that comprise the CBRN technical rescue protective ensemble, that include coats, trousers, coveralls, helmets, hoods, gloves, footwear, respirator, and interface components.

3.3.13 CBRN Technical Rescue Protective Footwear Element. The element of the certified CBRN technical rescue protective ensemble element that provides protection to the foot, ankle, and leg.

3.3.14 CBRN Technical Rescue Protective Garment Element. The coat, trouser, or coverall of the certified CBRN technical rescue protective ensemble that provides protection to the upper and lower torso, arms, and legs.

3.3.15 CBRN Technical Rescue Protective Glove Element. The element of the certified CBRN technical rescue protective ensemble that provides protection to the hand and wrist.

3.3.16 CBRN Technical Rescue Protective Helmet Element. The element of the certified CBRN technical rescue protective ensemble that provides protection to the head.

3.3.17 CBRN Technical Rescue Protective Hood Element. An interface element of the certified CBRN technical rescue protective ensemble that provides protection to the coat/helmet/respirator facepiece area.

3.3.18* CBRN Terrorism Agents. Chemicals, biological agents, radiological particulates (also known as "chemical, biological, radiological, nuclear") that could be released as an act of terrorism. *(See also 3.3.21, Chemical Terrorism Agents; 3.3.4, Biological Terrorism Agents; and 3.3.88, Radiological Particulate Terrorism Agents.)*

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

3.3.20 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.

3.3.21 Chemical Terrorism Agents. Liquid, solid, gaseous, and vapor chemical warfare agents and toxic industrial chemicals used to inflict lethal or incapacitating casualties, generally on a civilian population as a result of a terrorist attack.

3.3.22 Coat. See 3.3.14, CBRN Technical Rescue Protective Garment Element; 3.3.94, Rescue and Recovery Technical Rescue Protective Garment Element; and 3.3.128, Utility Technical Rescue Protective Garment Element.

3.3.23 Collar. The portion of a coat or coverall that encircles the neck.

3.3.24 Collar Lining. That part of collar fabric composite that is next to the skin when the collar is closed in the raised position.

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

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

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

3.3.28 Coverall. See 3.3.14, CBRN Technical Rescue Protective Garment Element; 3.3.94, Rescue and Recovery Technical Rescue Protective Garment Element; and 3.3.128, Utility Technical Rescue Protective Garment Element.

3.3.29 Decontamination. The act of removing contaminants from protective clothing and equipment by a physical, chemical, or combined process. [**1851,** 2008]

3.3.30 Drip. To run or fall in drops or blobs.

3.3.31 Element(s). See 3.3.33, Ensemble Elements.

3.3.32 Energy Absorbing System. Materials or systems used to attenuate impact energy.

3.3.33 Ensemble Elements. The certified parts of an ensemble that provide protection to the upper and lower torso, arms, legs, head, hands, and feet.

3.3.34* Flame Resistance. The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or nonflaming source of ignition, with or without subsequent removal of the ignition source.

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

3.3.36 Flash Fire. A fire that rapidly spreads through a diffuse fuel, such as a dust, gas, or the vapors of an ignitable liquid, without the production of damaging pressure.

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

3.3.38 Footwear. See 3.3.93, Rescue and Recovery Technical Rescue Protective Footwear Element; 3.3.13, CBRN Technical Rescue Protective Footwear Element; and 3.3.123, Utility Technical Rescue Protective Footwear Element.

3.3.39 Footwear Upper. The portion of the protective footwear element or item that includes, but is not limited to, the toe, vamp, quarter, shaft, collar, and throat, but not including the sole with heel, puncture-resistant device, and insole.

3.3.40 Garment. See 3.3.14, CBRN Technical Rescue Utility Protective Garment Element; 3.3.94, Rescue and Recovery Technical Rescue Protective Garment Element; and 3.3.128, Utility Technical Rescue Protective Garment Element.

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

3.3.42 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.

3.3.43 Garment Material. The primary protective material(s) used in the construction of garments.

3.3.44 Gauntlet. An interface component of the protective glove element that provides limited protection to the coat/glove interface area.

3.3.45 Glove. See 3.3.15, CBRN Technical Rescue Protective Glove Element; 3.3.95, Rescue and Recovery Technical Rescue Protective Glove Element; and 3.3.129, Utility Technical Rescue Protective Glove Element.

3.3.46 Glove Body. The part of the glove that extends from the tip of the fingers to 25 mm (1 in.) beyond the wrist crease.

3.3.47 Glove Gauntlet. See 3.3.44, Gauntlet.

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

3.3.49 Goggles. The component that provides protection to the wearer's eyes and a portion of the wearer's face.

3.3.50* Gusset. The part of the protective footwear that is a relatively flexible material joining the footwear upper (quarter) and the tongue, which is intended to provide expansion of the footwear front to enable donning of the footwear while maintaining continuous moisture integrity of the footwear.

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

3.3.52 Headband. The portion of the helmet suspension that encircles the head.

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

3.3.54 Helmet. See 3.3.16, CBRN Technical Rescue Protective Helmet Element; 3.3.97, Rescue and Recovery Technical Rescue Protective Helmet Element; and 3.3.131, Utility Technical Rescue Protective Helmet Element.

3.3.55 Helmet Positioning Index. The distance, as specified by the manufacturer, from the lowest point of the brow opening at the lateral midpoint of the helmet to the basic plane of

the headform when the helmet is firmly positioned on the headform.

3.3.56 Hood. See 3.3.17, CBRN Technical Rescue Protective Hood Element.

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

3.3.58 Interface Area. An area of the body where the protective garments, helmet, gloves, footwear, or SCBA facepiece meet. Interface areas include, but are not limited to, the coat/helmet/SCBA facepiece area, the coat/trouser area, the coat/glove area, and the trouser/footwear area.

3.3.59* Interface Component(s). Any material, part, or subassembly used in the construction of the compliant product that provides limited protection to interface areas.

3.3.60 Ladder Shank. See 3.3.103, Shank.

3.3.61 Liquid-Borne Pathogen. An infectious bacteria or virus carried in human, animal, or clinical body fluids, organs, or tissues.

3.3.62 Major A Seam. See 3.3.100.1.

3.3.63 Major B Seam. See 3.3.100.2.

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

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

3.3.66 Midsagittal Plane. The anatomical plane perpendicular to the basic plane and containing the midpoint of the line connecting the notches of the right and left inferior orbital ridges and the midpoint of the line connecting the superior rims of the right and left auditory meatus.

3.3.67 Minor Seam. See 3.3.100.3.

3.3.68 Model. The collective term used to identify a group of individual elements 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.

3.3.69 Nape Device. A component used to aid in helmet retention.

3.3.70 Operations.

3.3.70.1 ***Search Operations.*** Any land-based operations involving the search for victims or body recovery.

3.3.70.2 ***Technical Rescue Incidents.*** Those activities directed at locating endangered persons, removing endangered persons from danger, treating the injured at an emergency incident, and providing transport to an appropriate health care facility.

3.3.71 Outer Glove. A secondary glove worn over the glove ensemble element for the purpose of providing CBRN protection.

3.3.72 Outer Shell. The outermost component of an element or item not including trim, hardware, reinforcing material, pockets, wristlet material, accessories, fittings, or suspension systems.

3.3.73 Package. The wrapping or enclosure directly containing the technical rescue ensembles or element.

3.3.74 Product. The compliant protective ensemble or the compliant elements and the compliant interface elements of the protective ensemble.

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

3.3.76 Protective Clothing. See 3.3.11, CBRN Technical Rescue Protective Ensemble; 3.3.91, Rescue and Recovery Technical Rescue Protective Ensemble; and 3.3.125, Utility Technical Rescue Protective Ensemble.

3.3.77 Protective Coat. See 3.3.12, CBRN Technical Rescue Protective Ensemble Elements; 3.3.92, Rescue and Recovery Technical Rescue Protective Ensemble Elements; and 3.3.126, Utility Technical Rescue Protective Ensemble Elements.

3.3.78 Protective Coverall. See 3.3.12, CBRN Technical Rescue Protective Ensemble Elements; 3.3.92, Rescue and Recovery Technical Rescue Protective Ensemble Elements; and 3.3.126, Utility Technical Rescue Protective Ensemble Elements.

3.3.79 Protective Ensemble. See 3.3.11, CBRN Technical Rescue Protective Ensemble; 3.3.91, Rescue and Recovery Technical Rescue Protective Ensemble; and 3.3.125, Utility Technical Rescue Protective Ensemble.

3.3.80 Protective Footwear. See 3.3.13, CBRN Technical Rescue Protective Footwear Element; 3.3.93, Rescue and Recovery Technical Rescue Protective Footwear Element; and 3.3.127, Utility Technical Rescue Protective Footwear Element.

3.3.81 Protective Garment. See 3.3.14, CBRN Technical Rescue Protective Garment Element; 3.3.94, Rescue and Recovery Technical Rescue Protective Garment Element; and 3.3.128, Utility Technical Rescue Protective Garment Element.

3.3.82 Protective Glove. See 3.3.15, CBRN Technical Rescue Protective Glove Element; 3.3.95, Rescue and Recovery Technical Rescue Protective Glove Element; and 3.3.129, Utility Technical Rescue Protective Glove Element.

3.3.83 Protective Goggle. See 3.3.130, Utility Technical Rescue Protective Goggle Element.

3.3.84 Protective Helmet. See 3.3.16, CBRN Technical Rescue Protective Helmet Element; 3.3.97, Rescue and Recovery Technical Rescue Protective Helmet Element; and 3.3.131, Utility Technical Rescue Protective Helmet Element.

3.3.85 Protective Trouser. See 3.3.14, CBRN Technical Rescue Protective Garment Element; 3.3.94, Rescue and Recovery Technical Rescue Protective Garment Element; and 3.3.128, Utility Technical Rescue Protective Garment Element.

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

3.3.87 Radiological Agents. Radiation associated with X-rays, alpha, beta, and gamma emissions from radioactive isotopes, or other materials in excess of normal background radiation levels.

3.3.88* Radiological Particulate Terrorism Agents. Particles that emit ionizing radiation in excess of normal background levels, used to inflict lethal or incapacitating casualties, generally on a civilian population as a result of a terrorist attack.

3.3.89 Recovery. An operation involving the retrieval of either (1) the remains of a deceased victim or (2) property, but in no case a living person.

3.3.90 Rescue. Those operations directed at locating and removing endangered persons and treating the injured at an emergency incident.

3.3.91* Rescue and Recovery Technical Rescue Protective Ensemble. Multiple elements of compliant protective clothing and protective equipment designed and configured as an ensemble to provide limited protection in operational settings where exposure to physical, thermal, liquid, and body fluid–borne pathogen hazards is expected.

3.3.92 Rescue and Recovery Technical Rescue Protective Ensemble Elements. The parts that comprise the rescue and recovery technical rescue protective ensemble, that include coats, trousers, coveralls, helmets, gloves, footwear, and interface components.

3.3.93 Rescue and Recovery Technical Rescue Protective Footwear Element. The certified element of the rescue and recovery technical rescue protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.94 Rescue and Recovery Technical Rescue Protective Garment Element. The coat, trouser, or coverall certified element of the rescue and recovery technical rescue protective ensemble that provides protection to the upper and lower torso, arms, and legs.

3.3.95 Rescue and Recovery Technical Rescue Protective Glove Element. The certified element of the rescue and recovery technical rescue protective ensemble that provides protection to the hand and wrist.

3.3.96 Rescue and Recovery Technical Rescue Protective Goggle Element. The certified element of the rescue and recovery technical rescue protective ensemble that provides partial protection to the face and eyes.

3.3.97 Rescue and Recovery Technical Rescue Protective Helmet Element. The certified element of the rescue and recovery technical rescue protective ensemble that provides protection to the head.

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

3.3.99 Sample. The ensemble, element, item, component, or composite that is conditioned for testing. *(See also 3.3.106, Specimen.)*

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

3.3.100.1 ***Major A Seam.*** Outermost layer seam assemblies where rupture could reduce the protection of the garment by exposing the garment's inner layers.

3.3.100.2 ***Major B Seam.*** Inner layer seam assemblies where rupture could reduce the protection of the garment by exposing the next layer of the garment, the wearer's station/work uniform, other clothing, or skin.

3.3.100.3 ***Minor Seam.*** Remaining seam assemblies that are not classified as Major A or Major B seams.

3.3.101 Search. Land-based efforts to find victims or recover bodies.

3.3.102 Separate. A material response evidenced by splitting or delaminating.

3.3.103 Shank. The component of footwear that provides additional support to the instep.

3.3.104 Shell. See 3.3.72, Outer Shell.

3.3.105 Site Stabilization. Those activities directed at mitigating the dangerous elements of an emergency situation.

3.3.106 Specimen. The conditioned element, item, component, or composite that is tested; specimens are taken from samples. *(See also 3.3.99, Sample.)*

3.3.107 Strap.

3.3.107.1 ***Chin Strap.*** An adjustable strap for the helmet that fits under the chin to help secure the helmet to the head.

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

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

3.3.109 Sweatband. That part of a helmet headband, either integral or attached, that comes in contact with the wearer's forehead.

3.3.110 Technical Rescue Incidents. Complex rescue incidents requiring specially trained personnel and special equipment to complete the mission.

3.3.111 Technical Rescue Protective Ensembles. See 3.3.11, CBRN Technical Rescue Protective Ensemble; 3.3.91, Rescue and Recovery Technical Rescue Protective Ensemble; and 3.3.125, Utility Technical Rescue Protective Ensemble.

3.3.112 Technical Rescue Protective Footwear. See 3.3.13, CBRN Technical Rescue Protective Footwear Elements; 3.3.93, Rescue and Recovery Technical Rescue Protective Footwear Element; and 3.3.127, Utility Technical Rescue Protective Footwear Element.

3.3.113 Technical Rescue Protective Garments. See 3.3.128, Utility Technical Rescue Protective Garment Element; 3.3.94, Rescue and Recovery Technical Rescue Protective Garment Element; and 3.3.14, CBRN Technical Rescue Protective Garment Element.

3.3.114 Technical Rescue Protective Gloves. See 3.3.15, CBRN Technical Rescue Protective Glove Element; 3.3.95, Rescue and Recovery Technical Rescue Protective Glove Element; and 3.3.129, Utility Technical Rescue Protective Glove Element.

3.3.115 Technical Rescue Protective Goggles. See 3.3.96, Rescue and Recovery Technical Rescue Protective Goggle Element, and 3.3.130, Utility Technical Rescue Protective Goggle Element.

3.3.116 Technical Rescue Protective Helmets. See 3.3.16, CBRN Technical Rescue Protective Helmet Element; 3.3.97, Rescue and Recovery Technical Rescue Protective Helmet Element; and 3.3.131, Utility Technical Rescue Protective Helmet Element.

3.3.117 Textile Fabric. A planar structure consisting of yarns or fibers.

3.3.118 Toecap. A reinforcement to the toe area of footwear designed to protect the toes from impact and compression.

3.3.119* Tongue. The part of the protective footwear that is provided for protective footwear with a closure that extends from the vamp to the top line of the footwear between sides of the footwear upper and is exposed to the exterior environment when the footwear is correctly donned.

3.3.120 Top Line. The top edge of the protective footwear that includes the tongue, gusset, quarter, collar, and shaft.

3.3.121 Torso.

3.3.121.1 ***Lower Torso.*** The area of the body trunk below the waist, excluding the legs, ankles and feet.

3.3.121.2 ***Upper Torso.*** The area of body trunk above the waist and extending to the shoulder, excluding the arms, wrists, and hands.

3.3.122 Toxic Industrial Chemicals. Highly toxic solid, liquid, or gaseous chemicals that have been identified as mass casualty threats that could be used to inflict casualties, generally on a civilian population during a terrorist attack.

3.3.123 Treatment. The provision of medical first aid at the incident.

3.3.124 Trouser. See 3.3.14, CBRN Technical Rescue Protective Garment Element; 3.3.94, Rescue and Recovery Technical Protective Garment Element; and 3.3.128, Utility Technical Rescue Protective Garment Element.

3.3.125 Utility Technical Rescue Protective Ensemble. Multiple elements of protective clothing and protective equipment designed and configured as an ensemble to provide limited protection in operational settings where exposure to physical and thermal hazards are expected.

3.3.126 Utility Technical Rescue Protective Ensemble Elements. The parts that comprise the utility technical rescue protective ensemble, that include coats, trousers, coveralls, helmets, gloves, footwear, and interface components.

3.3.127 Utility Technical Rescue Protective Footwear Element. A certified element of the utility technical rescue protective ensemble that provides protection to the foot, ankle, and lower leg that is certified to the utility protection requirements.

3.3.128 Utility Technical Rescue Protective Garment Element. The coat, trouser, or coverall of the certified element of the utility technical rescue protective ensemble that provides protection to the upper and lower torso, arms, and legs.

3.3.129 Utility Technical Rescue Protective Glove Element. The certified element of the utility technical rescue protective ensemble that provides protection to the hand and wrist.

3.3.130 Utility Technical Rescue Protective Goggle Element. The certified element of the utility technical rescue protective ensemble that provides partial protection to the face and eyes.

3.3.131 Utility Technical Rescue Protective Helmet Element. The certified element of the utility technical rescue protective ensemble that provides protection to the head.

3.3.132 Wear Surface. The bottom of the footwear sole, including the heel.

3.3.133 Wristlet. The interface component of the protective element or item that provides limited protection to the coat/glove interface area.

Chapter 4 Certification

4.1 General.

4.1.1 The process of certification for protective ensembles and ensemble elements as being compliant with NFPA 1951 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 protective 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.

4.1.2.1 The certification organization shall only permit the certification of complete CBRN protective ensembles that include protective garments, protective helmets, protective gloves, protective footwear, and interface components.

4.1.2.2 The certification organization shall further require that the CBRN protective ensemble manufacturer specify the respiratory protection for the ensemble.

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 65, *General requirements for bodies operating product certification systems.* The accreditation shall be issued by an accreditation body operating in accordance with ISO 17011, *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 1951, 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.

4.1.6 All compliant protective ensembles and ensemble elements shall be listed by the certification organization. The listing shall uniquely identify the certified product, for example, by style, model number, or part number.

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

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

4.1.9 The certification organization shall not issue any new certifications to the 2007 edition of this standard on or after the NFPA effective date for the 2013 edition, which is August 29, 2012.

4.1.10 The certification organization shall not permit any manufacturer to continue to label any protective ensembles or ensemble elements that are certified as compliant with the

2007 edition of this standard on or after August 29, 2012 plus 12 months.

4.1.11 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2007 edition of this standard from all protective ensembles and ensemble elements that are under the control of the manufacturer on August 29, 2012 plus 12 months, and the certification organization shall verify that this action is taken.

4.2 Certification Program.

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

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

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

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

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

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

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

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

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

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

4.2.7 The certification organization shall require the manufacturer to establish and maintain a quality assurance program that meets the requirements of Section 4.5, Manufacturer's 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 manufacturing facilities of the compliant product with at least two random and unannounced visits per 12-month period.

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

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

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

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

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

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

4.3 Inspection and Testing.

4.3.1 For both initial certification and recertification of 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 calibration and testing 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, *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, *General requirements for accreditation bodies accrediting conformity assessment bodies*.

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

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

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

4.3.5 Inspection by the certification organization shall include a review of all product labels to ensure that all required label attachments, compliance statements, certification statements, and other product information are at least as specified for the protective 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 representations used on product labels or in user information, as permitted by 5.1.5, to ensure that the symbols are clearly explained in the product's user information package.

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

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

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

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

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

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

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

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

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

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

4.3.15 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.

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

4.4 Annual Verification of Product Compliance.

4.4.1 All individual elements of the protective ensemble that are labeled as being compliant with this standard shall undergo recertification on an annual basis. This recertification shall include the following:

(1) Inspection and evaluation to all design requirements as required by this standard on all manufacturer models and components
(2) Testing to all performance requirements as required by this standard on all manufacturer models and components within the following protocol:
    (a) When a test method incorporates testing both before and after the laundering precondition specified in 8.1.3 and the test generates quantitative results, recertification testing shall be limited to the conditioning that yielded the worst case test result during the initial certification for the model or component.
    (b) Where a test method incorporates testing both before and after the laundering precondition specified in 8.1.3 and the test generates nonquantitative results, recertifications shall be limited to a single conditioning procedure in any given year. Subsequent

annual recertifications shall cycle through the remaining conditioning procedures to ensure that all required conditionings are included over time.

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

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

4.4.2 Samples of manufacturer models and components for recertification acquired from the manufacturer or component supplier during random and unannounced visits as part of the follow-up inspection program in accordance with 4.2.9 shall be permitted to be used toward annual recertification.

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

4.5* Manufacturers' Quality Assurance Program.

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

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

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

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

4.5.3.2 Where the registrar specified in 4.5.3.1 is currently accredited for personal protective equipment in accordance with the 1996 edition of ISO Guide 62, *General requirements for bodies operating assessment and certification/registration of quality systems,* that accreditation shall be permitted until 14 September 2008.

4.5.3.3 Not later than 14 September 2008, registrars specified in 4.5.3.1 shall be accredited for personal protective equipment in accordance with the 2006 edition of ISO/IEC 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems.*

4.5.3.4 Any new accreditations for registrars specified in 4.5.3.1 for personal protective equipment shall only be in accordance with the 2006 edition of ISO/IEC 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems.*

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

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

4.6.12 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 one week period following the manufacturer's decision to issue a safety alert or to conduct a product recall, or after the manufacturer has been directed by the certification organization to issue a safety alert or conduct a product recall
(3) Techniques for communicating accurately and understandably the nature of the safety alert or product recall and in particular the specific hazard or safety issue found to exist
(4) Procedures for removing a product that is recalled and for documenting the effectiveness of the product recall
(5) A plan for either repairing, replacing, or compensating purchasers for returned product

Chapter 5 Labeling and Information

5.1 Product Label Requirements.

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

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

5.1.3* The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label. All letters shall be at least 2.5 mm (3⁄32 in.) high. The label, symbol, or identifying mark shall be at least 6 mm (1⁄4 in.) in height and shall be placed in a conspicuous location.

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

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

5.1.6 The statement specified in 5.1.6.3 or 5.1.6.4 for the specific element being certified shall be printed legibly on the product label. The appropriate term for the element (garment, helmet, glove, footwear, goggles, interface) shall be inserted in this compliance statement text where indicated. All letters shall be at least 2.5 mm (3⁄32 in.) in height.

5.1.6.1 The line that reads "CBRN PROTECTIVE ENSEMBLE FOR TECHNICAL RESCUE INCIDENTS" specified in 5.1.6.4 shall be in letters at least 10 mm (3⁄8 in.) in height.

5.1.6.2 Where the requirements for the utility protective ensemble helmet and footwear elements and for the rescue and recovery protective ensemble helmet and footwear elements are identical for both types of ensembles, the product label text for both "utility and rescue and recovery ensemble elements," as detailed in 5.1.6.3, shall be permitted to be selected.

5.1.6.3 For utility protective ensemble elements and for rescue and recovery protective ensemble elements, the following statement shall be printed as specified in 5.1.6:

"THIS [*insert* "UTILITY," *or* "RESCUE AND RECOVERY," *or both* "UTILITY AND RESCUE AND RECOVERY" *here*] PROTECTIVE ENSEMBLE *[insert appropriate element term here]* ELEMENT MEETS THE REQUIREMENTS OF NFPA 1951, *STANDARD ON PROTECTIVE ENSEMBLES FOR TECHNICAL RESCUE INCIDENTS*, 2013 EDITION. DO NOT REMOVE THIS LABEL."

5.1.6.4 For CBRN protective ensembles, the following statement shall be printed as specified in 5.1.6:

"CBRN PROTECTIVE ENSEMBLE FOR TECHNICAL RESCUE INCIDENTS *THIS ENSEMBLE IS NOT INTENDED AS PART OF A HAZARDOUS MATERIALS PROTECTIVE ENSEMBLE.* THIS CBRN PROTECTIVE ENSEMBLE *[insert appropriate element term here]* ELEMENT MEETS THE CBRN *[insert appropriate element term here]* REQUIREMENTS OF NFPA 1951, *STANDARD ON PROTECTIVE ENSEMBLES FOR TECHNICAL RESCUE INCIDENTS*, 2013 EDITION, WHEN WORN TOGETHER WITH THE OTHER SPECIFIED ELEMENTS AND INTERFACE COMPONENTS OF THE CBRN ENSEMBLE. DO NOT REMOVE THIS LABEL."

5.1.7 The following information shall also be printed legibly on the product label, and all letters shall be at least 1.6 mm (1/16 in.) high:

(1) Manufacturer's name, identification, or designation
(2) Manufacturer's address
(3) Country of manufacture
(4) Manufacturer's element identification number, lot number, or serial number
(5) Month and year of manufacture (not coded)
(6) Model name, number, or design
(7) Size or size range
(8)*Principal material(s) of construction.
   (a) For gloves, at least the outer layer, barrier layer, thermal lining layer, where applicable, and wristlet shall be listed. Generic names of materials shall be used. The type of leather shall be listed. Additional materials that are used throughout the majority of the glove body shall also be listed on the label.
   (b) For footwear, at least the outer layer, barrier layer, and thermal lining layer, where applicable, shall be listed. Generic names of materials shall be used. Additional materials that are used throughout the majority of the boot shall also be listed on the boot label.
   (c) For garments, at least the identification of the fiber or material type of the outer shell, moisture barrier, and thermal barrier, where applicable, shall be listed.
   (d) For helmets, at least the general terminology for the shell material shall be used.
(9) Cleaning precautions, if applicable

5.1.8 Supplementary Product Labels.

5.1.8.1 For garments only, where the outer shell and moisture barrier are separable, each separable layer shall also have a label containing the information required in 5.1.7(4) through 5.1.7(8).

5.1.8.2 Supplementary product labels shall also meet the requirements of 5.1.4 and 5.1.5.

5.1.9 Specific Requirements for CBRN Protective Ensemble for Technical Rescue Incidents Garment Elements.

5.1.9.1 Where the principal material of construction used in a garment is a component that is listed, the component name under which it is listed shall be used.

5.1.9.2 This listed component shall be on the product label by manufacturer name and model number after the following statement:

FOR COMPLIANCE WITH THE CBRN PROTECTIVE ENSEMBLE FOR TECHNICAL RESCUE INCIDENTS REQUIREMENTS OF NFPA 1951, THE FOLLOWING COMPONENT MUST BE WORN IN CONJUNCTION WITH THIS GARMENT:
[*list component here*]

5.1.9.3 All letters shall be at least 2.5 mm (3/32 in.) in height.

5.1.10 Specific Requirements for Technical Rescue Incidents Protective Goggles.

5.1.10.1 For goggles only, the product label shall be permitted to be placed on the package.

5.1.10.2 The package containing the smallest number of goggle elements from which the user withdraws product for use shall have a package product label.

5.1.10.3 The package product label shall be permanently and conspicuously located on the outside of the package or printed on the package.

5.1.10.4 The label shall not be removed, obscured, or otherwise mutilated by the opening of the package when the package is opened as intended.

5.1.10.5 Where goggles have a package label, the certification organization's label, symbol, or identifying mark and at least the following statement shall be legibly printed as the product label on each pair of goggles. All letters and numbers shall be at least 3 mm (1/8 in.) high.

"MEETS NFPA 1951, 2013 EDITION"

5.2 User Information.

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

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

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

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

(1) Pre-use information, including the following:
   (a) Safety considerations
   (b) Limitations of use
   (c) Marking recommendations and restrictions

(d) A statement that most performance properties of the element cannot be tested by the user in the field
(e) Warranty information

(2) Preparation for use, including the following:
(a) Sizing/adjustment
(b) Recommended storage practices

(3) Inspection, including inspection frequency and details

(4) Don/doff, including the following:
(a) Donning and doffing procedures
(b) Sizing and adjustment procedures
(c) Interface issues

(5) Use, including proper use consistent with 29 CFR 1910.132

(6) Maintenance and cleaning, including the following:
(a) Cleaning instructions and precautions with a statement advising users not to use garments 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, including criteria and considerations

5.2.5 For compliant CBRN protective ensembles for technical rescue incidents, the manufacturer shall provide the following additional instruction and information with the ensemble:

(1) A statement that only the ensemble and the specific elements with which the ensemble has been certified must be worn together to ensure that the CBRN protection is provided

(2) A list of the specific elements and interface components that must be worn as part of the CBRN protective ensemble for technical rescue incidents, including each type of CBRN self-contained breathing apparatus (SCBA), CBRN air-purifying respirator (APR), or CBRN powered air-purifying respirator (PAPR) with which the ensemble has been certified

(3) Specific limitations associated with the use of the ensemble for a response involving CBRN hazards, including, but not limited to, a statement that protection against radiological and nuclear hazards is limited to particulates only

(4) Specific care and maintenance provisions associated with properly maintaining the unique performance properties of the ensemble, its elements, or interface components

(5) A statement that if the ensemble is used in an emergency involving CBRN hazards, the ensemble be retired from use and not be further used

(6) When the requirements for CBRN protection necessitate a specific action to engage interface areas, manufacturer's details explaining those procedures.

Chapter 6 Design Requirements

6.1 Utility Protective Ensemble for Technical Rescue Incidents Design Requirements.

6.1.1 Utility Protective Ensemble Garment Elements.

6.1.1.1 Garments shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection Testing.

6.1.1.2 Garments shall be permitted to be single-layer or multiple-layer garments.

6.1.1.3 All garment collars shall remain upright after extension into a vertical position. The coat shall have a collar at least 50 mm (2 in.) in height at any point when measured from the top of the collar down and shall have a closure system. The collar and closure system shall consist of materials that meet all applicable requirements as specified in this section.

6.1.1.4 Garments shall not have turn-up cuffs. Sleeve cuffs shall have a closure system that can be adjusted to provide a snug and secure fit around the wrist when a technical rescue glove is worn.

6.1.1.5 Top-entry pockets shall have cover flaps with a closure system.

6.1.1.6 Pass-through openings of coveralls shall have a closure system that can be easily secured and easily opened by the wearer.

6.1.1.7 Sewing thread utilized in the construction of garments shall be made of an inherently flame-resistant fiber.

6.1.1.8 All garment hardware finish shall be free of rough spots, burrs, and sharp edges.

6.1.1.9 All snaps shall be Style 2 and shall comply with the design and construction requirements of MIL-F-10884G, *Fastener, Snap.*

6.1.1.10 Zippers shall meet the physical performance requirements of A-A-55634, *Commercial Item Description, Zippers (Fasteners, Slide Interlocking).*

6.1.1.11 Expandable pockets, where provided, shall have a means to drain water and shall have a means of being fastened in the closed position. This shall not apply to patch pockets that lie flat on the garment.

6.1.1.12 All upper torso garments shall have closure systems at the neckline.

6.1.1.13 One-piece coverall torso closure systems shall be continuous from the top of the crotch area to the top of the garment at the neck.

6.1.1.14 Metallic closure systems shall not come in direct contact with the body.

6.1.1.15 Metal components of the garments shall not come in direct contact with the body.

6.1.1.16* Garment Sizing.

6.1.1.16.1 Upper torso garment chest circumferences shall be provided in circumferences from 760 mm to 1270 mm (30 in. to 50 in.) in 50 mm (2 in.) increments or cut to order.

6.1.1.16.2 Upper torso garment sleeve lengths shall be provided in lengths from 760 mm to 915 mm (30 in. to 36 in.) in 25 mm (1 in.) increments or cut to order.

6.1.1.16.3 Lower torso garment waist circumferences shall be provided in circumferences from 660 mm to 1270 mm (26 in. to 50 in.) in 50 mm (2 in.) increments or cut to order.

6.1.1.16.4 Lower torso garment inseam lengths shall be provided in lengths from 660 mm to 890 mm (26 in. to 35 in.) in 25 mm (1 in.) increments or cut to order.

6.1.1.16.5 Men's and women's sizing shall be accomplished by the use of individual patterns for men's and women's garments.

6.1.2 Utility Protective Ensemble Helmet Elements.

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

6.1.2.2 Helmets shall consist of material or materials meeting the performance requirements of 7.1.2.

6.1.2.3 Suspension shall contain a nape device and shall be removable and replaceable.

6.1.2.3.1 Helmet suspension shall be adjustable in at least 3 mm (⅛ in.) hat size increments, and the size range that can be accommodated shall be marked on the product label.

6.1.2.3.2 With the suspension adjusted to the maximum designated size, there shall be sufficient clearance between the shell and the headband to provide ventilation.

6.1.2.4 A sweatband shall be provided that shall cover at least the forehead portion of the headband. Sweatbands shall be removable and replaceable or shall be integral with the headband.

6.1.2.5 Crown straps shall be provided and, when assembled, shall form a cradle for supporting the helmet on the wearer's head. The crown straps shall be designed so that the distance between the top of the head and the underside of the shell cannot be adjusted to less clearance than the manufacturer's requirements for that specific helmet.

6.1.2.6 Chin straps shall be provided and shall be attached to the helmet shell. Chin straps shall not be less than 13 mm (½ in.) in width.

6.1.2.7 Sewing thread utilized in the construction of helmets shall be made of an inherently flame-resistant fiber.

6.1.2.8 Product labels and any other identification labels or markers used on helmet shells shall be affixed without holes being made through the shell and without the use of any metal parts or metallic labels.

6.1.3 Utility Protective Ensemble Glove Elements.

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

6.1.3.2 Gloves shall consist of a material or materials meeting the performance requirements of 7.1.3. The composite shall be permitted to be configured as a single layer or multiple layers. If the glove is made up of multiple layers, all layers of the glove shall be individually graded per size.

6.1.3.3 The glove shall consist of a glove body and a glove interface component.

6.1.3.3.1 The glove shall extend circumferentially from the tip of the fingers to beyond the wrist crease.

6.1.3.3.2 The portion of the glove that extends from the tip of the fingers to the wrist crease shall be considered to be the glove body and shall meet the glove body requirements as specified in 7.1.3 or 7.3.4.

6.1.3.3.3 The portion of the glove that extends from the wrist crease up to the end of the entire glove shall be considered to be the glove interface component and shall meet the glove interface component requirements as specified in 7.1.3 or 7.3.4. The glove interface component shall allow the glove to fit closely around the wearer's wrist.

6.1.3.3.4 The weight shall be allowed to hang freely in the air of 60 seconds prior to any measurements.

6.1.3.3.5* Two points shall be marked on the back side of the glove, and the location of the points shall be determined by measuring down the distances shown in Table 6.1.3.3.5 from the finger crotch of digit two and from the finger crotch of digit three. The distances are shown according to glove size.

Table 6.1.3.3.5 Glove Sizes and Corresponding Palm Length

Glove Size	Palm Length	
	cm	in.
XS	9.46–10.04	3.72–3.95
S	10.04–10.68	3.95–4.20
M	10.68–11.21	4.20–4.42
L	11.21–11.73	4.42–4.62
XL	11.73–12.23	4.62–4.81
XXL	12.23–12.71	4.81–5.0

6.1.3.3.6 A straight line shall be drawn on the back side of the glove using the two points. This line shall be drawn around the side edges of the glove.

6.1.3.3.7 The glove shall be removed from the measurement board. A line shall be drawn on the palm side of the glove by connecting the lines from the side edges of the glove.

6.1.3.3.8 The resulting straight line around the circumference of the glove shall be the location of the wrist crease.

6.1.3.4 Sewing thread utilized in the construction of gloves shall be made of an inherently flame-resistant fiber.

6.1.3.5* In order to label or otherwise represent a glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in not fewer than five separate and distinct sizes.

6.1.3.6 Glove Sizing.

6.1.3.6.1 Gloves shall be available in all sizes from XS to XXL.

6.1.3.6.2 Gloves shall be available in at least two finger lengths for all sizes in 6.1.3.6.1.

6.1.4 Utility Protective Ensemble Footwear Elements.

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

6.1.4.2 The footwear shall consist of a composite meeting the performance requirements of 7.1.4. The composite shall be permitted to be configured as a continuous or joined single layer or continuous or joined multiple layers. If the footwear is made up of multiple layers, all layers of the footwear shall be individually graded per size.

6.1.4.3 Footwear shall consist of a sole with heel, an upper with lining, an insole with puncture-resistant device, a ladder shank, and a toecap permanently attached.

6.1.4.4 Footwear height shall be a minimum of 200 mm (8 in.).

6.1.4.4.1 The footwear height shall be determined by measuring inside the footwear from the center of the insole at the heel up to a perpendicular reference line extending across the footwear at the lowest point of the topline, excluding the tongue and gusset.

6.1.4.4.2 Removable insole inserts shall not be removed prior to measurement.

6.1.4.4.3 Moisture protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear topline at all locations with the exception of the area inside of and within 13 mm (0.5 in.) around pull-up holes that fully penetrate the footwear from the outside to the inside. The height of moisture protection at all locations of the boot shall be no less than 203 mm (8 in.) when measured as described in 6.1.4.4.1 and 6.2.4.4.1.

6.1.4.4.4 Thermal and physical protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear topline at all locations with the exception of the tongue, gusset, and the area inside of and within 13 mm (0.5 in.) around pull-up holes that fully penetrate the footwear from the outside to the inside. The height of thermal and physical protection at all locations of the boot with the exception of the tongue and gusset shall be no less than 203 mm (8 in.) when measured as described in 6.1.4.4.1 and 6.2.4.4.1.

6.1.4.5 The puncture-resistant device shall cover the maximum area of the insole.

6.1.4.6 Footwear shall have a toecap that extends not less than 50 mm (2 in.) from the front edge of the footwear.

6.1.4.7 Sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber.

6.1.4.8 Metal parts shall not penetrate from the outside into the lining or insole at any point unless the metal parts are covered.

6.1.4.9 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.

6.1.4.10 Where stud hooks are used, there shall be a minimum of four metal stud hooks on each side of the eyerow.

6.1.4.11 Eyelets, where used, shall be constructed of coated steel, solid brass, brass-coated nickel, or nickel.

6.1.4.12 Footwear shall incorporate a metatarsal impact guard positioned partially over the protective toecap and extended to cover the metatarsal bone area. The metatarsal protection shall be an integral and permanent part of the footwear.

6.1.4.12.1 Footwear shall meet the performance requirements as specified in ASTM F 2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact, compression, metatarsal, and puncture-resistant footwear, with the exception that flex resistance to cracking shall not be evaluated.

6.1.4.13 Footwear Sizing.

6.1.4.13.1 Footwear shall be available in all of the following sizes:

(1) Mens: 6–15, including half sizes, and a minimum of three widths
(2) Womens: 5–10, including half sizes, and a minimum of three widths

6.1.4.13.2 Manufacturers shall be required to establish and provide, upon request, a size conversion chart for each model or style of protective footwear based on toe length, arch length, and foot width as measured on the Brannock Scientific Foot-Measuring Device.

6.1.4.13.3 Full and half sizes in each of the three required widths shall be accomplished by individual and unique lasts to provide proper fit.

6.1.5 Utility Protective Ensemble Goggle Elements.

6.1.5.1 Goggle elements shall meet the respective requirements for goggles and be marked "Z87+" in accordance with ANSI Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices.*

6.1.5.2 Goggle elements shall be rated as "Z87+" in accordance with ANSI Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices.*

6.1.5.3 Goggle elements shall be permitted to be attached to the helmet.

6.2 Rescue and Recovery Protective Ensemble for Technical Rescue Incidents Design Requirements.

6.2.1 Rescue and Recovery Protective Ensemble Garment Elements.

6.2.1.1 Garments shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3, Inspection Testing.

6.2.1.2 Garments shall be permitted to be single-layer or multiple-layer garments.

6.2.1.3 All garment collars shall remain upright after extension into a vertical position. The coat shall have a collar at least 50 mm (2 in.) in height at any point when measured from the top of the collar down and shall have a closure system. The collar and closure system shall consist of materials that meet all applicable requirements as specified in this section.

6.2.1.4 Garments shall not have turn-up cuffs. Sleeve cuffs shall have a closure system that can be adjusted to provide a snug and secure fit around the wrist when a technical rescue glove is worn.

6.2.1.5 Rescue and recovery protective ensemble garments shall have a means for securing the liquid barrier to the outer shell.

6.2.1.6 Top-entry pockets shall have cover flaps with a closure system.

6.2.1.7 Pass-through openings of coveralls shall have a closure system that can be easily secured and easily opened by the wearer.

6.2.1.8 Sewing thread utilized in the construction of garments shall be made of an inherently flame-resistant fiber.

6.2.1.9 All garment hardware finish shall be free of rough spots, burrs, and sharp edges.

6.2.1.10 All snaps shall be Style 2 and shall comply with the design and construction requirements of MIL-F-10884G, *Fastener, Snap*.

6.2.1.11 Fastener tape shall meet the requirements of A-A-55126, *Commercial Item Description, Fastener Tapes, Hook and Pile, Synthetic*.

6.2.1.12 Zippers shall meet the physical performance requirements of A-A-55634, *Commercial Item Description, Zippers (Fasteners, Slide Interlocking)*.

6.2.1.13 Cargo pockets, where provided, shall have a means to drain water and shall have a means of being fastened in the closed position.

6.2.1.14 All upper torso garments shall have closure systems at the neckline.

6.2.1.15 One-piece coverall torso closure systems shall be continuous from the top of the crotch area to the top of the garment at the neck.

6.2.1.16 Metallic closure systems shall not come in direct contact with the body.

6.2.1.17 Metal components of the garments shall not come in direct contact with the body.

6.2.1.18* Garment Sizing.

6.2.1.18.1 Upper torso garment chest circumferences shall be provided in circumferences from 760 mm to 1270 mm (30 in. to 50 in.) in 50 mm (2 in.) increments or cut to order.

6.2.1.18.2 Upper torso garment sleeve lengths shall be provided in lengths from 760 mm to 915 mm (30 in. to 36 in.) in 25 mm (1 in.) increments or cut to order.

6.2.1.18.3 Lower torso garment waist circumferences shall be provided in circumferences from 660 mm to 1270 mm (26 in. to 50 in.) in 50 mm (2 in.) increments or cut to order.

6.2.1.18.4 Lower torso garment inseam lengths shall be provided in lengths from 660 mm to 890 mm (26 in. to 35 in.) in 25 mm (1 in.) increments or cut to order.

6.2.1.18.5 Men's and women's sizing shall be accomplished by the use of individual patterns for men's and women's garments.

6.2.2 Rescue and Recovery Protective Ensemble Helmet Elements.

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

6.2.2.2 Helmets shall consist of material or materials meeting the performance requirements of 7.2.2.

6.2.2.3 Suspension shall contain a nape device and shall be removable and replaceable.

6.2.2.3.1 Helmet suspension shall be adjustable in at least 3 mm (⅛ in.) hat size increments, and the size range that can be accommodated shall be marked on the product label.

6.2.2.3.2 With the suspension adjusted to the maximum designated size, there shall be sufficient clearance between the shell and the headband to provide ventilation.

6.2.2.4 A sweatband shall be provided that shall cover at least the forehead portion of the headband. Sweatbands shall be removable and replaceable or shall be integral with the headband.

6.2.2.5 Crown straps shall be provided and, when assembled, shall form a cradle for supporting the helmet on the wearer's head. The crown straps shall be designed so that the distance between the top of the head and the underside of the shell cannot be adjusted to less clearance than the manufacturer's requirements for that specific helmet.

6.2.2.6 Chin straps shall be provided and shall be attached to the helmet shell. Chin straps shall not be less than 13 mm (½ in.) in width.

6.2.2.7 Sewing thread utilized in the construction of helmets shall be made of an inherently flame-resistant fiber.

6.2.2.8 Product labels and any other identification labels or markers used on helmet shells shall be affixed without holes being made through the shell and without the use of any metal parts or metallic labels.

6.2.3 Rescue and Recovery Protective Ensemble Glove Elements.

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

6.2.3.2 Gloves shall consist of a material or materials meeting the performance requirements of 7.2.3. The composite shall be permitted to be configured as a single layer or multiple layers. If the glove is made up of multiple layers, all layers of the glove shall be individually graded per size.

6.2.3.3 The glove shall consist of a glove body and a glove interface component.

6.2.3.3.1 The glove shall extend circumferentially from the tip of the fingers to beyond the wrist crease.

6.2.3.3.2 The portion of the glove that extends from the tip of the fingers to the wrist crease shall be considered to be the glove body and shall meet the glove body requirements as specified in 7.2.3 or 7.3.4.

6.2.3.3.3 The portion of the glove that extends from the wrist crease up to the end of the entire glove shall be considered to be the glove interface component and shall meet the glove interface component requirements as specified in 7.2.3 or 7.3.4. The glove interface component shall allow the glove to fit closely around the wearer's wrist.

6.2.3.3.4 The weight shall be allowed to hang freely in the air of 60 seconds prior to any measurements.

6.2.3.3.5* Two points shall be marked on the back side of the glove, and the location of the points shall be determined by measuring down the distances shown in Table 6.1.3.3.5 from the finger crotch of digit two and from the finger crotch of digit three. The distances are shown according to glove size.

6.2.3.3.6 A straight line shall be drawn on the back side of the glove using the two points. This line shall be drawn around the side edges of the glove.

6.2.3.3.7 The glove shall be removed from the measurement board. A line shall be drawn on the palm side of the glove by connecting the lines from the side edges of the glove.

6.2.3.3.8 The resulting straight line around the circumference of the glove shall be the location of the wrist crease.

6.2.3.4 Sewing thread utilized in the construction of gloves shall be made of an inherently flame-resistant fiber.

6.2.3.5* In order to label or otherwise represent a glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in not fewer than five separate and distinct sizes.

6.2.3.6 Glove Sizes.

6.2.3.6.1 Gloves shall be available in all sizes from XS to XXL.

6.2.3.6.2 Gloves shall be available in at least two finger lengths for all sizes in 6.2.3.6.1.

6.2.4 Rescue and Recovery Protective Ensemble Footwear Elements.

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

6.2.4.2 The footwear shall consist of a composite meeting the performance requirements of 7.2.4. The composite shall be permitted to be configured as a continuous or joined single layer or continuous or joined multiple layers. If the footwear is made up of multiple layers, all layers of the footwear shall be individually graded per size.

6.2.4.3 Footwear shall consist of a sole with heel, an upper with lining, an insole with puncture-resistant device, a ladder shank, and a toecap permanently attached.

6.2.4.4 Footwear height shall be a minimum of 200 mm (8 in.).

6.2.4.4.1 The footwear height shall be determined by measuring inside the footwear from the center of the insole at the heel up to a perpendicular reference line extending across the width of the footwear at the lowest point of the topline, excluding the tongue and gusset.

6.2.4.4.2 Removable insole inserts shall not be removed prior to measurement.

6.2.4.4.3 Moisture protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear topline at all locations with the exception of the area inside of and within 13 mm (0.5 in.) around pull-up holes that fully penetrate the footwear from the outside to the inside. The height of moisture protection at all locations of the boot shall be no less than 203 mm (8 in.) when measured as described in 6.2.4.4.1.

6.2.4.4.4 Thermal and physical protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear topline at all locations with the exception of the tongue, gusset, and the area inside of and within 13 mm (0.5 in.) around pull-up holes that fully penetrate the footwear from the outside to the inside. The height of thermal and physical protection at all locations of the boot with the exception of the tongue and gusset shall be no less than 203 mm (8 in.) when measured as described in 6.1.4.4.1 and 6.2.4.4.1.

6.2.4.5 The puncture-resistant device shall cover the maximum area of the insole.

6.2.4.6 Footwear shall have a toecap that extends not less than 50 mm (2 in.) from the front edge of the footwear.

6.2.4.7 Sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber.

6.2.4.8 Metal parts shall not penetrate from the outside into the lining or insole at any point, unless the metal parts are covered.

6.2.4.9 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.

6.2.4.10 Where stud hooks are used, there shall be a minimum of four metal stud hooks on each side of the eyerow.

6.2.4.11 Eyelets, where used, shall be constructed of coated steel, solid brass, brass-coated nickel, or nickel.

6.2.4.12 Footwear shall incorporate a metatarsal impact guard positioned partially over the protective toecap and extended to cover the metatarsal bone area. The metatarsal protection shall be an integral and permanent part of the footwear.

6.2.4.13 Footwear shall meet the performance requirements as specified in ASTM F 2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact, compression, metatarsal, and puncture-resistant footwear, with the exception that flex resistance to cracking shall not be evaluated.

6.2.4.14 Footwear Sizing.

6.2.4.14.1 Footwear shall be available in all of the following sizes:

(1) Mens: 6–15, including half sizes, and a minimum of three widths
(2) Womens: 5–10, including half sizes, and a minimum of three widths

6.2.4.14.2 Manufacturers shall be required to establish and provide, upon request, a size conversion chart for each model or style of protective footwear based on toe length, arch length, and foot width as measured on the Brannock Scientific Foot-Measuring Device.

6.2.4.14.3 Full and half sizes in each of the three required widths shall be accomplished by individual and unique lasts to provide proper fit.

6.2.5 Rescue and Recovery Protective Ensemble Goggle Elements.

6.2.5.1 Goggle elements shall meet the respective requirements for goggles and be marked "Z87+" in accordance with ANSI Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices.*

6.2.5.2 Goggle elements shall be permitted to be attached to the helmet.

6.3 CBRN Protective Ensemble for Technical Rescue Incidents Design Requirements.

6.3.1 CBRN Protective Ensembles.

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

6.3.1.2 Ensembles, including the respirator, shall be designed to protect the wearer's upper and lower torso, head, arms, legs, hands, and feet.

6.3.1.3 Ensemble elements shall include protective garments, protective helmet, protective gloves, protective footwear, interface components, and a protective hood, where the protective hood is not already part of the protective garment.

6.3.1.4 The manufacturer shall specify each respirator that is part of the CBRN protective ensemble. All respirators specified by the ensemble manufacturer for inclusion in the ensemble shall be any of the following:

(1) Certified to NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, and certified as CBRN SCBA compliant with the *Statement of Standard for NIOSH CBRN SCBA Testing*, by the National Institute for Occupational Safety and Health (NIOSH)
(2) Certified as CBRN APR compliant with the *Statement of Standard for NIOSH CBRN SCBA Testing*, by NIOSH
(3) Certified as CBRN PAPR compliant with the *Statement of Standard for NIOSH CBRN PAPR Testing*, by NIOSH

6.3.1.5 Ensembles shall be designed to accommodate the respirator(s) as specified in 6.3.1.4 by the manufacturer for the specific ensemble.

6.3.1.6* The interface of and integration of the selected respirator with the protective ensemble shall not invalidate the NIOSH certification of the respective respirator.

6.3.2 CBRN Protective Ensemble Garment Elements.

6.3.2.1 CBRN protective ensemble garment elements shall meet the design requirements specified in 6.2.1.

6.3.2.2 Supplemental garments that are provided to meet the performance requirements of this standard but are not intended to be worn continuously with the wearing of the garment element shall not be permitted.

6.3.2.3 Garments shall be permitted to include integrated booties to protect the wearer's feet in conjunction with outer footwear.

6.3.2.4 Where garments incorporate booties, the booties shall be designed as an extension of the garment leg and shall cover the entire foot and ankle.

6.3.3 CBRN Protective Ensemble Helmet Elements.

6.3.3.1 Where the CBRN barrier layer is provided in a protective hood and provides an interface with the respirator specified by the ensemble manufacturer, the helmet shall not be required to incorporate a CBRN barrier layer.

6.3.3.2 Where the helmet is not required to demonstrate compliance with the CBRN protection requirements, the manufacturer shall not specify a helmet as part of the CBRN protective ensemble.

6.3.3.3 Supplemental helmets that are provided to meet the performance requirements of this standard but are not intended to be worn continuously with the wearing of the helmet shall not be permitted.

6.3.4 CBRN Protective Ensemble Glove Elements.

6.3.4.1 CBRN technical rescue gloves shall meet the design requirements specified in 6.2.3.

6.3.4.2 Supplemental gloves that are provided to meet the performance requirements of this standard but are not intended to be worn continuously with the wearing of the glove element shall not be permitted.

6.3.4.3 Where outer gloves are worn to provide a CBRN barrier layer, the manufacturer shall provide gloves in not fewer than five separate and distinct sizes.

6.3.4.4 If an interface component connects the glove to the coat sleeve in a manner providing continuous thermal protection and demonstrates liquid integrity, then gloves shall not be required to meet the requirements in 6.2.3.3.

6.3.5 CBRN Protective Ensemble Footwear Elements.

6.3.5.1 CBRN technical rescue footwear shall meet the design requirements in 6.2.4.

6.3.5.2 Where booties are used as part of the ensemble, the manufacturer shall specify types of outer footwear that provide the physical and other performance requirements for footwear as specified in 7.3.2.4, as applicable.

6.3.5.3 Where booties are used as part of the ensemble, the outer footwear shall not be required to have a liner in the upper.

6.3.5.4 Supplemental footwear that is provided to meet the performance requirements of this standard but is not intended to be worn continuously with the wearing of the footwear element shall not be permitted.

6.3.6 CBRN Protective Ensemble Hood Interface Elements. Where a hood interface element is provided for CBRN protection, hood interface elements shall meet the design criteria for structural fire-fighting protective hood requirements in Section 6.14 of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

Chapter 7 Performance Requirements

7.1* Utility Protective Ensemble for Technical Rescue Incidents Performance Requirements.

7.1.1 Utility Protective Ensemble Garment Elements.

7.1.1.1 Garment composites shall be tested for total heat loss as specified in Section 8.6, Total Heat Loss Test, and shall have a total heat loss equal to or greater than 650 W/m^2.

7.1.1.2 Textile fabrics and linings used for garments shall be tested for tear resistance as specified in Section 8.7, Tear Resistance Test, and shall have a tear resistance of not less than 30 N (6.75 lbf).

7.1.1.3 Outer shell fabric shall be tested for breaking strength as specified in Section 8.8, Breaking Strength Test, and shall have a breaking strength of not less than 400 N (90 lbf).

7.1.1.4 Garment outer shell fabrics shall be tested for abrasion resistance as specified in Section 8.9, Abrasion Resistance Test 1, and shall have an ending breaking strength of not less than 230 N (50 lbf).

7.1.1.5 Garment outer shell fabrics and liners shall be individually tested for cleaning shrinkage resistance as specified in Section 8.10, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in either direction.

7.1.1.6 All garment seam assemblies shall be tested for seam strength as specified in Section 8.12, Seam Breaking Strength Test, and shall demonstrate a seam strength equal to or greater than that stipulated for the respective seam type.

7.1.1.6.1 Garment seam assemblies shall demonstrate a seam strength equal to or greater than 315 N (70 lbf) force for Major A seams and 180 N (40 lbf) for Major B seams.

7.1.1.6.2 All combination woven and knit or stretch knit seam assemblies shall meet the requirements specified in 7.1.1.6.1.

7.1.1.6.3 Seam strength shall be considered acceptable where the fabric strength is less than the required seam strength specified in 7.1.1.6.1, provided the fabric fails without seam failure below the applicable forces specified in 7.1.1.6.1.

7.1.1.7* Textile fabrics, linings, collar linings, lettering, and other materials used in garment construction, including but not limited to padding, reinforcement, interfacing, binding, and hanger loops but excluding emblems, labels, and patches, shall be individually tested for flame resistance as specified in Section 8.4, Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.), shall not have an afterflame of more than 2 seconds, and shall not melt or drip.

7.1.1.7.1 Zippers shall meet the performance requirements specified in 7.1.1.7 only where located on the exterior of the garment or located where they will directly contact the wearer's body.

7.1.1.7.2 Elastic and hook and pile fasteners shall meet the performance requirements specified in 7.1.1.7 only where located where they will directly contact the wearer's body.

7.1.1.7.3 Small specimens such as hanger loops and emblems or patches that are not large enough to meet the sample size requirements in 8.4.2.1 shall be tested for resistance to flame as specified in 8.4.11 and shall not have an afterflame of more than 2 seconds and shall not melt or drip.

7.1.1.8 Textile fabrics and linings utilized in garments shall be individually tested for thermal shrinkage resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

7.1.1.9 Textile fabrics, linings, hardware, and other materials used in garment construction, including but not limited to padding, reinforcements, wristlets, collars, labels, hanger hooks, buttons, and fasteners but excluding hook and pile fasteners not in direct contact with the skin, shall be individually tested for heat resistance in their original form as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, or ignite; garment outer shells shall not char; and hardware items and closures shall remain functional.

7.1.1.9.1 Garment closures, including but not limited to zippers and hook and pile fasteners, shall meet the performance requirements specified in 7.1.1.9 only where they are located on the exterior of the garment or located where they will directly contact the wearer's body.

7.1.1.10 Sewing thread utilized in the construction of garments shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.1.1.11 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.1.1.12 Garment composites shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall have an average thermal protective performance (TPP) of 10 or greater.

7.1.1.13 Garment outer shell fabric shall be tested for water absorption resistance as specified in Section 8.13, Water Absorption Resistance Test, and shall have a percent water absorption of 15 percent or less.

7.1.1.14 Garment product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.1.1.15 Fastener tape shall be tested for breaking strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum breaking strength requirements as set forth in that specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*.

7.1.1.16 Fastener tape shall be tested for shear strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum shear strength requirements as set forth in the specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*.

7.1.1.17 Fastener tape shall be tested for peel strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum peel strength requirements as set forth in the specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*.

7.1.2 Utility Protective Ensemble Helmet Elements.

7.1.2.1 Helmets shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, Procedure A, and shall not have afterflame with a duration greater than 5 seconds.

7.1.2.2 Any antiglare material, where used, shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, Procedure B, and shall not have afterflame with a duration greater than 5 seconds.

7.1.2.3 Helmets shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not have any distortion of the shell extend more than 30 mm (1$\frac{3}{16}$ in.) below the original position of the helmet, and hardware shall remain functional.

7.1.2.4 Helmets shall be tested for top impact resistance as specified by Section 8.19, Top Impact Resistance Test (Force), and shall not transmit an average force of more than 3785 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf).

7.1.2.5 Helmets shall be tested for physical penetration resistance as specified in Section 8.20, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration striker and the headform.

7.1.2.6 Helmets shall be tested for electrical insulation as specified in Section 8.21, Electrical Insulation Test 1, and shall not have electrical leakage current exceeding 3 milliamperes.

7.1.2.7 Helmets shall be tested for suspension system separation as specified in Section 8.22, Suspension System Retention Test, and shall not have the minimum force required to separate any individual attachment point of the suspension assembly from the helmet shell be less than 22 N (5 lbf).

7.1.2.8 Helmets shall be tested for retention system and chin strap efficiency as specified in Section 8.23, Retention System Test, and the retention system shall not break or show any slip or stretch greater than 38 mm (1½ in.).

7.1.2.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.1.2.10 Sewing thread utilized in the construction of helmets shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.1.2.11 Helmet product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.1.3 Utility Protective Ensemble Glove Elements.

7.1.3.1 Glove body composites shall be tested in areas A, C, D, E, G, and H as shown in Figure 8.1.13.1, if different, for resistance to cut as specified in Section 8.26, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.1.3.2 Glove body composites shall be tested in areas A, C, and D, if different, for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not puncture under an average applied force of 22 N (5 lbf).

7.1.3.3 Glove body composites shall be tested in areas A, C, D, E, G, and H, if different, for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.1.3.4 Gloves shall be tested for hand function as specified in Section 8.28, Glove Hand Function Test, and shall not have an average percent of barehanded control exceeding 170 percent.

7.1.3.5 Gloves shall be tested for grip as specified in Section 8.29, Grip Test, and shall not have a drop of more than 30 percent from the peak pull force value.

7.1.3.6 Gloves shall be tested for ease of donning as specified in Section 8.30, Glove Donning Test, and shall not have a baseline donning time exceed 10 seconds nor a final donning time exceed the baseline donning time plus 20 seconds, shall have no detachment of the inner liner, shall have no detachment of the moisture barrier, and shall allow full insertion of all digits.

7.1.3.7 Glove body composites, including but not limited to trim, labels, and external tags, but excluding hardware and hook and pile fasteners that do not directly contact the wearer's body, shall be individually tested for flame resistance as specified in Section 8.24, Flame Resistance Test 3; shall have an average char length of not more than 100 mm (4 in.); shall have an average afterflame of not more than 2 seconds; and shall not melt or drip.

7.1.3.8 Gloves shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not separate, melt, ignite, or drip. Hook and pile fasteners on gloves shall be excluded from these requirements because these items are placed such that they will not directly contact the wearer's body.

7.1.3.9 All glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.1.3.10 Glove body composites shall be tested in areas A, C, and D, if different, for conductive heat resistance as specified in Section 8.25, Conductive Heat Resistance Test, shall not have a second-degree burn time of less than 7 seconds, and shall not have the pain time be less than 4 seconds.

7.1.3.11 Glove knit wristlet material shall be tested for material strength as specified in Section 8.39, Burst Strength Test, and shall have a burst strength of not less than 180 N (40.7 lbf).

7.1.3.12 Sewing thread utilized in the construction of gloves shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.1.3.13 Glove product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.1.3.14 Glove body composites shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall have an average TPP of 10 or greater.

7.1.3.15 Glove interface component composites shall be individually tested for flame resistance as specified in Section 8.24, Flame Resistance Test 3, and shall have an average char length of not more than 100 mm (4 in.), shall have an average afterflame of not more than 2 seconds, and shall not melt or drip.

7.1.3.16 Gloves shall be tested for grip function as specified in Section 8.45, Torque Test, and shall have an average percent of barehanded control not less than 80 percent.

7.1.4 Utility Protective Ensemble Footwear Elements.

7.1.4.1 Footwear uppers shall be tested for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.1.4.2 Footwear uppers shall be tested for cut resistance as specified in Section 8.26, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.1.4.3 Footwear uppers shall be tested for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not puncture under an applied force of 45 N (10 lbf).

7.1.4.4 Footwear ladder shanks shall be tested for resistance to bending as specified in Section 8.33, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (¼ in.).

7.1.4.5 Footwear soles and heels shall be tested for abrasion resistance as specified in Section 8.34, Abrasion Resistance

Test 3, and the relative volume loss shall not be greater than 200 mm^3 (0.01 $in.^3$).

7.1.4.6 Footwear shall be tested for slip resistance as specified in Section 8.35, Slip Resistance Test, and shall have a coefficient of friction of 0.45 or greater.

7.1.4.7 Footwear shall be tested for electrical conduction as specified in Section 8.36, Electrical Insulation Test 2, and shall not have any electrical leakage exceed 3 milliamperes.

7.1.4.8 Eyelets and stud hooks shall be tested for detachment strength as specified in Section 8.37, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 300 N (66 lbf).

7.1.4.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.1.4.10 Footwear shall be individually tested for flame resistance as specified in Section 8.32, Flame Resistance Test 4, shall not have an afterflame of more than 5 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.1.4.11 Footwear shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and, other than the laces, shall not have any part of the footwear melt, shall have no delamination or separation of any part of the footwear, shall have all hardware remain functional, and shall show no water penetration.

7.1.4.12 Footwear uppers shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall not have an average TPP of less than 10.

7.1.4.13 Footwear uppers shall be tested for conductive heat resistance as specified in Section 8.25, Conductive Heat Resistance Test, shall not have a second-degree burn time of less than 7 seconds, and shall not have the pain time be less than 4 seconds.

7.1.4.14 Footwear upper material composite, upper seams, and vamp seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.1.4.15 Footwear upper material composite, upper seams, and vamp seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.1.4.16 Sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber, shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.1.4.17 Footwear product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.1.4.18 Footwear shall meet the performance requirements as specified in ASTM F 2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact, compression, metatarsal, and puncture-resistant footwear, with the exception that flex resistance to cracking shall not be evaluated.

7.1.5 Utility Protective Ensemble Goggle Elements.

7.1.5.1 Goggle elements shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, and shall not show any visible afterflame 5 seconds after removal of the test flame.

7.1.5.2 Goggle elements shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, or ignite.

7.2* Rescue and Recovery Protective Ensemble for Technical Rescue Incidents Performance Requirements.

7.2.1 Rescue and Recovery Protective Ensemble Garment Elements.

7.2.1.1 Garment composites shall be tested for total heat loss as specified in Section 8.6, Total Heat Loss Test, and shall have a total heat loss equal to or greater than 450 W/m^2.

7.2.1.2 Textile fabrics and linings used for garments shall be tested for tear resistance as specified in Section 8.7, Tear Resistance Test, and shall have a tear resistance of not less than 30 N (6.75 lbf).

7.2.1.3 Outer shell fabrics shall be tested for breaking strength as specified in Section 8.8, Breaking Strength Test, and shall have a breaking strength of not less than 400 N (90 lbf).

7.2.1.4 Garment outer shell fabrics shall be tested for abrasion resistance as specified in Section 8.9, Abrasion Resistance Test 1, and shall have an ending breaking strength of not less than 230 N (50 lbf).

7.2.1.5 Garment outer shell fabrics, liquid barrier, and liners shall be individually tested for cleaning shrinkage resistance as specified in Section 8.10, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in either direction.

7.2.1.6 All garment seam assemblies shall be tested for seam strength as specified in Section 8.12, Seam Breaking Strength Test, and shall demonstrate a seam strength equal to or greater than that stipulated for the respective seam type.

7.2.1.6.1 Garment seam assemblies shall demonstrate a seam strength equal to or greater than 315 N (70 lbf) for Major A seams and 180 N (40 lbf) for Major B seams.

7.2.1.6.2 All combination woven and knit or stretch knit seam assemblies shall meet the requirements as specified in 7.2.1.6.1.

7.2.1.6.3 Seam strength shall be considered acceptable where the fabric strength is less than the required seam strength specified in 7.2.1.6.1, provided the fabric fails without seam failure below the applicable forces specified in 7.2.1.6.1.

7.2.1.7* Textile fabrics, linings, collar linings, lettering, and other materials used in garment construction, including but not limited to padding, reinforcement, interfacing, binding, and hanger loops but excluding emblems, labels, and patches, shall be individually tested for flame resistance as specified in Section 8.4, Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.), shall not have an afterflame of more than 2 seconds, and shall not melt or drip.

7.2.1.7.1 Zippers and seam-sealing materials shall meet the performance requirements specified in 7.2.1.7 only where lo-

cated on the exterior of the garment or located where they will directly contact the wearer's body.

7.2.1.7.2 Elastic and hook and pile fasteners shall meet the performance requirements specified in 7.2.1.7 only where located where they will directly contact the wearer's body.

7.2.1.7.3 Small specimens such as hanger loops and emblems or patches that are not large enough to meet the sample size requirements in 8.4.2.1 shall be tested for resistance to flame as specified in 8.4.11 test format and shall not have an afterflame of more than 2 seconds, and shall not melt or drip.

7.2.1.8 Textile fabrics and linings utilized in garments shall be individually tested for thermal shrinkage resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10.0 percent in any direction.

7.2.1.9 Textile fabrics, linings, hardware, and other materials used in garment construction, including but not limited to padding, reinforcements, wristlets, collars, labels, hanger hooks, buttons, and fasteners but excluding hook and pile fasteners not in direct contact with the skin, shall be individually tested for heat resistance in their original form as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, or ignite; garment outer shells shall not char; and hardware items and closures shall remain functional.

7.2.1.9.1 Garment closures, including but not limited to zippers and hook and pile fasteners, shall meet the performance requirements specified in 7.2.1.9 only where they are located on the exterior of the garment or located where they will directly contact the wearer's body.

7.2.1.9.2 Liquid barrier seams shall be individually tested for resistance to heat as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not drip or ignite.

7.2.1.10 Sewing thread utilized in the construction of garments shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.2.1.11 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.2.1.12 Garment composites shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall have an average TPP of 10 or greater.

7.2.1.13 Garment outer shell fabrics shall be tested for water absorption resistance as specified in Section 8.13, Water Absorption Resistance Test, and shall have a percent water absorption of 15 percent or less.

7.2.1.14 Garment composites and seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no liquid penetration.

7.2.1.15 Garment composites and seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.2.1.16 Garments shall be tested for liquid penetration resistance as specified in Section 8.3, Overall Liquid Integrity Test 1, and shall not allow liquid penetration.

7.2.1.17 Garment product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.2.1.18 Fastener tape shall be tested for breaking strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum breaking strength requirements as set forth in that specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic.*

7.2.1.19 Fastener tape shall be tested for shear strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum shear strength requirements as set forth in the specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic.*

7.2.1.20 Fastener tape shall be tested for peel strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum peel strength requirements as set forth in the specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic.*

7.2.2 Rescue and Recovery Protective Ensemble Helmet Elements.

7.2.2.1 Helmets shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, Procedure A, and shall not have afterflame with a duration greater than 5 seconds.

7.2.2.2 Any antiglare material, where used, shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, Procedure B, and shall not have afterflame with a duration greater than 5 seconds.

7.2.2.3 Helmets shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not have any distortion of the shell extend more than 30 mm (1 3/16 in.) below the original position of the helmet, and shall have hardware remain functional.

7.2.2.4 Helmets shall be tested for top impact resistance as specified by Section 8.19, Top Impact Resistance Test (Force), and shall not transmit an average force of more than 3785 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf).

7.2.2.5 Helmets shall be tested for physical penetration resistance as specified in Section 8.20, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration striker and the headform.

7.2.2.6 Helmets shall be tested for electrical insulation as specified in Section 8.21, Electrical Insulation Test 1, and shall not have electrical leakage current exceeding 3 milliamperes.

7.2.2.7 Helmets shall be tested for suspension system separation as specified in Section 8.22, Suspension System Retention Test, and shall not have the minimum force required to separate any individual attachment point of the suspension assembly from the helmet shell be less than 22 N (5 lbf).

7.2.2.8 Helmets shall be tested for retention system and chin strap efficiency as specified in Section 8.23, Retention System

Test, and the retention system shall not break or show any slip or stretch greater than 38 mm (1½ in.).

7.2.2.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.2.2.10 Sewing thread utilized in the construction of helmets shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.2.2.11 Helmet product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.2.3 Rescue and Recovery Protective Ensemble Glove Elements.

7.2.3.1 Glove body composites shall be tested in areas A, C, D, E, G, and H, if different, for resistance to cut as specified in Section 8.26, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.2.3.2 Glove body composites shall be tested in areas A, C, and D, if different, for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not puncture under an average applied force of 22 N (5 lbf).

7.2.3.3 Glove body composites shall be tested in areas A, C, D, E, G, and H, if different, for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.2.3.4 Gloves shall be tested for hand function as specified in Section 8.28, Glove Hand Function Test, and shall not have an average percent of barehand control exceeding 170 percent.

7.2.3.5 Gloves shall be tested for grip as specified in Section 8.29, Grip Test, and shall not have a drop of more than 30 percent from the peak pull force value.

7.2.3.6 Gloves shall be tested for ease of donning as specified in Section 8.30, Glove Donning Test; shall not have a baseline donning time exceed 10 seconds, nor a final donning time exceed the baseline donning time plus 20 seconds; shall have no detachment of the inner liner; shall have no detachment of the moisture barrier; and shall allow full insertion of all digits.

7.2.3.7 Glove body composites, including but not limited to trim, labels, and external tags, but excluding hardware and hook and pile fasteners that do not directly contact the wearer's body, shall be individually tested for flame resistance as specified in Section 8.24, Flame Resistance Test 3, shall have an average char length of not more than 100 mm (4 in.); shall have an average afterflame of not more than 2 seconds; and shall not melt or drip.

7.2.3.8 Glove interface component composites shall be individually tested for flame resistance as specified in Section 8.24, Flame Resistance Test 3, shall have an average char length of not more than 100 mm (4 in.); shall have an average afterflame of not more than 2 seconds; and shall not melt or drip.

7.2.3.9 Gloves shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not separate, melt, ignite, or drip. Hook and pile fasteners on gloves shall be excluded from these requirements because these items are placed such that they will not directly contact the wearer's body.

7.2.3.10 All glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware remain functional.

7.2.3.11 Glove body composites shall be tested in areas A, C, and D, if different, for conductive heat resistance as specified in Section 8.25, Conductive Heat Resistance Test, and shall not have a second-degree burn time of less than 7 seconds, and shall not have the pain time be less than 4 seconds.

7.2.3.12 Glove materials and seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no liquid penetration.

7.2.3.13 Glove materials and seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.2.3.14 Gloves shall be tested for overall watertight integrity as specified in Section 8.31, Overall Liquid Integrity Test 2, and shall show no water penetration.

7.2.3.15 Glove knit wristlet material shall be tested for material strength as specified in Section 8.39, Burst Strength Test, and shall have a burst strength of not less than 180 N (40.7 lbf).

7.2.3.16 Sewing thread utilized in the construction of gloves shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.2.3.17 Glove product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.2.3.18 Glove body composites shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall have an average TPP of 10 or greater.

7.2.3.19 Gloves shall be tested for grip function as specified in Section 8.45, Torque Test, and shall have an average percent of bare-hand control not less than 80 percent.

7.2.4 Rescue and Recovery Protective Ensemble Footwear Elements.

7.2.4.1 Footwear uppers shall be tested for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.2.4.2 Footwear uppers shall be tested for cut resistance as specified in Section 8.26, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.2.4.3 Footwear uppers shall be tested for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not puncture under an applied force of 45 N (10 lbf).

7.2.4.4 Footwear ladder shanks shall be tested for resistance to bending as specified in Section 8.33, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (¼ in.).

7.2.4.5 Footwear soles and heels shall be tested for abrasion resistance as specified in Section 8.34, Abrasion Resistance Test 3, and the relative volume loss shall not be greater than 200 mm^3 (0.01 $in.^3$).

7.2.4.6 Footwear shall be tested for slip resistance as specified in Section 8.35, Slip Resistance Test, and shall have a coefficient of friction of 0.45 or greater.

7.2.4.7 Footwear shall be tested for electrical conduction as specified in Section 8.36, Electrical Insulation Test 2, and shall not have any electrical leakage exceed 3 milliamperes.

7.2.4.8 Eyelets and stud hooks shall be tested for detachment strength as specified in Section 8.37, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 300 N (66 lbf).

7.2.4.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.2.4.10 Footwear shall be individually tested for flame resistance as specified in Section 8.32, Flame Resistance Test 4, shall not have an afterflame of more than 5 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.2.4.11 Footwear shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and, other than the laces, shall not have any part of the footwear melt, shall have no delamination or separation of any part of the footwear, shall have all hardware remain functional, and shall show no water penetration.

7.2.4.12 Footwear uppers shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall not have an average TPP of less than 10.

7.2.4.13 Footwear uppers shall be tested for conductive heat resistance as specified in Section 8.25, Conductive Heat Resistance Test, shall not have a second-degree burn time of less than 7 seconds, and shall not have the pain time be less than 4 seconds.

7.2.4.14 Footwear upper material composites, upper seams, and vamp seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.2.4.15 Footwear upper material composites, upper seams, and vamp seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.2.4.16 Sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber, shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.2.4.17 Footwear product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.2.4.18 Footwear shall meet the performance requirements as specified in ASTM F 2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact, compression, metatarsal, and puncture-resistant footwear with the exception that flex resistance to cracking shall not be evaluated.

7.2.5 Rescue and Recovery Protective Ensemble Goggle Elements.

7.2.5.1 Goggle elements shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, and shall not show any visible afterflame 5 seconds after removal of the test flame.

7.2.5.2 Goggle elements shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, or ignite.

7.3* CBRN Protective Ensemble for Technical Rescue Incidents Performance Requirements.

7.3.1 CBRN Protective Ensembles.

7.3.1.1* The entire ensemble shall be tested for overall inward leakage as specified in Section 8.40, Man-In-Simulant Test, and shall have an average local physiological protective dosage factor ($PPDF_i$) value at each PAD location for the four ensembles tested of no less than 120.0 and an average systemic physiological protective dosage factor ($PPDF_{sys}$) value for each of the four tested ensembles of no less than 76.

7.3.1.2 The entire ensemble shall be tested as specified in Section 8.3, Overall Liquid Integrity Test 1, and shall show no liquid penetration.

7.3.1.3 Each ensemble element's CBRN barrier layer and the barrier layer seams shall be tested for permeation resistance as specified in Section 8.41, Chemical Permeation Resistance Test, and shall meet the following performance criteria:

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

7.3.2 CBRN Protective Ensemble Garment Elements.

7.3.2.1 Garment composites shall be tested for total heat loss as specified in Section 8.6, Total Heat Loss Test, and shall have a total heat loss equal to or greater than 250 W/m^2.

7.3.2.2 Textile fabrics and linings used for garments shall be tested for tear resistance as specified in Section 8.7, Tear Resistance Test, and shall have a tear resistance of not less than 30 N (6.75 lbf).

7.3.2.3 Outer shell fabrics shall be tested for breaking strength as specified in Section 8.8, Breaking Strength Test, and shall have a breaking strength of not less than 400 N (90 lbf).

7.3.2.4 Garment outer shell fabrics shall be tested for abrasion resistance as specified in Section 8.9, Abrasion Resistance Test 1, and shall have an ending breaking strength of not less than 230 N (50 lbf).

7.3.2.5 Garment outer shell fabrics, liquid barrier, and liners shall be individually tested for cleaning shrinkage resistance as specified in Section 8.10, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in either direction.

7.3.2.6 All garment seam assemblies shall be tested for seam strength as specified in Section 8.12, Seam Breaking Strength Test, and shall demonstrate a seam strength equal to or greater than that stipulated for the respective seam type.

7.3.2.6.1 Garment seam assemblies shall demonstrate a seam strength equal to or greater than 315 N (70 lbf) for Major A seams and 180 N (40 lbf) for Major B seams.

7.3.2.6.2 All combination woven and knit or stretch knit seam assemblies shall meet the requirements as specified in 7.3.2.6.1.

7.3.2.6.3 Seam strength shall be considered acceptable where the fabric strength is less than the required seam strength specified in 7.3.2.6.1, provided the fabric fails without seam failure below the applicable forces specified in 7.3.2.6.1.

7.3.2.7* Textile fabrics, linings, collar linings, lettering, and other materials used in garment construction, including but not limited to padding, reinforcement, interfacing, binding, and hanger loops but excluding emblems, labels, and patches, shall be individually tested for flame resistance as specified in Section 8.4, Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.), shall not have an afterflame of more than 2 seconds, and shall not melt or drip.

7.3.2.7.1 Zippers and seam-sealing materials shall meet the performance requirements specified in 7.3.2.7 only where located on the exterior of the garment or located where they will directly contact the wearer's body.

7.3.2.7.2 Elastic and hook and pile fasteners shall meet the performance requirements specified in 7.3.2.7 only where located where they will directly contact the wearer's body.

7.3.2.7.3 Small specimens such as hanger loops and emblems or patches that are not large enough to meet the sample size requirements in 8.4.2.1 shall be tested for resistance to flame as specified in 8.4.11 and shall not have an afterflame of more than 2 seconds, and shall not melt or drip.

7.3.2.8 Textile fabrics and linings utilized in garments shall be individually tested for thermal shrinkage resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

7.3.2.9 Textile fabrics, linings, hardware, and other materials used in garment construction, including but not limited to padding, reinforcements, wristlets, collars, labels, hanger hooks, buttons, and fasteners but excluding hook and pile fasteners not in direct contact with the skin, shall be individually tested for heat resistance in their original form as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, or ignite; garment outer shells shall not char; and hardware items and closures shall remain functional.

7.3.2.9.1 Garment closures, including but not limited to zippers and hook and pile fasteners, shall meet the performance requirements specified in 7.3.2.9 only where they are located on the exterior of the garment or located where they will directly contact the wearer's body.

7.3.2.9.2 Liquid barrier seams shall be individually tested for resistance to heat as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not drip or ignite.

7.3.2.10 Sewing thread utilized in the construction of garments shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.3.2.11 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.3.2.12 Garment composites shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall have an average TPP of 10 or greater.

7.3.2.13 Garment outer shell fabrics shall be tested for water absorption resistance as specified in Section 8.13, Water Absorption Resistance Test, and shall have a percent water absorption of 15 percent or less.

7.3.2.14 Garment composites and seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.3.2.15 Garment composites and seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.3.2.16 Garment product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.3.2.17 Where the garment CBRN barrier layer and the CBRN barrier layer seams are also the moisture barrier and the moisture barrier seams for the garment, the garment CBRN barrier layer and CBRN barrier layer seams shall meet all the performance requirements for the moisture barrier and the moisture barrier seams in 7.3.2.5, 7.3.2.6, 7.3.2.7, 7.3.2.8, 7.3.2.9, 7.3.2.14, and 7.3.2.15.

7.3.2.18 Where the garment CBRN barrier layer and the CBRN barrier layer seams are also the external layer of the garment, the garment CBRN outer layer and CBRN outer layer seams shall meet all the performance requirements for the barrier layer and barrier layer seams in 7.3.2.3, 7.3.2.4, 7.3.2.5, 7.3.2.6, 7.3.2.7, 7.3.2.8, 7.3.2.9, and 7.3.2.18.

7.3.2.19 Where the CBRN barrier layer is configured as an external layer of the garment, the CBRN barrier layer shall be tested for bursting strength as specified in Section 8.39, Burst Strength Test, and shall have a bursting strength test of not less than 156 N (35 lbf).

7.3.2.20 Where the CBRN barrier layer is configured as an external layer of the garment, the CBRN barrier layer shall be tested for puncture propagation tear resistance as specified in Section 8.42, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 31 N (7 lbf).

7.3.2.21 Where the CBRN barrier layer is configured as an external layer of the garment, the CBRN barrier layer shall be tested for cold weather performance as specified in Section 8.43, Cold Temperature Performance Test, and shall have a bending moment of not greater than 0.057 N/m (½ in.-lbf) at an angular deflection of 60 degrees at –25°C (–13°F).

7.3.2.22 Fastener tape shall be tested for breaking strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum breaking strength requirements as set forth in that specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*.

7.3.2.23 Fastener tape shall be tested for shear strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum shear strength requirements as set forth in the specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*.

7.3.2.24 Fastener tape shall be tested for peel strength as specified in Section 8.46, Fastener Tape Strength Tests, in A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*, and shall meet or exceed the minimum peel strength requirements as set forth in the specification established in Table 1 of A-A-55126B, *CID Fastener Tapes, Hook and Loop, Synthetic*.

7.3.3 CBRN Protective Ensemble Helmet Elements.

7.3.3.1 Helmets shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, Procedure A, and shall not have afterflame with a duration greater than 5 seconds.

7.3.3.2 Any antiglare material, where used, shall be tested for flame resistance as specified in Section 8.18, Flame Resistance Test 2, Procedure B, and shall not have afterflame with a duration greater than 5 seconds.

7.3.3.3 Helmets shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not have any distortion of the shell extend more than 30 mm (1³⁄₁₆ in.) below the original position of the helmet, and the hardware shall remain functional.

7.3.3.4 Helmets shall be tested for top impact resistance as specified by Section 8.19, Top Impact Resistance Test (Force), and shall not transmit an average force of more than 3785 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf).

7.3.3.5 Helmets shall be tested for physical penetration resistance as specified in Section 8.20, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration striker and the headform.

7.3.3.6 Helmets shall be tested for electrical insulation as specified in Section 8.21, Electrical Insulation Test 1, and shall not have electrical leakage current exceeding 3 milliamperes.

7.3.3.7 Helmets shall be tested for suspension system separation as specified in Section 8.22, Suspension System Retention Test, and shall not have the minimum force required to separate any individual attachment point of the suspension assembly from the helmet shell be less than 22 N (5 lbf).

7.3.3.8 Helmets shall be tested for retention system and chin strap efficiency as specified in Section 8.23, Retention System Test, and the retention system shall not break or show any slip or stretch greater than 38 mm (1½ in.).

7.3.3.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items the remain functional.

7.3.3.10 Sewing thread utilized in the construction of helmets shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.3.3.11 Helmet product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.3.3.12 Where the protective helmet element is used for CBRN terrorism agent protection, any helmet CBRN barrier layer and the barrier layer seams shall be tested for permeation resistance as specified in Section 8.41, Chemical Permeation Resistance Test, and shall meet the performance criteria in 7.3.1.3.

7.3.4 CBRN Protective Ensemble Glove Elements.

7.3.4.1 Glove body composites shall be tested in areas A, C, D, E, G, and H, if different, for resistance to cut as specified in Section 8.26, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.3.4.2 Glove body composites shall be tested in areas A, C, and D, if different, for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not puncture under an average applied force of 22 N (5 lbf).

7.3.4.3 Glove body composites shall be tested in areas A, C, D, E, G, and H, if different, for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.3.4.4 Gloves shall be tested for hand function as specified in Section 8.28, Glove Hand Function Test, and shall not have an average percent of barehanded control exceeding 170 percent.

7.3.4.5 Gloves shall be tested for grip as specified in Section 8.29, Grip Test, and shall not have a drop of more than 30 percent from the peak pull force value.

7.3.4.6 Gloves shall be tested for ease of donning as specified in Section 8.30, Glove Donning Test; shall not have a baseline donning time exceed 10 seconds, nor a final donning time exceed the baseline donning time plus 20 seconds; shall have

no detachment of the inner liner; shall have no detachment of the moisture barrier; and shall allow full insertion of all digits.

7.3.4.7 Glove body composites, including but not limited to trim, labels, and external tags, but excluding hardware and hook and pile fasteners that do not directly contact the wearer's body, shall be individually tested for flame resistance as specified in Section 8.24, Flame Resistance Test 3, and shall have an average char length of not more than 100 mm (4 in.), shall have an average afterflame of not more than 2 seconds, and shall not melt or drip.

7.3.4.8 Glove interface component composites shall be individually tested for flame resistance as specified in Section 8.24, Flame Resistance Test 3, and shall have an average char length of not more than 100 mm (4 in.), shall have an average afterflame of not more than 2 seconds, and shall not melt or drip.

7.3.4.9 Gloves shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not separate, melt, ignite, or drip. Hook and pile fasteners on gloves shall be excluded from these requirements because these items are placed such that they will not directly contact the wearer's body.

7.3.4.10 All glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.3.4.11 Glove body composites shall be tested for conductive heat resistance as specified in Section 8.25, Conductive Heat Resistance Test; shall not have a second-degree burn time of less than 7 seconds; and shall not have the pain time be less than 4 seconds.

7.3.4.12 Glove materials and seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no liquid penetration.

7.3.4.13 Glove materials and seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.3.4.14 Gloves shall be tested for overall watertight integrity as specified in Section 8.31, Overall Liquid Integrity Test 2, and shall show no water penetration.

7.3.4.15 Glove knit wristlet material shall be tested for material strength as specified in Section 8.39, Burst Strength Test, and shall have a burst strength of not less than 180 N (40.7 lbf).

7.3.4.16 Sewing thread utilized in the construction of gloves shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test, and shall not melt.

7.3.4.17 Glove product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.3.4.18 Glove body composites shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall have an average TPP of 10 or greater.

7.3.4.19 Where the glove element's CBRN barrier layer is the most external layer of the element, the CBRN barrier layer shall be tested for cut resistance as specified in Section 8.26, Cut Resistance Test, and shall have a blade travel distance of not less than 20 mm (0.8 in.).

7.3.4.20 Where the glove element's CBRN barrier layer is the most external layer of the ensemble element for hand protection, the CBRN barrier layer shall be tested for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not be punctured under an average applied force of 22 N (5 lbf).

7.3.4.21 Where the glove element's CBRN barrier layer is the most external layer of the ensemble element, the CBRN barrier layer shall be tested for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.3.4.22 Gloves shall be tested for grip function as specified in Section 8.45, Torque Test, and shall have an average percent of barehanded control not less than 80 percent.

7.3.5 CBRN Protective Ensemble Footwear Elements.

7.3.5.1 Footwear uppers shall be tested for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test 2, and shall show no wear-through.

7.3.5.2 Footwear uppers shall be tested for cut resistance as specified in Section 8.26, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.3.5.3 Footwear uppers shall be tested for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not puncture under an applied force of 45 N (10 lbf).

7.3.5.4 Footwear ladder shanks shall be tested for resistance to bending as specified in Section 8.33, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (¼ in.).

7.3.5.5 Footwear soles and heels shall be tested for abrasion resistance as specified in Section 8.34, Abrasion Resistance Test 3, and the relative volume loss shall not be greater than 200 mm^3 (0.01 in^3).

7.3.5.6 Footwear soles shall be tested for slip resistance as specified in Section 8.37, Slip Resistance Test, and shall have a coefficient of friction of 0.45 or greater.

7.3.5.7 Footwear shall be tested for electrical conduction as specified in Section 8.36, Electrical Insulation Test 2, and shall not have any electrical leakage exceed 3 milliamperes.

7.3.5.8 Eyelets and stud hooks shall be tested for detachment strength as specified in Section 8.37, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 300 N (66 lbf).

7.3.5.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.15, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.3.5.10 Footwear shall be individually tested for flame resistance as specified in Section 8.32, Flame Resistance Test 4, and

shall not have an afterflame of more than 2 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.3.5.11 Footwear shall be tested for heat resistance as specified in Section 8.5. Heat and Thermal Shrinkage Resistance Test, and, other than the laces, shall not have any part of the footwear melt, shall have no delamination or separation of any part of the footwear; shall have all hardware remain functional; and shall show no water penetration.

7.3.5.12 Footwear uppers shall be tested for thermal protective performance as specified in Section 8.2, Thermal Protective Performance Test, and shall not have an average TPP of less than 10.

7.3.5.13 Footwear uppers shall be tested for conductive heat resistance as specified in Section 8.25, Conductive Heat Resistance Test; shall not have a second-degree burn time of less than 7 seconds; and shall not have the pain time be less than 4 seconds.

7.3.5.14 Footwear upper material composites, upper seams, and vamp seams shall be tested for liquid penetration resistance as specified in Section 8.16, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.3.5.15 Footwear upper material composites, upper seams, and vamp seams shall be tested for biopenetration resistance as specified in Section 8.17, Viral Penetration Resistance Test, and shall show no viral penetration.

7.3.5.16 Sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber; shall be tested for heat resistance as specified in Section 8.14, Thread Heat Resistance Test; and shall not melt.

7.3.5.17 Footwear product labels shall be tested for legibility as specified in Section 8.38, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.3.5.18 Where the footwear element's CBRN barrier layer is the most external layer of the element, the CBRN barrier layer from the upper portion of the footwear element shall be tested for cut resistance as specified in Section 8.26, Cut Resistance Test, and shall have a blade travel distance of not less than 20 mm (0.8 in.).

7.3.5.19 Where the footwear element's CBRN barrier layer is the most external layer of the element, the CBRN barrier layer from the upper portion of the footwear element shall be tested for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not be punctured under an average applied force of 36 N (8 lbf).

7.3.5.20 Where the footwear element's CBRN barrier layer is the most external layer of the element, the CBRN barrier layer from the wear surface of the footwear element shall be tested for puncture resistance as specified in Section 8.27, Puncture Resistance Test 1, and shall not be punctured under an average applied force of 200 N (45 lbf).

7.3.5.21 Where the footwear element's CBRN barrier layer is the most external layer of the element, the CBRN barrier layer from the wear surface of the footwear element shall be tested for abrasion resistance as specified in Section 8.44, Abrasion Resistance Test 4, and shall not show wear-through of the film portion of the barrier layer in fewer than 3000 cycles.

7.3.5.22 Footwear shall meet the performance requirements as specified in ASTM F 2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact, compression, metatarsal, and puncture-resistant footwear, with the exception that flex resistance to cracking shall not be evaluated.

7.3.6 CBRN Protective Ensemble Hood Interface Elements. Where a protective hood interface element is used for CBRN terrorism agent protection, the materials used in the construction of the hood shall meet the criteria for garments specified in 7.3.2.

Chapter 8 Test Methods

8.1 Sample Preparation Procedures.

8.1.1 Application.

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

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

8.1.2 Room Temperature Conditioning Procedure for Garments, Helmets, Gloves, Footwear, and Goggles. Specimens shall be conditioned at a temperature of 21°C ± 3°C (70°F ± 5°F) and a relative humidity of 65 percent ± 5 percent for at least 24 hours. Specimens shall be tested within 5 minutes after removal from conditioning.

8.1.3 Washing and Drying Procedure for Garment Materials. Specimens shall be subjected to 10 cycles of washing and drying in accordance with the procedure specified in Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai, of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. A 1.8 kg ± 0.1 kg (4.0 lb ± 0.2 lb) load shall be used. A laundry bag shall not be used.

8.1.4 Low Temperature Environmental Conditioning Procedure for Helmets.

8.1.4.1 Sample helmets shall be conditioned by exposing them to a temperature of −18°C + 1°C (0°F + 2°F) for at least 4 hours but not more than 24 hours. The impact/penetration test shall be completed within 15 seconds ± 5 seconds after removal from the cold temperature environment, or the helmet shall be reconditioned and tested.

8.1.4.2 If during testing, as specified in Section 8.19, Top Impact Resistance Test (Force), and Section 8.20, Physical Penetration Resistance Test, a helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet.

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

8.1.5 Wet Conditioning Procedure for Helmets. Sample helmets shall be conditioned by immersing them in water at a temperature of 20°C to 28°C (68°F to 82°F) for at least 4 hours but not more than 24 hours. The helmet shall be allowed to

drain and tested within 10 minutes after removal from water. If during testing, as specified in Section 8.19, Top Impact Resistance Test (Force) and Section 8.20, Physical Penetration Resistance Test, a helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet. If the time out of the environment exceeds 4 minutes, the helmet shall be returned to the environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or for a maximum of 12 hours, whichever is less, before the resumption of testing with that helmet.

8.1.6 Radiant and Convective Heat Environmental Conditioning Procedure for Helmets.

8.1.6.1 Sample helmets shall be conditioned by exposing the area to be impacted/penetrated to a radiant heat source. The top, sides, front, and back test areas to be impacted/penetrated shall be as specified in Figure 8.1.6.1.

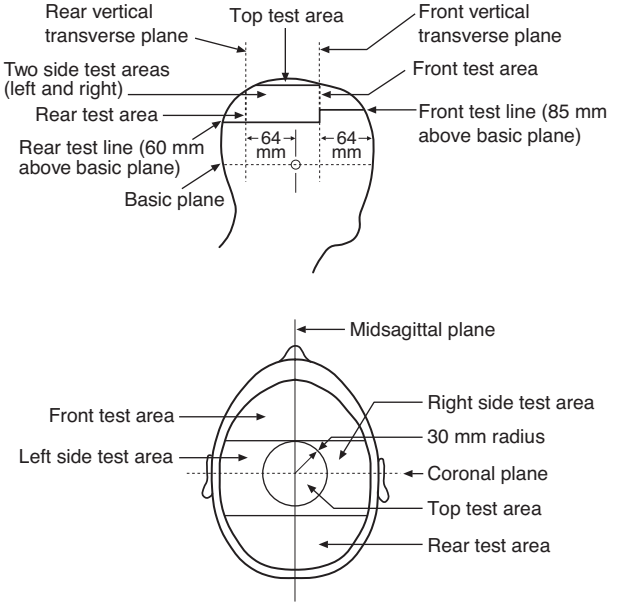


FIGURE 8.1.6.1 Helmet Test Areas and Landmarks.

8.1.6.2 The area to be impacted/penetrated shall be exposed to an irradiance of 1.0 W/cm^2 ± 0.1 W/cm^2 for a length of time determined by exposure of a radiant heat transducer. The heat source shall be removed, and the helmet shall be tested. The helmet shall be impacted/penetrated in 15 seconds ± 5 seconds after removal from the conditioning environment, or the helmet shall be cooled to room temperature and reconditioned and tested as above.

8.1.6.3 The radiometer shall have a spectral response that is flat within ±3 percent over a range of at least 1.0 mm to 10.1 mm (1/25 in. to 2/5 in.) and an overall accuracy of at least ±5 percent of the reading.

8.1.6.4 The radiant panel shall have an effective radiating surface of at least 150 mm ± 5 mm (6 in. ± 1/4 in.) square. The spectral radiant emittance curve of the radiant panel shall be that of a blackbody at a temperature of 1000 K ± 200 K (1340°F ± 360°F).

8.1.6.5 The radiant heat transducer specified in Figure 8.1.6.5 shall be constructed from sheet copper, ASTM B 152, *Specification for Copper Sheet, Strip, Plate, and Rolled Bar,* Type 110 ETP, half hard, 0.64 mm ± 0.05 mm (0.025 in. ± 0.002 in.) thick and 50 mm ± 0.4 mm (2 in. ± 0.02 in.) square. A constantan wire 0.81 mm ± 0.04 mm (0.032 in. ± 0.002 in.) in diameter and an iron wire of the same diameter shall be silver-soldered near the edges of the copper sheet on the same side, as illustrated in Figure 8.1.6.5. The side of the copper sheet opposite that with the wires attached shall be painted flat black. The resulting transducer, a Type J thermocouple, shall be used in conjunction with appropriate instrumentation to monitor the heat exposure to which the helmet is to be subjected.

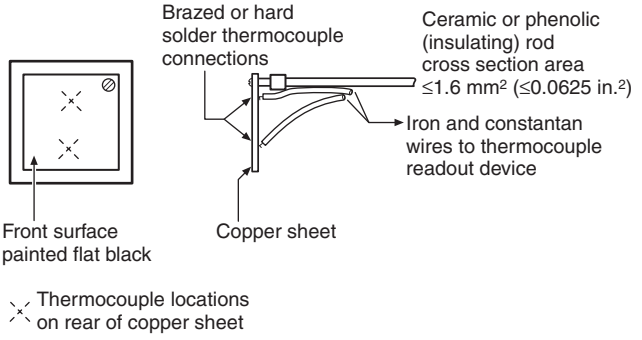


FIGURE 8.1.6.5 Radiant Heat Transducer.

8.1.6.6 Sample helmets shall be mounted in the position to be conditioned. The point of impact or penetration on the helmet shell shall be determined in accordance with the specific test to be performed. The helmet shall be temporarily removed, and a radiometer shall be located at that point perpendicular to and facing away from the helmet surface.

8.1.6.7* The radiant panel shall be introduced in front of the radiometer with its effective radiating surface parallel to the plane tangent to the helmet surface at the center of the impact/penetration site on the helmet. The radiant panel shall be adjusted to obtain a stable uniform irradiance of 1.0 W/cm^2 ± 0.1 W/cm^2 over at least a 75 mm (3 in.) diameter circle located on the plane and centered at the center of impact or penetration. Stability shall be achieved when the irradiance changes by less than 10 percent during a 3-minute period.

8.1.6.8 The radiometer shall be replaced with the radiant heat transducer. The center of the transducer shall be positioned with its center coincident with the center of the impact/penetration site on the helmet and parallel to the plane tangent to the helmet surface at that point. The flat black surface of the transducer shall face the radiant panel. The time required for the transducer to reach a temperature of 177°C (350°F) shall be recorded. That time shall be 1 minute +5/–0 seconds. A closed insulated chamber shall be required to achieve this exposure time.

8.1.6.9 The chamber and helmet shall be stabilized at 25°C ± 5°C (77°F ± 9°F). The helmet shall be positioned in the chamber in the same position as in 8.1.6.6. The helmet shall be subjected to the exposure conditions specified in 8.1.6.1

for the time recorded in 8.1.6.8. The exposure time shall be not less than the time recorded in 8.1.6.8 nor more than 5 seconds longer than that time.

8.1.7 Wet Conditioning Procedure for Whole Gloves.

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

8.1.7.2 The wrist crease location shall be marked as described in 6.1.3.3 on each specimen around the entire glove +0/–3 mm (+0/–0.25 in.). In the same manner, the water height line shall then be marked on each specimen 25 mm +0/–3 mm (1 in. +0/–0.25 in.) below (toward the fingers) the location of the wrist crease around the entire glove.

8.1.7.3 The test subject shall don the test specimen gloves.

8.1.7.4 The test subject shall immerse the donned specimens into two containers of water at a temperature of 21°C ± 3°C (70°F ± 5°F) to the water height line for 15 seconds +1.5/–0 seconds.

8.1.7.5 The glove specimens shall be tested within 1 minute.

8.1.8 Convective Heat Conditioning for Labels, Visibility Markings, and CBRN Barrier Layers. Samples shall be conditioned by exposing them to the procedures specified in 8.5.4 and in 8.5.5.2 through 8.5.5.4, with the following modifications:

(1) The oven temperature shall be stabilized at 140°C, +6°C/–0°C (285°F, +10°/0°F), and the test exposure time shall be 10 minutes, +15/–0 seconds.
(2) The test exposure time shall begin when the test thermocouple reading has stabilized at the required test exposure temperature.
(3) The requirements of 8.5.5.5 and 8.5.5.6 shall be disregarded.
(4) The required post–oven exposure testing shall be performed within 4 hours.

8.1.9 Washing and Drying Procedures for Whole Garments, Gloves, Glove Pouches, and CBRN Materials.

8.1.9.1 Samples shall be washed and dried alternately for a total of ten washing cycles and ten drying cycles.

8.1.9.2 Samples shall be washed and dried with all closures fastened.

8.1.9.3 A front-loading washer/extractor shall be used for washing the samples.

8.1.9.4 The wash load shall be two-thirds the rated capacity of the washer. If ballast is needed to reach two-thirds capacity, 7.5 oz. Nomex ballast shall be used. Two-thirds of the rated capacity shall not be exceeded.

8.1.9.5 The wash cycle procedure in Table 8.1.9.5 shall be followed.

8.1.9.6 A tumble dryer with a dry stack temperature of 38°C to 49°C (100°F to 120°F) measured 20 minutes into the drying cycle shall be used for drying the samples.

8.1.9.7 Samples shall be removed from the dryer after 60 minutes of tumble drying, except that CBRN material samples shall be removed after 20 minutes. At the conclusion of the final drying cycle, the sample shall be allowed to dry completely for at least 48 hours in accordance with 8.1.2.

Table 8.1.9.5 Wash Cycle Procedure for Whole Garments, Gloves, Glove Pouches, and CBRN Materials

Operation	Time (min)	Temperature °C ± 3°C	Temperature °F ± 5°F	Water Level
Suds using AATCC detergent #1993, 1.0 g/4 L (1 gal) water	10	49	120	Low
Drain	1			
Carryover	5	49	120	Low
Drain	1			
Rinse	2	38	100	High
Drain	1			
Rinse	2	38	100	High
Drain	1			
Rinse	2	38	100	High
Drain	1			
Extract	5			

8.1.9.8 Gloves and hoods that are part of CBRN protective ensembles shall be washed and dried for a total of ten washing cycles and ten drying cycles.

8.1.9.9 CBRN materials shall be washed and dried for a total of ten washing cycles and ten drying cycles.

8.1.9.10 The CBRN material samples shall be tumbled for 20 minutes and shall be removed immediately at the end of the drying cycle.

8.1.9.11 Gloves and glove pouches that are not part of CBRN ensembles shall be washed and dried for a total of ten cycles.

8.1.9.12 For gloves and glove pouches, the wash load shall be at two-thirds of the rated capacity of the washer. If ballast is needed to reach two-thirds capacity, 7.5 oz Nomex ballast shall be used. Two-thirds of the rated capacity of the washer shall not be exceeded.

8.1.9.13 Gloves and glove pouches shall be dried using a tumble dryer with a stack temperature of 38°C to 49°C (100°F to 120°F) when measured on an empty load 20 minutes into the drying cycle.

8.1.9.14 Gloves and glove pouches shall be tumbled for 60 minutes and shall be removed immediately at the end of the drying cycle. At the conclusion of the final drying cycle, the gloves or glove pouches shall be permitted to be dried on a forced air nontumble drying mechanism operated at 10°C (50°F) above current room temperature until completely dry.

8.1.10 Flexural Fatigue Procedure for CBRN Barrier Layer.

8.1.10.1 Samples shall be subjected to flexural fatigue in accordance with ASTM F 392, *Standard Test Method for Flex Durability of Flexible Barrier Materials*, with the following modifications.

8.1.10.2 Samples shall be flexed at 21°C, +/–3°C and a relative humidity of 65 percent, +/–5 percent.

8.1.10.3 In lieu of flexing conditions A, B, C, D, or E, test samples shall have a flex period of 3000 cycles at 45 cycles/min.

8.1.10.4 The mandrels shall be spaced at a distance of 235 mm (9¼ in.) in the starting position and 83 mm (3¼ in.) in the closed position. A cycle shall be full flex and twisting action.

8.1.11 Abrasion Procedure for CBRN Barrier Layer. Specimens shall be abraded in accordance with ASTM D 4157, *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 abradants shall be each of the material layers in the composite that are adjacent to the CBRN barrier layer.
(4) The specimen shall be abraded for a total of 60,000 cycles.
(5) The specimen shall be abraded for half of the cycles against the outer layer of the composite with the specimen facing the outer layer in its normal "as worn" orientation.
(6) The specimen shall then be abraded for the remaining cycles against the inner layer of the composite with the specimen facing the inner layer in its normal "as worn" orientation.

8.1.12 Helmet Positioning.

8.1.12.1 The helmet shall be seated firmly on the applicable test headform in accordance with the helmet positioning index (HPI).

8.1.12.2 The HPI shall be the vertical distance as specified by the helmet manufacturer from the lowest point of the front lateral midpoint of the helmet shell aligned with the midsagittal plane, to the basic plane of an ISO size J headform conforming to the nominal dimensions in Figure 8.23.4.1, with the helmet firmly positioned on the headform.

8.1.12.3 When positioning the helmet for testing on headforms other than the ISO size J, the basic plane used for the HPI positioning shall be located 134 mm (5¼ in.) below and parallel to the crown of the headform and shall be marked on the headform.

8.1.13 Glove Test Areas.

8.1.13.1 Glove test areas shall be as described in this paragraph and as shown in Figure 8.1.13.1. Glove test area abbreviations shall be as follows:

(1) P = Palm; B = Back; S = Side.
(2) A-P: Palm side of hand from finger crotch line to ⅓ of the way down (grasp area)
(3) B-P: Palm side of hand from ⅓ of the way down (grasp area) to the wrist crease
(4) C-P: Palm side of hand from the wrist crease to 50 mm (2 in.) past the wrist crease
(5) D-P: Palm side of thumb
(6) E-P: Palm side of tip of thumb
(7) F-P: Palm side of index finger
(8) G-P: Palm side of fingertip of index finger
(9) H-P: Palm side of non-index fingers
(10) I-P: Palm side of fingertip of non-index fingers
(11) A-PS: Sides of hand adjacent to area A-P
(12) B-PS: Outside of hand adjacent to area B-P
(13) C-PS: Sides of hand adjacent to area C-P
(14) D-PS: Outside of thumb adjacent to area D-P
(15) E-PS: Inside of thumb adjacent to area D-P
(16) F-PS: Outside of index finger adjacent to area F-P
(17) H-PS: Between fingers adjacent to areas F-P and H-P
(18) I-PS: Outside of and adjacent to the smallest finger
(19) A-B: Back side of hand from finger crotch line to ⅓ of the way down (knuckle area)
(20) B-B: Back side of hand from ⅓ of the way down (knuckle area) to the wrist crease
(21) C-B: Back side of hand from the wrist crease to 50 mm (2 in.) past the wrist crease
(22) D-B: Back side of thumb
(23) E-B: Back side of tip of thumb
(24) F-B: Back side of index finger
(25) G-B: Back side of fingertip of index finger
(26) H-B: Back side of non-index fingers
(27) I-B: Back side of fingertip of non-index fingers
(28) A-BS: Sides of hand adjacent to area A-B
(29) B-BS: Outside of hand adjacent to area B-B
(30) C-BS: Sides of hand adjacent to area C-B
(31) D-BS: Outside of thumb adjacent to area D-B
(32) E-BS: Inside of thumb adjacent to area D-B
(33) F-BS: Outside of index finger adjacent to area F-B
(34) H-BS: Between fingers adjacent to areas F-B and H-B
(35) I-BS: Outside of and adjacent to the smallest finger

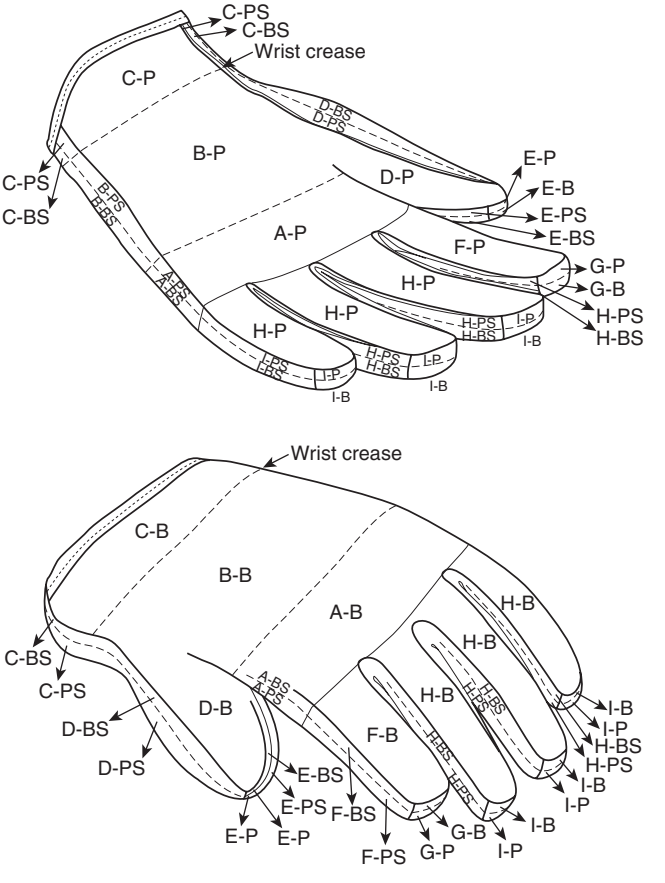


FIGURE 8.1.13.1 Glove Test Areas.

8.1.14* Pouch Construction for Glove Composite Sample One.

8.1.14.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test. How-

ever, for the test specified in Section 8.2, the pouch size shall not be reduced.

8.1.14.2 The pouch shall be made of two glove composite swatches.

8.1.14.3 The two glove composite swatches shall be of the same materials and construction.

8.1.14.4 The two glove composite swatches shall be constructed to simulate the actual layers of the glove body or glove interface component as appropriate, arranged in proper order.

8.1.14.5 Each of the two glove composite swatches shall be stitched on all four sides using the same thread as used in the glove construction.

8.1.14.6 The two glove composite swatches shall then be sewn together, inner liner to inner liner, or inside to inside for single layer composites, on three sides using the same thread as used in the glove construction.

8.1.14.7 The two glove composite swatches and resulting pouch shall be permitted to not be stitched or have reduced stitching if a laundering preconditioning is not required to be performed on the composite sample.

8.1.15 Pouch Construction for Glove Composite Sample Two.

8.1.15.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test.

8.1.15.2 The pouch shall be made of two glove composite swatches.

8.1.15.3 The two glove composite swatches shall be permitted to be made of the same materials and construction and shall be permitted to be representative of either the palm or the back of the glove.

8.1.15.4 The two glove composite swatches shall be constructed to simulate the actual layers of the glove body, arranged in proper order.

8.1.15.5 Where the moisture barrier material seam is being tested, the moisture barrier layer shall contain a seam. The seam shall run within 25 mm (1 in.) of the center and shall extend across the entire width of the specimen.

8.1.15.6 Each of the two glove composite swatches shall be stitched on all four sides using the same thread as used in the glove construction.

8.1.15.7 The two glove composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

8.2 Thermal Protective Performance Test.

8.2.1 Application.

8.2.1.1 This test method shall apply to protective garment materials, glove materials, and footwear upper materials.

8.2.1.2 Modifications to this test method for testing garment materials shall be as specified in 8.2.8.

8.2.1.3 Modifications to this test method for testing glove materials shall be as specified in 8.2.9.

8.2.1.4 Modifications to this test method for testing footwear upper materials shall be as specified in 8.2.10.

8.2.2 Sample Preparation.

8.2.2.1 Samples shall be as specified in 8.2.8, 8.2.9, or 8.2.10.

8.2.2.2 Samples except CBRN garment and material samples shall be conditioned as specified in 8.2.8, 8.2.9, or 8.2.10.

8.2.3 Specimens.

8.2.3.1 Specimens shall be as specified in 8.2.8, 8.2.9, or 8.2.10.

8.2.3.2 Three specimens for each conditioning specified in 8.2.8, 8.2.9, and 8.2.10 shall be tested.

8.2.4 Apparatus. The test apparatus specified in ASTM F 2700, *Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating*, shall be used.

8.2.5 Procedure. Thermal protective performance testing shall be performed in accordance with ASTM F 2700, *Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame Resistant Materials for Clothing with Continuous Heating*, with the following modifications:

(1) The contact configuration shall be used for testing of all material specimens.
(2) The heat transfer performance value calculations using the heat flux in calories/cm^2/sec shall be reported as the TPP rating.

8.2.6 Report.

8.2.6.1 The individual test TPP rating of each specimen shall be reported.

8.2.6.2 The average TPP rating shall be calculated, recorded, and reported.

8.2.6.3 Where a TPP rating is greater than 60, the TPP rating shall be reported as ">60."

8.2.7 Interpretation.

8.2.7.1 Pass or fail determinations shall be separately based on the average reported TPP rating of all specimens.

8.2.7.2 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. For glove body composites, this variance requirement shall be eliminated.

8.2.8 Specific Requirements for Testing Garment Composites.

8.2.8.1 Specimens shall consist of all layers used in the construction of the garment, excluding any areas with special reinforcements. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together.

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

8.2.8.3 Testing shall be performed as described in 8.2.2 through 8.2.7.

8.2.8.4 Specimens shall be tested both before and after preconditioning as specified in 8.1.2 and then conditioned as specified in 8.1.3.

8.2.9 Specific Requirements for Testing Glove Body Composites.

8.2.9.1 Samples for conditioning shall be in the form of a pouch as described in 8.2.9.4.

8.2.9.2 Samples shall be representative of each glove body composite construction.

8.2.9.2.1 All variations in composite construction, including number of layers and the order of layering of composite materials shall constitute a new composite and shall be tested separately.

8.2.9.2.2 Where a composite is identical to another composite except for additional reinforcement layer(s) and the reinforcement layer(s) is the same as one or more of the base composite layers, the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s).

8.2.9.2.3 Samples shall not include seams except in the following cases:

(1) Ridged areas or similar areas where stitching is used to create specific performance characteristics rather than for glove assembly
(2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required

8.2.9.2.4 Stitching of seams shall be of the same type used in the actual glove construction.

8.2.9.3 Samples shall be tested both before and after preconditioning as specified in 8.1.2 and then conditioned as specified in 8.1.9.

8.2.9.4 After conditioning, the glove composite pouch and stitching shall be cut to form specimens measuring 175 mm × 175 mm (7 in. × 7 in.) for testing.

8.2.9.4.1 Samples shall not be stitched to hold individual layers together during testing.

• **8.2.9.5** Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.2.10 Specific Requirements for Testing Footwear Upper Materials.

8.2.10.1 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, excluding the tongue and gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested. Specimens shall not include seams.

8.2.10.2 Samples for conditioning shall include footwear upper material that is a minimum of 150 mm × 150 mm, ±6 mm (6 in. × 6 in., ±¼ in.), consisting of the material used in the actual footwear construction, with the layers arranged in proper order.

8.2.10.3 Testing shall be performed as described in 8.2.2 through 8.2.7.

8.2.10.4 Footwear upper specimens shall be conditioned as specified in 8.1.2 only.

8.3 Overall Liquid Integrity Test 1.

8.3.1 Application. This test method shall apply to complete garments.

8.3.1.1 This test method shall apply to protective garments, protective coats with interface device to integrate gloves, protective trousers with integrated booties, and entire ensembles that are being evaluated for optional CBRN terrorism agent protection.

8.3.1.2 Modifications to this test method for testing protective coats and protective coats with an interface device to integrate gloves shall be as specified in 8.3.8.

8.3.1.3 Modifications to this test method for testing protective trousers and protective trousers with integrated booties shall be as specified in 8.3.9.

8.3.1.4 Modifications to this test method for testing protective coat and trouser sets or protective coveralls shall be as specified in 8.3.10.

8.3.1.5 Modifications to this test method for testing entire ensembles for CBRN terrorism agent protection shall be as specified in 8.3.11.

8.3.2 Sample Preparation.

8.3.2.1 Samples shall be complete garments or ensemble elements, with all layers assembled that are required for the garment to be compliant.

8.3.2.2 Samples shall be preconditioned as specified in 8.1.9 followed by 8.1.2.

8.3.3 Specimens.

8.3.3.1 A minimum of three specimens shall be tested. Specimens shall consist of individual coats, trousers, coveralls, sets of coats and trousers, or entire ensembles for CBRN terrorism agent protection. Each element shall have in place all layers that are required for the element to be compliant.

8.3.3.2 The size of the elements that the specimens comprise shall be chosen to conform with the dimensions of the mannequin for proper fit of the specimen on the mannequin in accordance with the manufacturer's sizing system. The size of the elements that the specimen comprises shall be the same size as the mannequin in terms of chest circumference, waist circumference, and inseam height.

8.3.4 Apparatus. The apparatus and supplies for testing shall be those specified in ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin,* using the following modifications:

(1) The surface tension of the water used in testing shall be 35 dynes/cm ± 5 dynes/cm.
(2) The mannequin used in testing shall have straight arms and legs, with the arms positioned at the mannequin's side.

8.3.5 Procedure. Liquidtight integrity testing of garments shall be conducted in accordance with ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin,* with the following modifications:

(1) No provisions for partial garments shall be permitted.

(2) Blocking of the specimen shall be as specified in 8.3.8, 8.3.9, and 8.3.10, as appropriate, for the type of specimen being tested.
(3) The method used for mounting of the mannequin in the spray chamber shall not interfere with the water spray.
(4) The normal outer surface of the material shall be exposed to the liquid as oriented in the clothing item.
(5) Fluorescent or visible dyes shall not be used in the water for spraying the suited mannequin.
(6) The suited mannequin shall be exposed to the liquid spray for 5 minutes in each of the four specified mannequin orientations, for a total of 20 minutes.
(7) At the end of the liquid spray exposure period, excess liquid shall be removed from the surface of the specimen.
(8) The specimen shall be inspected within 10 minutes of the end of the liquid spray exposure period for evidence of liquid penetration.

8.3.6 Report. A diagram shall be prepared for each test that identifies the locations of any liquid leakage as detected on the liquid-absorptive garment and the interior of the garment.

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

8.3.8 Specific Requirements for Testing Coats.

8.3.8.1 The liquid-absorptive garment shall cover only the upper torso and arms of the mannequin from the middle of the mannequin's neck, down to the mannequin's waistline, and down to the mannequin's wrist crease.

8.3.8.2 The coat shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.3.8.3 The coat collar shall be placed in the up position on the mannequin with the collar closure system fastened in the closed position. The head of the mannequin shall be sealed off with a plastic bag. The plastic bag shall extend downward over the collar a distance of not greater than 25 mm (1 in.) and shall be taped down with duct tape or similar waterproof tape. The tape shall not extend downward more than 25 mm (1 in.) from the top of the collar. The bottom edge of the tape and the plastic bag shall not come closer than 25 mm (1 in.) to the collar seam, where a collar seam is present. Where present, the collar neck seam shall not be covered.

8.3.8.4 The test shall be conducted with the mannequin's hands removed. The coat sleeve hem shall be taped smoothly to a can or an object of similar cylindrical, rigid shape of the same nominal diameter as the sleeve opening. The can or cylinder shall be fitted under the coat outer shell sleeve hem. The tape shall be duct tape or similar waterproof tape.

8.3.8.4.1 Where the coats have an interface device to integrate gloves as permitted in 6.3.4.4, the mannequin hands shall not be removed.

8.3.8.4.2 The interface device shall be mounted with gloves in accordance with the manufacturer's instructions for proper wearing.

8.3.8.5 The coat shall be tested in conjunction with the protective trousers specified by the manufacturer, even where the trousers are not being specifically evaluated by this test.

8.3.8.6 Testing shall be performed as specified in 8.3.3 through 8.3.6.

8.3.9 Specific Requirements for Testing Trousers.

8.3.9.1 The liquid-absorptive garment shall only cover the lower torso and legs of the mannequin from the mannequin's waistline down to the mannequin's ankles.

8.3.9.2 The trousers shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.3.9.3 Trousers shall be tested in conjunction with the protective coat specified by the manufacturer, even where the coat is not being specifically evaluated by this test.

8.3.9.4 Absorbent toweling or similar material shall be placed underneath the mannequin to prevent water splashing up inside the trouser leg.

8.3.9.5 Where trousers are provided with integrated booties, outer footwear specified to be worn with the booties shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.3.9.6 Testing shall be performed as specified in 8.3.3 through 8.3.6.

8.3.10 Specific Requirements for Testing Coveralls and for Testing Sets of Coats and Trousers.

8.3.10.1 The liquid-absorptive garment shall cover only the torso, arms, and legs of the mannequin from the middle of the mannequin's neck, down to the mannequin's wrist crease, and down to the mannequin's ankles.

8.3.10.2 The coverall or set of coat and trousers shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.3.10.3 The coat or coverall collar shall be placed in the up position on the mannequin with the collar closure system fastened in the closed position. The head of the mannequin shall be sealed off with a plastic bag. The plastic bag shall extend downward over the collar a distance of not greater than 25 mm (1 in.) and shall be taped down with duct tape or similar waterproof tape. The tape shall not extend downward more than 25 mm (1 in.) from the top of the collar. The collar neck seam shall not be covered. The bottom edge of the tape and the plastic bag shall not come closer than 25 mm (1 in.) to the collar seam, where a collar seam is present. Where present, the collar neck seam shall not be covered.

8.3.10.4 The test shall be conducted with the mannequin's hands removed. The coat or coverall sleeve hem shall be taped smoothly to a can or an object of similar cylindrical, rigid shape of the same nominal diameter as the sleeve opening. The can or cylindrical object shall be fitted under the coat or coverall outer shell sleeve hem. The tape shall be duct tape or similar waterproof tape.

8.3.10.4.1 Where the coats or coveralls have an interface device to integrate gloves as permitted in 6.3.4.4, the mannequin hands shall not be removed.

8.3.10.4.2 The interface device shall be mounted with gloves in accordance with the manufacturer's instructions for proper wearing.

8.3.10.5 Absorbent toweling or similar material shall be placed underneath the mannequin to prevent water splashing up inside the trouser leg.

8.3.10.6 Where trousers are provided with integrated booties, outer footwear specified to be worn with the booties shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.3.10.7 Testing shall be performed as specified in 8.3.3 through 8.3.6.

8.3.11 Specific Requirements for Testing Ensembles for CBRN Terrorism Agent Protection.

8.3.11.1 Specimens for testing shall consist of CBRN protective ensembles and the garment, helmet, glove, and footwear elements, and the CBRN SCBA, CBRN PAPR, or CBRN APR specified for the ensemble by the ensemble manufacturer. The hood interface component shall also be tested where the hood is not part of the CBRN ensemble garment elements.

8.3.11.2 A total of three different ensemble specimens shall be evaluated.

8.3.11.3 Garment, glove, and hood elements shall be conditioned as specified in 8.1.9.

8.3.11.4 Where the ensemble garment element does not include booties and the CBRN barrier layer is incorporated into footwear, footwear shall be conditioned by flexing for 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:

(1) Water shall not be used.
(2) The flex speed shall be 60 cycles/min, +/−2 cycles/min
(3) Alternative flexing equipment shall be permitted to be used provided it 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/min, +/−2 cycles/min
    (c) Provides a means of securing the footwear during flexing

8.3.11.5 The liquid-absorptive garment shall be a hooded coverall made of fabric meeting the requirements in ASTM F 1359, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*. The liquid-absorptive garment shall not interfere with the correct wearing of the ensemble. In addition to the liquid-absorptive garment, the mannequin's hands shall be covered with suitably sized 100 percent cotton gloves and the mannequin's feet covered with suitably sized 100 percent cotton socks.

8.3.11.6 Specimens provided in 8.3.11.1 shall be donned on the mannequin in accordance with manufacturer specifications.

8.3.11.7 No taping, blockage, coverage, or provision of absorbent toweling of or to any part of any interface or element on the ensemble shall be permitted.

8.3.11.8 The mannequin with ensemble in place shall be exposed to the liquid spray for a total of 20 minutes, 5 minutes in each of the four mannequin orientations.

8.3.11.9 Following the test, the liquid-absorptive garment, inner cotton gloves, and inner cotton socks on the mannequin shall be inspected to determine evidence of liquid leakage.

8.3.11.10 Other than the exposure duration specified in 8.3.11.8, testing shall be performed as specified in 8.3.3 through 8.3.6.

8.4 Flame Resistance Test 1.

8.4.1 Application.

8.4.1.1 This test method shall apply to protective garment textiles and visibility markings.

8.4.1.2 Modifications to this test method for testing woven textile materials shall be as specified in 8.4.8.

8.4.1.3 Modifications to this test method for testing knit textile materials shall be as specified in 8.4.9.

8.4.1.4 Modifications to this test method for testing nonwoven textile materials shall be as specified in 8.4.10.

8.4.1.5 Modifications to this test method for testing small specimens not meeting the specimen size requirements of 8.4.2.1 shall be as specified in 8.4.11.

8.4.2 Sample Preparation.

8.4.2.1 Samples shall be as specified in 8.4.8, 8.4.9, 8.4.10, or 8.4.11.

8.4.2.2 Samples shall be conditioned as specified in 8.1.2. Other samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.4.3 Specimens.

8.4.3.1 Specimens shall consist of a 75 mm × 305 mm (3 in. × 12 in.) rectangle with the long dimension parallel to either the warp direction (machine or course), the filling direction (cross-machine), or wales of the material.

8.4.3.2 Each individual layer of multilayer material systems or composites shall be separately tested.

8.4.3.3 All specimens except CBRN garment and material specimens to be tested shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

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

8.4.5 Procedure.

8.4.5.1 Flame resistance testing shall be performed in accordance with Method ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test).*

8.4.5.2 Each specimen shall be examined for evidence of melting or dripping.

8.4.6 Report.

8.4.6.1 Afterflame time and char length shall be reported for each specimen.

8.4.6.2 The average afterflame time and char length for each material shall be calculated, recorded, and reported.

8.4.6.3 The afterflame time shall be reported to the nearest 0.1 second and the char length to the nearest 3 mm (⅛ in.).

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

8.4.7 Interpretation.

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

8.4.7.2 Failure in either direction shall constitute failure of the material.

8.4.8 Specific Requirements for Testing Woven Textile Materials.

8.4.8.1 Five specimens from each of the warp and filling directions shall be tested.

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

8.4.8.3 Testing shall be performed as described in 8.4.2 through 8.4.7.

8.4.9 Specific Requirements for Testing Knit Textile Materials.

8.4.9.1 Five specimens from each of the warp and filling directions shall be tested.

8.4.9.2 Samples for conditioning shall include material that is a minimum of 75 mm × 305 mm (3 in. × 12 in.).

8.4.9.3 Testing shall be performed as described in 8.4.2 through 8.4.7.

8.4.10 Specific Requirements for Testing Nonwoven Textile Materials.

8.4.10.1 Five specimens from each of the machine and cross-machine directions shall be tested.

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

8.4.10.3 Testing shall be performed as described in 8.4.2 through 8.4.7.

8.4.11 Specific Requirements for Testing Small Materials.

8.4.11.1 Five specimens attached to the textile layer as used in the protective garments shall be tested. The specimens shall be attached to the textile layer such that the bottom (exposure) edge of the item coincides with the bottom (exposure) edge of the textile support layer.

8.4.11.2 Samples for conditioning shall be 1 m (1 yd) square of the textile layer on which the small specimens are attached.

8.4.11.3 Testing shall be performed as described in 8.4.2 through 8.4.7, other than char length, which shall not be measured.

8.5 Heat and Thermal Shrinkage Resistance Test.

8.5.1 Application.

8.5.1.1 This test method shall apply to protective garment textiles, liquid barrier seams, and hardware; labels; protective helmets; protective gloves; protective footwear; and goggles.

8.5.1.2 Modifications to this test method for testing garment textiles and liquid barrier seams shall be as specified in 8.5.8.

8.5.1.3 Modifications to this test method for other garments and label materials shall be as specified in 8.5.9.

8.5.1.4 Modifications to this test method for testing hardware shall be as specified in 8.5.10.

8.5.1.5 Modifications to this test method for testing helmets shall be as specified in 8.5.11.

8.5.1.6 Modifications to this test method for testing gloves shall be as specified in 8.5.12.

8.5.1.7 Modifications to this test method for testing footwear shall be as specified in 8.5.13.

8.5.1.8 Modifications to this test method for testing goggles shall be as specified in 8.5.14.

8.5.2 Sample Preparation.

8.5.2.1 Samples shall be as specified in 8.5.8, 8.5.9, 8.5.10, 8.5.11, 8.5.12, 8.5.13, or 8.5.14.

8.5.2.2 Samples except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.5.2.3 Other samples shall be conditioned as specified in 8.1.2 only.

8.5.3 Specimens.

8.5.3.1 Specimens shall be as specified in 8.5.8, 8.5.9, 8.5.10, 8.5.11, 8.5.12, 8.5.13, or 8.5.14.

8.5.3.2 Heat resistance testing shall be conducted on a minimum of three specimens for each hardware item, label material, helmet, footwear, goggle, and other protective garment materials not listed in 8.5.3.3.

8.5.3.3 Both heat and thermal shrinkage resistance testing shall be conducted on a minimum of three specimens for each garment textile and on whole gloves.

8.5.3.4 Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

8.5.3.5 Testing shall be conducted on specimens taken from samples conditioned according to both 8.5.2.2 and 8.5.2.3, except as modified by 8.5.8, 8.5.9, 8.5.10, 8.5.11, 8.5.12, 8.5.13, and 8.5.14.

8.5.4 Apparatus.

8.5.4.1 The test oven shall be a horizontal-flow circulating oven with minimum interior dimensions of 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.) such that a specimen can be suspended and be at least 50 mm (2 in.) from any interior oven surface or other specimen.

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

8.5.4.3 A test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted sample specimen. The thermocouple shall be equidistant between the vertical centerline of a mounted specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber. The thermocouple shall be an exposed bead, Type J or Type K, No. 30 AWG thermocouple. The test oven shall be heated and the test thermocouple stabilized at 260°C, +6/–0°C (500°F, +10/–0°F) for a period of not less than 30 minutes.

8.5.5 Procedure.

8.5.5.1 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

8.5.5.2 The specimen shall be suspended by metal hooks at the top and centered in the oven so that the entire specimen is not less than 50 mm (2 in.) from any oven surface or other specimen, and airflow is parallel to the plane of the material.

8.5.5.3 The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and shall be turned on when the door is closed. The total oven recovery time after the door is closed shall not exceed 30 seconds.

8.5.5.4 The specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +0.15/−0 minutes. The test exposure time shall begin when the test thermocouple recovers to a temperature of 260°C, +6/−0°C (500°F, +10/−0°F).

8.5.5.5 Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition, melting, dripping, or separation.

8.5.5.6 After the specified exposure, the specimen shall also be measured to determine pass or fail performance. Knit fabric shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement to determine pass or fail performance.

8.5.6 Report.

8.5.6.1 Observations of ignition, melting, dripping, or separation shall be recorded and reported for each specimen.

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

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

8.5.7 Interpretation.

8.5.7.1 Any evidence of ignition, melting, dripping, or separation on any specimen shall constitute failing performance.

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

8.5.7.3 Failure in any one direction shall constitute failure for the entire sample.

8.5.8 Specific Requirements for Testing Garment Textiles.

8.5.8.1 Each specimen shall be 380 mm × 380 mm ± 13 mm (15 in. × 15 in. ± ½ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

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

8.5.8.3 Testing shall be performed as described in 8.5.2 through 8.5.7.

8.5.9 Specific Requirements for Testing Other Garment and Label Materials.

8.5.9.1 Specimen length shall be 150 mm (6 in.), except for textiles utilized in the clothing item in lengths less than 150 mm (6 in.), where length shall be the same as utilized in the clothing item. Specimen width shall be 150 mm (6 in.), except for textiles utilized in the clothing item in widths less than 150 mm (6 in.), where widths shall be the same as utilized in the clothing item.

8.5.9.2 Samples for conditioning shall include material sewn onto a 1 m (1 yd) square ballast material no closer than 50 mm (2 in.) apart in parallel strips. The ballast material shall be as specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*. Specimens shall be removed from the ballast material prior to testing.

8.5.9.3 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.10 Specific Requirements for Testing Hardware.

8.5.10.1 Only the conditioning specified in 8.1.2 shall be required prior to testing.

8.5.10.2 A minimum of three complete hardware items shall be tested.

8.5.10.3 Other than as specified in 8.5.6.1 and 8.5.6.2, testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.10.4 Observations of hardware items and closure condition following heat exposure shall be limited to ignition.

8.5.10.5 Hardware items and closures shall be evaluated for functionality within 10 minutes following removal from the oven.

8.5.11 Specific Testing Requirements for Helmets.

8.5.11.1 Helmet specimens shall include complete helmets. Only one helmet shall be tested at a time.

8.5.11.2 Only the conditioning specified in 8.1.2 shall be required prior to testing.

8.5.11.3 The test oven shall be heated and stabilized to a temperature of 177°C, +5°C/−0°C (350°F, +10°/−0°F).

8.5.11.4 Sample helmets shall be positioned according to the HPI as described in 8.1.13 on the thermal headform conforming to the dimensions in Figure 8.5.11.4.

8.5.11.5 A series of points shall be marked 75 mm (3 in.) apart on the outer edge of the peak or brim of the sample helmets, allowing at least three points on a peak and eight or more points on a full brim. The vertical distance from a known horizontal base plane to the marked points on the peak or brim shall be measured and recorded.

8.5.11.6 The sample helmet mounted on the headform shall be placed in the center of the oven with the centerline of the front of the helmet facing the airflow. The thermocouple shall be equidistant between the vertical centerline of a mounted test helmet placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

8.5.11.7 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.11.8 After 5 minutes, +15/−0 seconds, the sample helmet mounted on the headform shall be removed from the test oven. The helmet shall be allowed to cool for a minimum of 2 minutes. The vertical distance from the marked points to the base plane shall be measured, recorded, and compared with the measurements recorded in 8.5.11.5 to determine pass or fail performance.

8.5.11.9 Hardware shall be evaluated to determine functionality.

8.5.12 Specific Requirements for Testing Gloves.

8.5.12.1 Specimens shall include complete gloves with labels. Only three glove specimens shall be tested at a time.

8.5.12.2 The glove body shall be filled with 4 mm (0.15 in.) perforated soda-lime glass beads, with care taken to tightly pack the glass beads into the fingers of the glove and the glove body. The opening of the glove shall be clamped closed, and

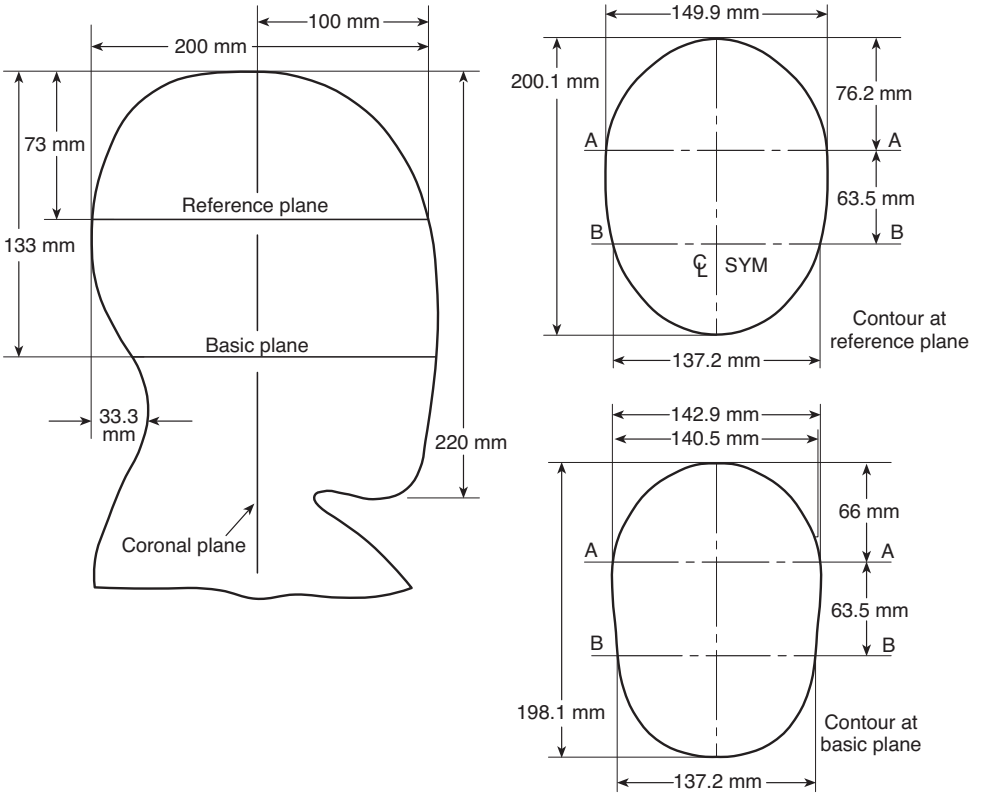


FIGURE 8.5.11.4 Thermal Headform.

the specimen shall be suspended by the clamp in the oven so that the entire glove is not less than 50 mm (2 in.) from any oven surface or other specimen and airflow is parallel to the plane of the material.

8.5.12.3 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.13 Specific Testing Requirements for Footwear.

8.5.13.1 Only the conditioning specified in 8.1.2 shall be required prior to testing. One footwear specimen shall be tested at a time.

8.5.13.2 Samples for conditioning shall be whole boots.

8.5.13.3 The footwear specimen for testing shall be size 9.

8.5.13.4 A minimum of three specimens shall be tested. One footwear specimen shall be tested at a time.

8.5.13.5 Footwear specimens shall be filled to capacity with nominal 4 mm (0.15 in.) perforated soda-lime glass beads or borosilicate glass beads. Any closures shall be fastened.

8.5.13.6 The test thermocouple shall be positioned so that it is level with the horizontal centerline of a footwear test specimen. The thermocouple shall be equidistant between the vertical centerline of a footwear test specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

8.5.13.7 The specimen shall be placed in the center of the test oven with the centerline of the front of the specimen facing the airflow.

8.5.13.8 Testing shall be performed as specified in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.13.9 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 5 minutes, +15/−0 seconds. The test specimen shall be examined inside and outside for evidence of melting, separation, or ignition within 10 minutes, +15/−0 seconds after removal from the oven. Separation occurring in this test shall be recorded and reported if it is at least 1.4 mm × 18 mm (0.5 in. × 0.7 in.) in any orientation.

8.5.13.10 Each test specimen shall then be reconditioned as specified in 8.1.2 and then reexamined inside and outside for evidence of melting, separation, or ignition.

8.5.13.11 Footwear functionality shall be determined by flexing the specimen for 100,000 cycles performed in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:

(1) Water shall not be used.
(2) The flex speed shall be 60 +/−2 cycles/min.
(3) Alternative flexing equipment shall be permitted to be used provided it 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 +/−2 cycles/min
    (c) Provides a means of securing the footwear during flexing

8.5.13.12 Specimens shall then be examined for evidence of sole separation, seam separation, or component breakage.

8.5.13.13 After flexing, the footwear specimen shall be marked with a water height line on the exterior at a height of 75 mm (3 in.) below the height of the boot as defined in 6.1.4.4.1 and 6.2.4.4.1 but no lower than 178 mm (7 in.) where measured up from the center of the insole at the heel. The measurement shall be made on the interior and transferred to the exterior.

8.5.13.14 Plain white paper toweling shall be placed inside the footwear specimen such that the paper toweling intimately contacts all areas inside the footwear specimen to at least the water height line.

8.5.13.15 The footwear specimen shall then be placed in a container that allows its immersion in tap water, treated with a dye and surfactant that achieves a surface tension of 35 dynes/cm ± 5 dynes/cm, to within 0.5 in. of the water height line.

8.5.13.16 After 2 hours ± 10 minutes, the paper toweling shall be removed and examined for evidence of liquid leakage. The test specimen shall also be reexamined for evidence of sole separation or seam separation.

8.5.13.17 Footwear not remaining functional after flexing shall be recorded and reported as a failure for the tested specimen. The appearance of any liquid on the removed paper toweling shall be recorded and reported as a failure for the tested specimen. One or more footwear specimens failing this test shall constitute failing performance.

8.5.14 Specific Testing Requirements for Goggles.

8.5.14.1 Only the conditioning specified in 8.1.2 shall be required prior to testing.

8.5.14.2 Where provided, goggle specimens shall include straps or headbands and attachment devices.

8.5.14.3 Goggles shall be mounted on a thermal headform conforming to the dimensions in Figure 8.5.11.4. The headform with goggles attached shall be placed in the center of the test oven with the centerline of the front of the goggles facing the airflow.

8.5.14.4 The test thermocouple shall be positioned so that it is level with the horizontal centerline of the mounted goggles. The thermocouple shall be equidistant between the vertical centerline of the mounted test goggles placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

8.5.14.5 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.14.6 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 2 minutes. The specimen shall be examined to ascertain any effects of the heat exposure.

8.6 Total Heat Loss Test.

8.6.1 Application. This test method shall apply to the protective garment base composites.

8.6.2 Sample Preparation.

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

8.6.2.2 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 4 hours.

8.6.3 Specimens.

8.6.3.1 Specimen size shall be the size required to cover the sweating guarded hot plate.

8.6.3.2 At least three specimens shall be tested.

8.6.3.3 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.

8.6.4 Apparatus. The test apparatus shall be as specified in ASTM F 1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials using a Sweating Hot Plate.*

8.6.5 Procedure. Testing shall be conducted in accordance with ASTM F 1868, *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 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, the edges shall be secured.
(4) Once the test is started, no further adjustments to the specimen shall be made.

8.6.6 Report.

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

8.6.6.2 The average apparent intrinsic evaporative resistance (AR_{ef}) of the sample shall be recorded and reported.

8.6.6.3 The average total heat loss (Q_t) of the sample shall be calculated and reported.

8.6.7 Interpretation.

8.6.7.1 Pass or fail determination shall be based on the average reported total heat loss measurement of all specimens tested.

8.6.7.2 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.

8.7 Tear Resistance Test.

8.7.1 Application. This test shall apply to garment materials. If the garment is constructed of several separable layers, then all layers shall be individually tested.

8.7.2 Sample Preparation.

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

8.7.2.2 Samples except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by the conditioning as specified in 8.1.2.

8.7.2.3 Other samples shall be conditioned as specified in 8.1.2 only.

8.7.3 Specimens.

8.7.3.1 Specimens shall be the size specified in ASTM D 5587, *Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure.*

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

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

8.7.3.4 Testing shall be conducted on 10 specimens taken from both samples conditioned according to 8.7.2.2 and 8.7.2.3.

8.7.4 Procedure. Specimens shall be tested in accordance with ASTM D 5587, *Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure,* using Option 1 for the calculation of tear resistance.

8.7.5 Report.

8.7.5.1 The tear resistance of each specimen shall be recorded and reported to the nearest 0.2 N (0.1 lbf).

8.7.5.2 An average tear resistance shall be individually calculated for the warp and filling directions.

8.7.5.3 For isotropic materials, a single average tear resistance shall be calculated.

8.7.6 Interpretation.

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

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

8.8 Breaking Strength Test.

8.8.1 Application. This test shall apply to garment outer shell materials.

8.8.2 Sample Preparation.

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

8.8.2.2 Samples except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.8.2.3 Other samples shall be conditioned as specified in 8.1.2 only.

8.8.3 Specimens.

8.8.3.1 Specimens shall be the size specified in ASTM D 5034, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Grab Method).*

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

8.8.3.3 If the material is isotropic, then 10 specimens shall be tested.

8.8.3.4 Testing shall be conducted on 10 specimens taken from both samples conditioned according to 8.8.2.2 and 8.8.2.3.

8.8.4 Procedure. Specimens shall be tested in accordance with ASTM D 5034, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Grab Method).*

8.8.5 Report.

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

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

8.8.5.3 For isotropic materials, a single average breaking strength shall be calculated.

8.8.6 Interpretation.

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

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

8.9 Abrasion Resistance Test 1.

8.9.1 Application. This test shall apply to garment outer shell materials.

8.9.2 Sample Preparation.

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

8.9.2.2 Samples except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.9.3 Specimens.

8.9.3.1 Specimens shall be the size specified in ASTM D 3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method).*

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

8.9.3.3 If the material is isotropic, then 10 specimens shall be tested.

8.9.4 Procedure.

8.9.4.1 Specimens shall be subjected to abrasion in accordance with ASTM D 3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method),* under the following conditions:

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

8.9.4.2 After being abraded as specified in 8.9.4.1, specimens shall be tested in accordance with ASTM D 5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).*

8.9.5 Report.

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

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

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

8.9.6 Interpretation.

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

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

8.10 Cleaning Shrinkage Resistance Test.

8.10.1 Application.

8.10.1.1 This test method shall apply to garment materials.

8.10.1.2 Modifications to this test method for woven material shall be as specified in 8.10.7.

8.10.1.3 Modifications to this test method for knit and stretch woven materials shall be as specified in 8.10.8.

8.10.2 Sample Preparation.

8.10.2.1 Samples shall be as specified in 8.10.7 or 8.10.8.

8.10.2.2 Samples shall be conditioned as specified in 8.1.2.

8.10.3 Specimens.

8.10.3.1 Samples shall be as specified in 8.10.7 or 8.10.8.

8.10.3.2 At least three specimens shall be tested.

8.10.3.3 Each material shall be tested separately.

8.10.4 Procedure.

8.10.4.1 Specimens shall be tested using five cycles of Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai, of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

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

8.10.4.3 Specimen marking and measurements shall be conducted in accordance with the procedure specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*

8.10.5 Report.

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

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

8.10.6 Interpretation.

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

8.10.6.2 Failure in any one direction shall constitute failure for the entire sample.

8.10.7 Specific Requirements for Testing Woven Textile Materials.

8.10.7.1 Each specimen shall be 380 mm × 380 mm ± 13 mm (15 in. × 15 in. ± ½ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

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

8.10.7.3 Testing shall be performed as described in 8.10.2 through 8.10.6.

8.10.8 Specific Requirements for Testing Knit and Stretch Woven Textile Materials.

8.10.8.1 Each specimen shall be 380 mm × 380 mm ± 13 mm (15 in. × 15 in. ± ½ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.10.8.2 Samples for conditioning shall include material that is at least 50 mm (2 in.) larger than necessary for the dimensional change measurement in each of the two required specimen dimensions.

8.10.8.3 Testing shall be performed as described in 8.10.2 through 8.10.6.

8.10.8.4 Knit fabric specimens, instead of being restored to 7.4.2 of AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*, shall be pulled to their original dimensions and shall be allowed to relax for 1 minute prior to measurement.

8.11 Abrasion Resistance Test 2.

8.11.1 Application.

8.11.1.1 This test shall apply to glove palm composites and footwear upper materials.

8.11.1.2 Modifications to this test method for testing glove composite shall be as specified in 8.11.7.

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

8.11.2 Sample Preparation.

8.11.2.1 Samples shall be as specified in 8.11.7 or 8.11.8.

8.11.2.2 Samples shall be conditioned as specified in 8.1.2.

8.11.3 Specimens.

8.11.3.1 Samples shall be as specified in 8.11.7 or 8.11.8.

8.11.3.2 Samples shall be the size specified in ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method).*

8.11.3.3 At least five samples shall be tested.

8.11.4 Procedure. Specimens shall be tested in accordance with ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, using a Calibrade H-18 wheel for a total of 2500 cycles. At the end of each abrasion exposure, the specimen shall be examined for wear-through of the outermost separable layer.

8.11.5 Report. The wear-through determination shall be reported for each specimen tested.

8.11.6 Interpretation. Any specimen of the outermost separable layer showing wear-through shall constitute failure of this test.

8.11.7 Requirements for Testing Glove Composites.

8.11.7.1 Specimens shall be representative of the glove body composite construction at the glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B as described in 8.1.14 and shall not include seams. Samples and specimens shall be permitted to be materials representative of those used in the construction of the glove.

8.11.7.2 Samples for conditioning shall be full gloves.

8.11.7.3 A load of 500 g on each wheel shall be used in abrasion testing of gloves.

8.11.8 Requirements for Testing Footwear Upper Materials.

8.11.8.1 Specimens shall be taken from the footwear upper area, excluding the tongue and gusset, and shall not include seams. Samples and specimens shall be permitted to be materials representative of those used in the construction of the footwear. Specimens shall consist of the outer separable layer of the boot composite and the outer separable layer of the boot that is at least 50 percent of the total surface area.

8.11.8.2 Samples for conditioning shall be complete footwear items.

8.11.8.3 A load of 1000 g on each wheel shall be used in abrasion testing of footwear.

8.12 Seam Breaking Strength Test.

8.12.1 Application. This test method shall apply to seam assemblies for garments.

8.12.2 Sample Preparation.

8.12.2.1 Samples for conditioning shall be full clothing items or 305 mm (12 in.) or greater lengths of seam with at least 150 mm (6 in.) of material on either side of the seam centerline.

8.12.2.2 Samples shall be conditioned as specified in 8.1.2.

8.12.3 Specimens.

8.12.3.1 Specimens shall be cut from the finished garment or shall be permitted to be prepared by the joining of two pieces of the garment fabric as specified in 8.2.1.2 of ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics,* for woven fabrics or 7.2.2 of ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics,* for knit or stretch woven fabrics, using the same thread, seam type, and stitch type as used in the finished garment.

8.12.3.2 Specimens shall be the size specified in ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics,* for woven fabrics or ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics,* for knit or stretch woven fabrics.

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

8.12.4 Procedure.

8.12.4.1 All woven seam assemblies shall be tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*. The test machine shall be operated at a rate of 305 mm/min (12 in./min).

8.12.4.2 All knit seam assemblies shall be tested in accordance with ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*.

8.12.5 Report.

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

8.12.5.2 The average seam breaking strength for each seam type shall also be reported.

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

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

8.13 Water Absorption Resistance Test.

8.13.1 Application. This test method shall apply to the protective garment outer shell and collar lining materials.

8.13.2 Sample Preparation.

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

8.13.2.2 Specimens except CBRN garment and material specimens shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.13.3 Specimens.

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

8.13.3.2 At least 3 specimens shall be tested.

8.13.4 Apparatus. The test apparatus shall be as specified in AATCC 42, *Water Resistance: Impact Penetration Test*, with the following modifications:

(1) A metal roller 113 mm ± 6 mm (4½ in. ± ¼ in.) long and weighing 1 kg (2¼ lb) shall be used.
(2) Embroidery hoops, measuring 150 mm to 180 mm (6 in. to 7 in.) in diameter shall be used for mounting the specimen.

8.13.5 Procedure.

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

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

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

8.13.5.4 A 500 mL volume of distilled water at a temperature of 27°C ± 1°C (80°F ± 2°F) shall be poured quickly into the funnel and allowed to spray onto the specimen.

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

(1) The specimen shall be removed from the hoops and placed between sheets of blotting paper on a flat horizontal surface.
(2) The metal roller shall be rolled quickly forward and back one time over the paper without application of any pressure other than the weight of the roller.
(3) A square 100 mm × 100 mm (4 in. × 4 in.) shall be cut out of the center of the wet portion of the specimen and weighed to the nearest 0.05 g. This weight shall be designated the "wet weight." Not more than 30 seconds shall elapse between the time the water has ceased flowing through the spray nozzle and the start of the weighing.
(4) The same 100 mm (4 in.) square shall be conditioned as specified in 8.1.2 until it has dried and reached moisture equilibrium with the surrounding standard atmosphere for textiles.
(5) Following this conditioning it shall be reweighed.
(6) This weight shall be designated the "dry weight."

8.13.5.6 The percent water absorption shall be calculated using the following equation: *Percent water absorption* = [(*wet weight* − *dry weight*) / (*dry weight*)] × 100.

8.13.6 Report.

8.13.6.1 The percent water absorption for each specimen shall be recorded and reported.

8.13.6.2 The average percent water absorption for all tested specimens shall be calculated and reported.

8.13.7 Interpretation. The average percent water absorption shall be used to determine pass or fail performance.

8.14 Thread Heat Resistance Test.

8.14.1 Application. This test method shall apply to each type of thread used in the construction of garments, helmets, gloves, and footwear.

8.14.2 Sample Preparation.

8.14.2.1 Samples shall be 150 mm (6 in.) or greater in length.

8.14.2.2 Samples shall be conditioned as specified in 8.1.2.

8.14.3 Specimens.

8.14.3.1 Samples shall be 150 mm (6 in.) or greater in length.

8.14.3.2 At least three samples of each thread type shall be tested.

8.14.4 Apparatus.

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

8.14.4.2 The following equipment shall also be used:

(1) An armored stem thermometer with a range of 150°C to 300°C (302°F to 572°F), accurate to 1°C (33.8°F)
(2) A low-powered magnifying glass
(3) Two micro cover glasses
(4) Spatula, pick needle, or other instrument for applying pressure to the cover glasses
(5) Soxhlet extraction apparatus

8.14.4.3* The following reagents and reference materials shall be used:

(1) Chloroform, USP
(2) U.S. Pharmacopeia reference standards for melting point calibration of the apparatus

8.14.5 Procedure.

8.14.5.1 The sample shall be extracted with chloroform for a minimum of 20 extractions in a Soxhlet extractor and dried. The specimen shall then be cut into lengths of 2 mm (1⁄16 in.) or less to serve as the specimens for testing.

8.14.5.2 The apparatus shall be calibrated by determining the melting point of a pure material of known material of known melting point. The melting point of the pure material shall be 260°C ± 20°C (500°F ± 68°F). The value obtained shall agree within 1°C (33.8°F) of the known value of the reference material.

8.14.5.3 Following each successive determination of melting temperature for the reference material and for test specimens, the stage in each case shall be cooled to at least 230°C (446°F) before a new specimen is placed for testing.

8.14.5.4 The specimen shall be placed in a small mound on the cover glass and covered with another cover glass. The two cover glasses shall be pressed together and placed in the circular depression on the stage. The temperature of the stage shall be raised to 245°C (473°F) and thereafter at a rate of 3°C to 4°C (5.4°F to 7.2°F) per minute. At this rate of temperature rise, a slight pressure shall be applied on the upper glass cover with a spatula, pick needle, or other instrument, so that the complete fiber is in contact with the cover glass.

8.14.5.5 When the temperature of the stage reaches 260°C, +5/−0°C (500°F, +41/−32°F), the specimen shall be observed with the aid of the magnifying glass for ignition, melting, or charring.

8.14.6 Report. Observations of ignition, melting, and charring shall be recorded and reported for each specimen.

8.14.7 Interpretation. Any specimen showing ignition, melting, or charring shall constitute failure of the sample.

8.15 Corrosion Resistance Test.

8.15.1 This test method shall apply to hardware items on garments, helmets, gloves, and footwear.

8.15.2 Modifications to this test method for testing garment and glove hardware shall be as specified in 8.15.10.

8.15.3 Modifications to this test method for testing helmet hardware shall be as specified in 8.15.11.

8.15.4 Modifications to this test method for testing footwear hardware shall be as specified in 8.15.12.

8.15.5 Sample Preparation.

8.15.5.1 Samples shall be as specified in 8.15.10, 8.15.11, or 8.15.12.

8.15.5.2 Samples shall be conditioned as specified in 8.1.2.

8.15.6 Specimens.

8.15.6.1 Specimens shall be the same as the samples.

8.15.6.2 At least five specimens shall be tested for each hardware type.

8.15.7 Procedure.

8.15.7.1 Specimens shall be tested in accordance with ASTM B 117, *Standard Practice for Using Salt Spray (Fog) Apparatus*. Salt spray shall be 5 percent saline solution, and test exposure shall be for 20 hours.

8.15.7.2 Immediately following the test exposure and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

8.15.7.3 Specimens shall then be examined visually with the unaided eye to determine pass or fail.

8.15.7.4 The functionality of each specimen shall be evaluated.

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

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

8.15.10 Specific Requirements for Testing Garment and Glove Hardware. Samples for conditioning shall be whole hardware items.

8.15.11 Specific Requirements for Testing Helmets. Samples for conditioning shall be whole helmets.

8.15.12 Specific Requirements for Testing Footwear. Samples for conditioning shall be whole footwear.

8.16 Liquid Penetration Resistance Test.

8.16.1 Application.

8.16.1.1 This test shall apply to garments, gloves, and footwear materials.

8.16.1.2 Modifications to this test method for testing garment materials shall be as specified in 8.16.7.

8.16.1.3 Modifications to this test method for testing gloves materials shall be as specified in 8.16.8.

8.16.1.4 Modifications to this test method for testing footwear materials shall be as specified in 8.16.9.

8.16.2 Sample Preparation.

8.16.2.1 Samples shall be 1 m (1 yd) square of material for garments and garment seams and whole elements for gloves and footwear.

8.16.2.2 Garment material samples except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.16.2.3 Footwear samples shall be conditioned as specified in 8.1.2 only.

8.16.2.4 Glove material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.16.3 Specimens.

8.16.3.1 Specimens shall be as specified in 8.16.7, 8.16.8, or 8.16.9.

8.16.3.2 Specimens shall be 75 mm (3 in.) squares of each composite type.

8.16.3.3 At least three specimens per liquid shall be tested for each material type.

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

8.16.4 Procedure.

8.16.4.1 Liquid penetration resistance testing shall be conducted in accordance with ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids,* exposure procedure C.

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

(1) Aqueous film-forming foam (AFFF), 3 percent concentrate
(2) Battery acid (37 percent w/w sulfuric acid)
(3) Fire-resistant hydraulic fluid, phosphate ester base
(4) Surrogate gasoline fuel C as defined in ASTM D 471, *Standard Test Method for Rubber Property — Effect of Liquids,* a 50/50 percent volume of toluene and iso-octane
(5) Swimming pool chlorinating chemical containing at least 65 percent free chlorine (saturated solution)

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

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

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

8.16.7 Specific Requirements for Testing Garment Materials. Specimens shall consist of the barrier layer, which is intended to prevent the penetration of liquids.

8.16.8 Specific Requirements for Testing Glove Materials.

8.16.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

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

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

8.16.8.4 Specimens for testing shall be the barrier layer only.

8.16.8.5 Where the moisture barrier material is continuous through the glove body, only the barrier seams shall be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

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

8.17 Viral Penetration Resistance Test.

8.17.1 Application.

8.17.1.1 This test shall apply to garments, gloves, and footwear materials.

8.17.1.2 Modifications to this test method for testing garment materials shall be as specified in 8.17.7.

8.17.1.3 Modifications to this test method for testing glove materials shall be as specified in 8.17.8.

8.17.1.4 Modifications to this test method for testing footwear materials shall be as specified in 8.17.9.

8.17.2 Sample Preparation.

8.17.2.1 Samples shall be 1 m (1 yd) square of material for garments and garment seams and whole elements for gloves and footwear.

8.17.2.2 Garment material samples except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.17.2.3 Footwear samples shall be conditioned as specified in 8.1.2 only.

8.17.2.4 Glove material samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.17.3 Specimens.

8.17.3.1 Specimens shall be as specified in 8.17.7, 8.17.8, or 8.17.9.

8.17.3.2 Specimens shall be 75 mm (3 in.) squares of each composite type. A minimum of three specimens per liquid shall be tested for each material type.

8.17.3.3 At least three specimens per liquid shall be tested for each material type.

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

8.17.4 Procedure.

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

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

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

8.17.6 Interpretation. One or more failures of any specimen shall constitute failure of the material.

8.17.7 Specific Requirements for Testing Garment Materials. Specimens shall consist of the barrier layer that is intended to prevent the penetration of liquids.

8.17.8 Specific Requirements for Testing Glove Materials.

8.17.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

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

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

8.17.8.4 Specimens for testing shall be the barrier layer only.

8.17.8.5 Where the moisture barrier material is continuous through the glove body, only the barrier seams shall be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

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

8.18 Flame Resistance Test 2.

8.18.1 Application. This test method shall apply to protective helmets and goggles.

8.18.1.1 Helmets shall be tested to Procedure A. Where helmets include antiglare material on the underside of the brim, helmets shall also be tested to Procedure B.

8.18.1.2 Goggles shall be tested to Procedure C only.

8.18.2 Sample Preparation. No sample preparation shall be performed.

8.18.3 Specimens.

8.18.3.1 Specimens shall be complete helmets or goggles.

8.18.3.2 At least three specimens shall be tested for each of the tests in this section.

8.18.4 Apparatus.

8.18.4.1 A standard Bunsen burner shall be used.

8.18.4.2 The Bunsen burner shall be fueled by methane gas, 99 percent purity or better.

8.18.4.3 A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 3.5 kPa, +0.7/−0 kPa (0.5 psi, +0.1/−0.0 psi) at the burner shall be utilized.

8.18.4.4 The barrel of the Bunsen burner shall be 13 mm ±3 mm (½ in. ± ⅛ in.) in diameter. A flame spreader shall not be used.

8.18.5 Procedures.

8.18.5.1 Procedure A.

8.18.5.1.1 The helmet shall be positioned according to the HPI as described in 8.1.12 on the ISO J headform specified in Figure 8.23.4.1 according to the manufacturer's positioning index, as specified in the manufacturer's instruction for the specific helmet.

8.18.5.1.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ± 1.5 mm (2 in. ± 1/16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1/16 in.). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200°C ± 100°C (2912°F ± 180°F). The tip of the inner cone in the flame shall then be applied to the helmet shell from below the helmet at an angle of 90 degrees to the basic plane as shown in Figure 8.18.5.1.2:

(1) At the intersection of the front edge of the brim and midsagittal plane
(2) At the intersection of each side of the brim and the coronal plane
(3) At the intersection of the rear edge of the brim and the midsagittal plane

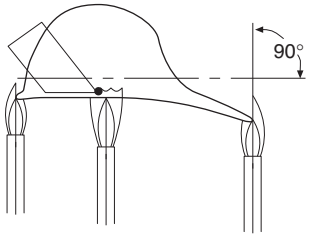


FIGURE 8.18.5.1.2 Test Procedure A.

8.18.5.1.3 The flame shall be applied for 15 seconds, +1/−0 seconds; the flame shall then be removed and the duration of the afterflame and afterglow shall be measured and recorded.

8.18.5.2 Procedure B.

8.18.5.2.1 The helmet shall be positioned according to the HPI as described in 8.1.12 on the ISO J headform specified in

Figure 8.23.4.1 according to the manufacturer's positioning index, as specified in the manufacturer's instruction for the specific helmet.

8.18.5.2.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ± 1.5 mm (2 in. ± 1⁄16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1⁄16 in.). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200°C ± 100°C (2912°F ± 180°F). The tip of the inner cone in the flame shall then be applied at the helmet surface, ±5 mm (±13⁄64 in.) at any point under the brim and 13 mm ± 3 mm (½ in. ± ⅛) from the edge of the brim.

8.18.5.2.3 The flame shall be applied to the test surface for 5 seconds, +1/–0 seconds; the flame shall then be removed and the duration of the afterflame shall be measured and recorded.

8.18.5.3 Procedure C.

8.18.5.3.1 The goggle specimen shall be attached to an appropriate test fixture so that the lower edge of the specimen is exposed. The test setup shall be as shown in Figure 8.18.5.3.1.

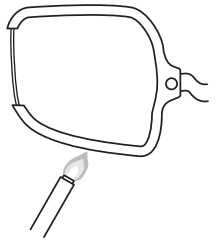


FIGURE 8.18.5.3.1 Test Procedure C.

8.18.5.3.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ± 1.5 mm (2 in. ± 1⁄16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1⁄16 in.). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200°C ± 100°C (2912°F ± 180°F). The tip of the inner cone of the flame shall be applied on the outer edge of the specimen at the lowest exposed edge of the specimen. The burner shall be held to the test point of the specimen in an angle of 45 degrees ± 10 degrees.

8.18.5.3.3 After 15 seconds, +1/–0 seconds, the flame shall be removed and the duration of the afterflame measured and recorded.

8.18.6 Report.

8.18.6.1 Afterflame times shall be recorded and reported for each specimen at each flame impingement location.

8.18.6.2 The average afterflame times shall be calculated and recorded and reported for each flame impingement location.

8.18.6.3 The afterflame times shall be reported to the nearest 0.2 second.

8.18.7 Interpretation. Pass or fail performance shall be based on the longest measured afterflame times.

8.19 Top Impact Resistance Test (Force).

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

8.19.2 Sample Preparation.

8.19.2.1 Samples shall be complete helmets. Externally mounted faceshield/goggle components shall be removed. Internally mounted faceshield components shall be removed except where the internal faceshield is an integral part of the structural integrity of the helmet.

8.19.2.2 Samples shall be conditioned for each environmental condition specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each impact.

8.19.3 Specimens.

8.19.3.1 Specimens shall be complete helmets.

8.19.3.2 At least three specimens shall be tested as specified for each environmental condition.

8.19.4 Apparatus.

8.19.4.1 An aluminum ISEA size 7 headform shall be used. The headform shall have a mass of 3.6 kg ± 0.5 kg (8 lb ± 1.0 lb). The test headform shall be the nominal dimensions of the headform in Table 8.19.4.1 and Figure 8.19.4.1(a) through Figure 8.19.4.1(c).

8.19.4.2 A steel drop mass of 3.58 kg ± 0.05 kg (7.9 lb ± 0.10 lb) shall be used. The striking face of the drop mass shall be a spherical segment with a radius of 50 mm ± 8 mm (1.9 in. ± 0.3 in.) and a chord length of at least 75 mm (3 in.).

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

(1) Range, 4450 N (1000 lbf)
(2) Peak force measurement accuracy, ±2.5 percent
(3) Resolution, 22 N (5 lbf)
(4) Load cell rigidity, 4.4×10^9 N/m (2.5×10^7 lb/ft)
(5) Minimum mechanical resonant frequency of the headform/load cell system, 5000 Hz
(6) Load cell diameter, 75 mm (3 in.)

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

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

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

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

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

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

Table 8.19.4.1 Data for Contour Drawing of ISEA Headform

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

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

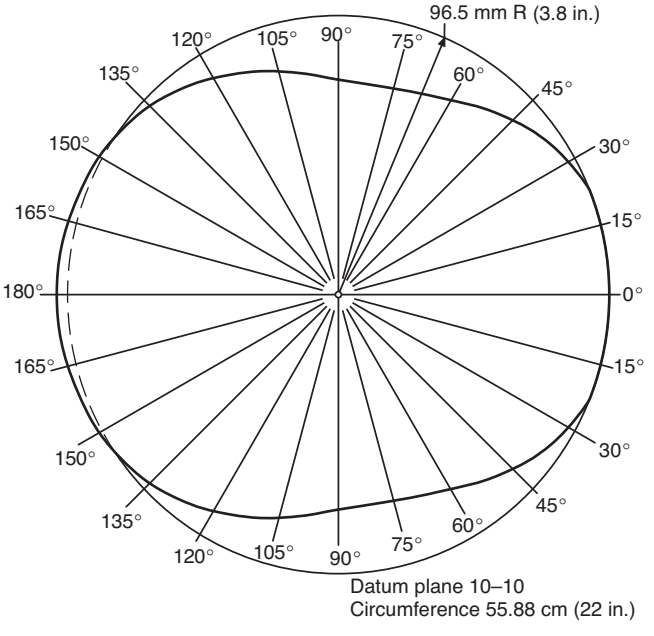


FIGURE 8.19.4.1(a) ISEA Size 7 Headform, Top.

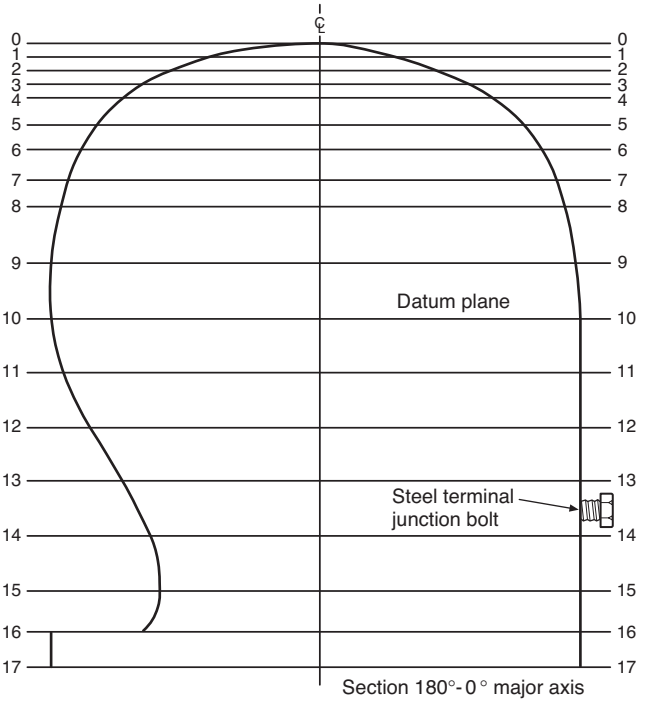


FIGURE 8.19.4.1(b) ISEA Size 7 Headform, Side with Modification for Steel Terminal Junction Bolt.

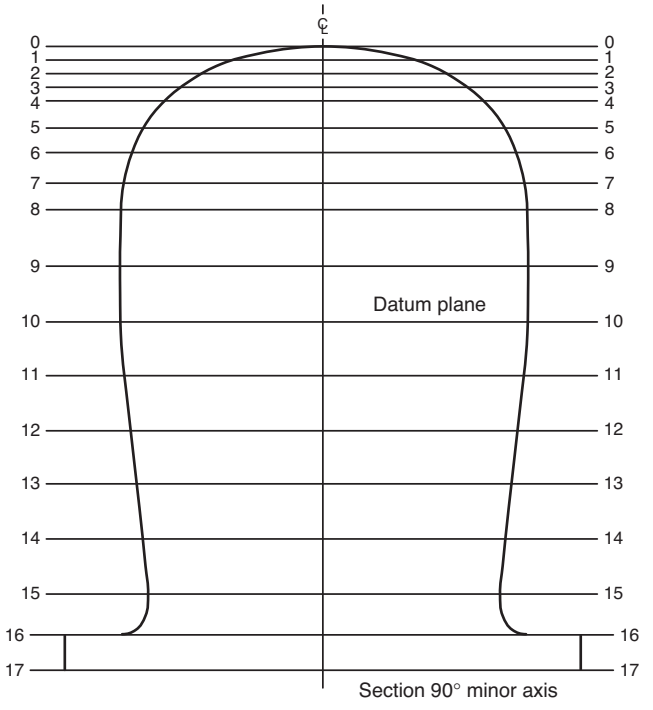


FIGURE 8.19.4.1(c) ISEA Size 7 Headform, Front.

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

8.19.4.9* The instrumentation shall be calibrated. The equipment shall be checked for repeatability before and after each test series by impacting a standardized elastomeric shock pad. A minimum of three such impacts shall be recorded before and after testing. If the post-test average readings of the three impacts differ from the pre-test average by more than 5 percent, the entire test series shall be discarded.

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

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

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

8.19.5 Procedure.

8.19.5.1 Specimen helmets shall be positioned on the headform according to the HPI as described in 8.1.12. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. Helmets shall be subjected to the environmental conditions specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each impact and within the specified time after being removed from conditioning.

8.19.5.2 The impactor shall be dropped from a height that yields an impact velocity within 2 percent of 5.47 m/sec (17.9 ft/sec). A means of verifying the impact velocity to within 2 percent for each impact shall be incorporated.

8.19.6 Report.

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

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

8.19.7 Interpretation.

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

8.19.7.2 Pass or fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

8.20 Physical Penetration Resistance Test.

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

8.20.2 Sample Preparation.

8.20.2.1 Samples shall be complete helmets. Externally mounted faceshield/goggle components shall be removed. Internally mounted faceshield components shall be removed except where the internal faceshield is an integral part of the structural integrity of the helmet.

8.20.2.2 Separate samples shall be conditioned for each environmental condition specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each physical penetration.

8.20.3 Specimens.

8.20.3.1 Specimens shall be complete helmets.

8.20.3.2 At least three specimens shall be tested as specified for each environmental condition.

8.20.4 Apparatus.

8.20.4.1 The ISO size J headform shall conform to the nominal dimensions in Figure 8.23.4.1. Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

8.20.4.2 The penetration striker shall have a mass of 1 kg, +0.02/–0/00 kg (2.2 lb, +0.01/–0.00 lb). The point of the striker shall be a cone with an included angle of 60 degrees ± ½ degree, a height of 38 mm (1½ in.), and a tip radius of 0.5 mm ± 0.1 mm (0.020 in. ± 0.004 in.). The hardness of the striking tip shall be Rockwell Scale C-60, minimum. The penetration striker shall be electrically connected to the contact indicator.

8.20.4.3 The contact indicator shall indicate when electrical contact has been made between the penetration striker and the conductive surface of the test headform. The contact indicator shall have a response time of less than 0.5 second.

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

8.20.5 Procedure.

8.20.5.1 The environmentally conditioned helmet shall be positioned according to the HPI as described in 8.1.13 on the test headform and secured by the helmet retention system or

by other means that will not interfere with the test. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. The helmet shall be positioned so that the penetration striker shall impact perpendicular to the helmet. The helmet shall be adjusted to a size sufficient to properly fit on the headform with the horizontal center plane parallel and within 5 degrees of the reference plane. The front-to-back centerline of the shell shall be within 13 mm (0.5 in.) of the midsagittal plane of the headform.

8.20.5.2 The drop height of the penetration striker shall be adjusted so that the velocity at impact is 7 m/sec ± 0.1 m/sec (23 ft/sec ± 0.5 ft/sec). The penetration striker shall be dropped to strike the sample helmet shell within a circle whose diameter is 75 mm (3 in.) and whose center shall be the geometric center of the shell. The penetration striker shall not fall on any portion of the ridges or make contact with the headform.

8.20.6 Report. The pass or fail result for each helmet shall be recorded and reported.

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

8.21 Electrical Insulation Test 1.

8.21.1 Application. This test method shall apply to helmets: Procedure A shall apply to all helmets, and Procedure B shall apply to helmets that include metallic hardware mounted on the helmet shell.

8.21.2 Sample Preparation.

8.21.2.1 Samples shall be complete helmets.

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 complete helmets.

8.21.3.2 At least three specimens shall be tested in each test.

8.21.4 Apparatus.

8.21.4.1 The following equipment shall be provided for Procedure A:

(1) A source of 60 Hz alternating current variable from 0 volts to 2200 volts true rms
(2) Wiring and terminals for application of voltage to the water in the vessel
(3) A voltmeter to measure the applied voltage within 2 percent
(4) A milliammeter to measure the leakage current to within 2 percent
(5) A vessel, containing tap water, of sufficient size to submerge an inverted helmet to the dielectric test plane
(6) A frame for suspending the test specimen in water

8.21.4.2 The following equipment shall be provided for Procedure B:

(1) A source of 60 Hz alternating current variable from 0 volts to 2200 volts true rms
(2) Wiring and terminals for application of voltage across the crown of the test specimen
(3) A voltmeter to measure the applied voltage within 2 percent
(4) A milliammeter to measure the leakage current to within 2 percent
(5) A vessel, containing fresh tap water, of sufficient size to submerge an inverted helmet shell
(6) An aluminum ISEA/size 7 headform modified in accordance with Table 8.19.4.1 and Figure 8.19.4.1(a) through Figure 8.19.4.1(c)

8.21.5 Procedures.

8.21.5.1 Procedure A.

8.21.5.1.1 The helmet shall be positioned according to the HPI as described in 8.1.13 on the ISO size J headform specified in Figure 8.23.4.1. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance.

8.21.5.1.2 The dielectric test plane specified in Figure 8.21.5.1.2 shall be marked on the shell of the helmet. The dielectric test plane shall be the plane that passes through the point located 85 mm (3.3 in.) above the basic plane, where the basic plane and the midsagittal plane intersect at the front of the headform, and the point located 60 mm (2.4 in.) above the basic plane, where the basic plane and the midsagittal plane intersect at the rear of the headform.

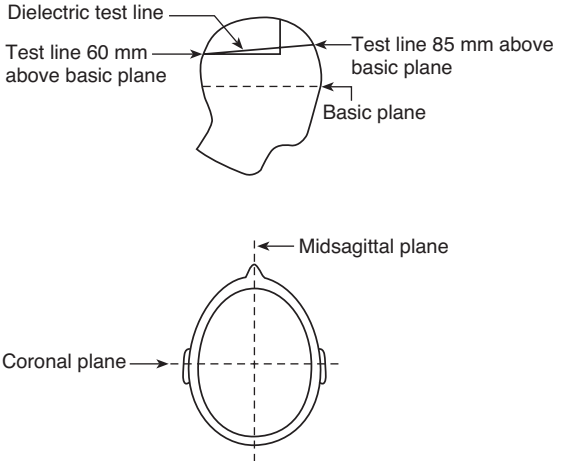


FIGURE 8.21.5.1.2 Test Setup.

8.21.5.1.3 The helmet shall be inverted and the inside of the helmet shall be filled with fresh tap water up to the dielectric test plane. The helmet shall then be submerged in the same type of water up to the same level as the water inside the helmet. Care shall be taken to keep the unsubmerged portion of the test sample dry so that flashover will not occur when voltage is applied.

8.21.5.1.4 A 60 Hz alternating current voltage shall be applied to the water in the vessel and increased to 2200 volts. The voltage shall be maintained at 2200 volts ± 2 percent for 1 minute.

8.21.5.2 Procedure B.

8.21.5.2.1 The specimen and retention system shall be completely submerged in tap water for a period of 15 minutes, +2/−0 minutes. The helmet shall be removed from the water and allowed to drain for not longer than 2 minutes.

8.21.5.2.2 The specimen shall then be positioned according to the HPI as described in 8.1.12 on the modified ISEA size 7

aluminum headform, with chin strap firmly secured to the headform by means of the conductive terminal junction bolt. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

8.21.5.2.3 A lead carrying 60 Hz alternating voltage shall be attached to all metal parts on the helmet's exterior at or above the brim edge. A second pickup lead shall be attached to the terminal junction bolt. A voltage shall be applied to the external helmet shell lead and increased to 2200 volts ± 2 volts. The voltage shall be maintained for 15 seconds.

8.21.6 Report. Any current leakage or evidence of breakdown shall be recorded and reported for each helmet.

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

8.22 Suspension System Retention Test.

8.22.1 Application. This test method shall apply to helmets.

8.22.2 Sample Preparation.

8.22.2.1 Samples shall be complete helmets.

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 complete helmets.

8.22.3.2 At least three specimens shall be tested.

8.22.4 Apparatus.

8.22.4.1 The suspension system retention test fixtures shall consist of rigid material of sufficient thickness to facilitate firm attachment of the inverted helmet to the tensile test machine as shown in Figure 8.22.4.1.

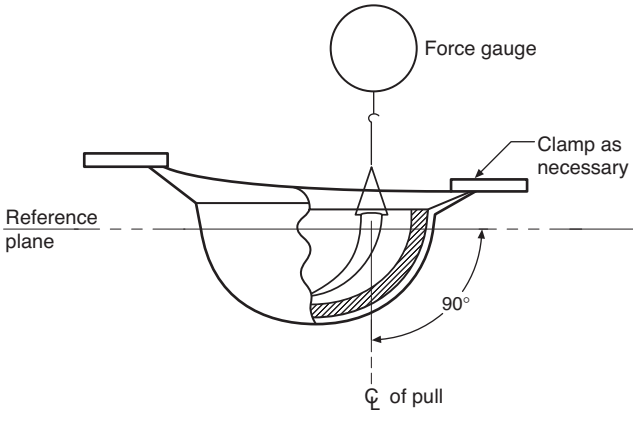


FIGURE 8.22.4.1 Suspension System Test Setup.

8.22.4.2 The calibrated tensile testing machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified forces.

8.22.5 Procedure.

8.22.5.1 Each helmet suspension strap shall be cut such that sufficient length of strap remains to be gripped by the movable jaw of the testing machine.

8.22.5.2 Specimens shall be positioned and secured in the tensile testing machine so that the helmet's reference plane is horizontal.

8.22.5.3 Each attachment point of the crown strap shall be tested by applying a pull force along the centerline of the suspension strap, perpendicular to the reference plane, to a maximum load of 22 N ± 2 N (5 lb ± 0.5 lb). The force shall be increased from 0 N to 22 N ± 2 N (0 lbf to 5 lbf ± 0.5 lbf) at a load rate of 25 mm/min ± 5 mm/min (1 in./min ± 3⁄16 in./min).

8.22.5.4 After application of the force is complete, the load shall be released and the suspension system shall be inspected for any separation from the helmet shell.

8.22.6 Report. The pass or fail result for each attachment point shall be recorded and reported.

8.22.7 Interpretation.

8.22.7.1 Separation of the helmet suspension from the helmet shall constitute failing performance.

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

8.23 Retention System Test.

8.23.1 Application. This test method shall apply to helmets.

8.23.2 Sample Preparation.

8.23.2.1 Samples shall be complete helmets.

8.23.2.2 Samples shall be conditioned as specified in 8.1.2.

8.23.3 Specimens.

8.23.3.1 Specimens shall be complete helmets.

8.23.3.2 At least three specimens shall be tested.

8.23.4 Apparatus.

8.23.4.1 An ISO size J headform shall be used and shall be of the nominal dimensions given in Figure 8.23.4.1.

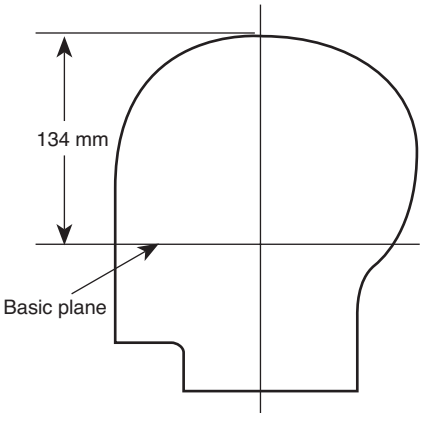
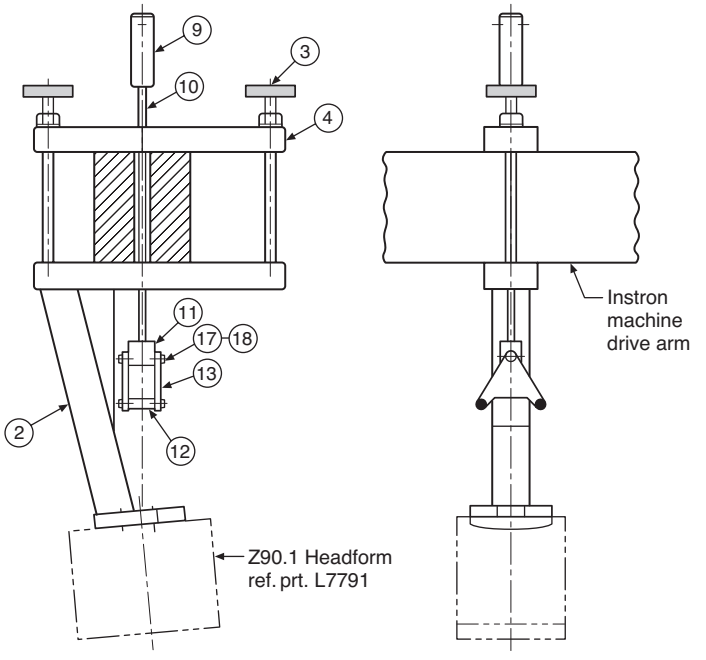


FIGURE 8.23.4.1 ISO Size J Headform.

8.23.4.2 A mechanical chin structure shall be designed for use with a calibrated tensile test machine. The mechanical chin structure shall consist of two rollers 13 mm (½ in.) in diameter with centers 75 mm (3 in.) apart. The mechanical chin structure shall conform with Figure 8.23.4.2.



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

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

FIGURE 8.23.4.2 Retention System Test Setup.

8.23.4.3 The calibrated tensile test machine that shall be capable of measuring the force applied to the retention system within 2 percent at the specified force.

8.23.5 Procedure.

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

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

8.23.5.3 The headform and mechanical chin structure shall be positioned such that the distance between the bottom of the rollers and the top of the headform is 210 mm ± 10 mm (8.3 in. ± 0.4 in.). The chin strap shall be passed around the rollers, and the helmet shall be secured to the headform. The chin strap shall be adjusted and preloaded to 45 N ± 5 N (10 lbf ± 1 lbf). The distance between the top of the helmet and the rollers shall be measured and recorded to the nearest 0.5 mm (1/64 in.).

8.23.5.4* The force applied to the retention system shall be increased smoothly from 45 N (10 lbf) to 225 N (50 lbf) at a rate between 9.0 N/sec (2 lbf/sec) and 45 N/sec (10 lbf/sec).

8.23.5.5 The load rate of the tensile testing machine shall be 25 mm (1 in.) per minute to a limit of 225 N (50 lbf).

8.23.5.6 The distance between the top of the helmet and the rollers shall be measured and recorded again after the force has been maintained at 225 N (50 lbf) for 60 seconds, +15/–0 seconds. The difference between the second measurement and the first shall be the retention system elongation.

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

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

8.24 Flame Resistance Test 3.

8.24.1 Application. This test method shall be applied to glove composite materials.

8.24.1.1 This test method shall be applied to glove body composites and glove interface component composites.

8.24.1.2 Modifications to this test method for evaluation of glove body composites shall be as specified in 8.24.8.

8.24.1.3 Modifications to this test method for evaluation of glove interface component composites other than wristlet composites shall be as specified in 8.24.9.

8.24.1.4 Modifications to this test method for evaluation of wristlet glove interface component composites shall be as specified in 8.24.10.

8.24.2 Sample Preparation.

8.24.2.1 Samples shall be prepared for each glove body composite and glove interface component composite. Samples shall be the composite used in actual glove construction, consisting of each single layer, with all layers arranged in proper order.

8.24.2.2 Samples for conditioning shall be in the form of a 200 mm × 200 mm (8 in. × 8 in.) pouch.

8.24.2.2.1 The pouch shall be made of two glove body composite swatches. The two glove body composite swatches shall be of the same materials and construction. The two composite swatches shall be 200 mm × 200 mm (8 in. × 8 in.), and shall be constructed to simulate the actual layers of the glove arranged in proper order.

8.24.2.2.2 If multiple layers are involved, each of the two composite swatches shall be stitched on all four sides using the same thread as used in the glove construction.

8.24.2.2.3 The two composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

8.24.2.3 Samples shall be conditioned as specified in 8.1.9, followed by conditioning as specified in 8.1.2.

8.24.2.4 Other samples shall be conditioned as specified in 8.1.2 only.

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

8.24.3 Specimens.

8.24.3.1 Specimens shall be cut from the samples.

8.24.3.2 At least three specimens shall be tested for each material.

8.24.3.3 Testing shall be conducted on specimens taken from samples conditioned according to 8.24.2.3 and 8.24.2.4.

8.24.3.4 In each test, the specimen's normal outer surface shall be exposed to the flame.

8.24.4 Apparatus.

8.24.4.1 The test apparatus shall consist of a burner, crucible tongs, support stand, utility clamp, stopwatch, butane gas, gas regulator valve system, and measuring scale, and the following criteria shall be met:

(1) The burner shall be a high temperature, liquefied petroleum gas–type Fisher burner.
(2) The stopwatch or other timing device shall measure the burning time to the nearest 0.1 second.
(3) The butane shall be of commercial grade, 99.0 percent pure or better.
(4) The gas regulator system shall consist of a control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 17.3 kPa ± 1.7 kPa (2.5 psi ± 0.25 psi) at the reducing valve.
(5) The flame height shall be adjusted at the reducing valve producing a pressure of 0.7 kPa ± 0.07 kPa (0.1 psi ± 0.01 psi).

8.24.4.2 A freestanding flame height indicator shall be used to assist in adjusting the burner flame height. The indicator shall mark a flame height of 75 mm (3 in.) above the top of the burner.

8.24.4.3 A specimen support assembly shall be used that consists of a frame and steel rod of 1.6 mm (1⁄16 in.) diameter to support the specimen in an L-shaped position as shown in Figure 8.24.4.3.

8.24.4.4 The horizontal portion of the specimen shall be not less than 50 mm (2 in.), and the vertical portion shall be not less than 100 mm (4 in.). The specimen shall be held at each end by spring clips under light tension as shown in Figure 8.24.4.3.

8.24.5 Procedure.

8.24.5.1 The burner shall be ignited, and the test flame shall be adjusted to a height of 75 mm (3 in.) with the gas on/off valve fully open and the air supply completely and permanently off, as it is important that the flame height be closely controlled. The 75 mm (3 in.) height shall be obtained by adjusting the orifice in the bottom of the burner so that the top of the flame is level with the marked flame height indicator.

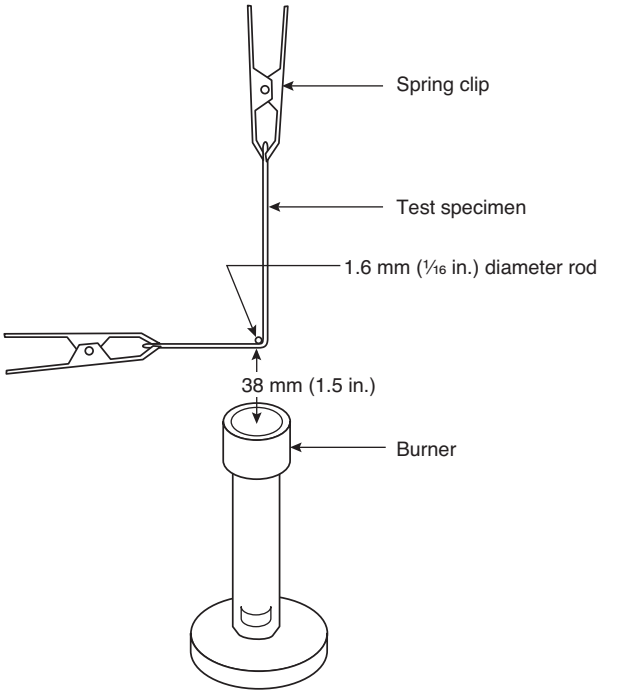


FIGURE 8.24.4.3 Relationship of Test Material to Burner.

8.24.5.2 With the specimen mounted in the support assembly, the burner shall be moved such that the middle of the folded corner contacts the flame as shown in Figure 8.24.4.3.

8.24.5.3 The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

8.24.5.4 The afterflame time shall be measured as the time, in seconds, to the nearest 0.1 second, that the specimen continues to flame after the burner is removed from the flame.

8.24.5.5 Each layer of the specimen shall be examined for melting or dripping.

8.24.5.6 The specimen shall then be further examined for char length. The char length shall be determined by measuring the length of the tear through the center of the charred area as specified in 8.24.5.6.1 through 8.24.5.6.4.

8.24.5.6.1 The specimen shall be folded lengthwise and creased, by hand, along a line through the highest peak of the charred area.

8.24.5.6.2 The hook shall be inserted in the specimen or a hole that is 6 mm (¼ in.) in diameter or less that is punched out for the hook, at one side of the charred area 6 mm (¼ in.) from the adjacent outside edge at the point where the specimen contacted the steel rod, and 6 mm (¼ in.) in from the lower end.

8.24.5.6.3 A weight of sufficient size such that the weight and hook together shall equal the total tearing load required in Table 8.24.5.6.3 shall be attached to the hook. The specific load for determining char length applicable to the weight of the composite specimen shall be as shown in Table 8.24.5.6.3.

8.24.5.6.4 A tearing force shall be applied gently to the specimen by grasping the side of the material at the edge of the char opposite from the load and raising the specimen and

Table 8.24.5.6.3 Determining Tearing Weight

Specified Weight of Material Before Any Fire-Retardant Treatment or Coating		Total Tearing Weight for Determining Charred Length	
g/m^2	oz/yd^2	kg	lb
68–203	2.0–6.0	0.1	0.25
>203–508	>6.0–15.0	0.2	0.5
>508–780	>15.0–23.0	0.3	0.75
>780	>23.0	0.45	1.0

weight clear of the supporting surface. The end of the tear shall be marked off on the edge and the char length measurement made along the undamaged edge.

8.24.6 Report.

8.24.6.1 The afterflame time and char length shall be reported for each specimen.

8.24.6.2 The average afterflame time and char length shall also be calculated and reported.

8.24.6.3 The afterflame time shall be reported to the nearest 0.1 second and the char length to the nearest 2.5 mm (1/10 in.).

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

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

8.24.8 Specific Requirements for Testing Glove Body Composites.

8.24.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.24.8.2 Specimens shall be representative of each glove body composite construction.

8.24.8.3 After conditioning, the pouch and necessary stitching shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing.

8.24.8.4 If a proposed glove body construction has stitched-through seams, three additional specimens containing these seams shall be tested. The seam shall be in the direction of the 150 mm (6 in.) dimension.

8.24.9 Specific Requirements for Testing Protective Glove Interface Components Other than Wristlet Composites.

8.24.9.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.24.9.2 Specimens shall be representative of the glove interface component composite construction.

8.24.9.3 After conditioning, the necessary stitching shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing.

8.24.10 Specific Requirements for Testing Protective Wristlet Glove Interface Components.

8.24.10.1 Samples for conditioning shall include wristlet material.

8.24.10.2 Specimens shall be representative of the wristlet glove interface component composite construction.

8.24.10.3 After conditioning, the material shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing.

8.25 Conductive Heat Resistance Test.

8.25.1 Application.

8.25.1.1 This test method shall apply to glove and upper footwear materials.

8.25.1.2 Modifications to this method for glove materials shall be as specified in 8.25.7.

8.25.1.3 Modifications to this method for footwear upper materials shall be as specified in 8.25.8.

8.25.2 Sample Preparation.

8.25.2.1 Samples shall be as specified in ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact.*

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 the same as samples.

8.25.3.2 At least three specimens shall be tested.

8.25.4 Procedure.

8.25.4.1 Sample specimens shall be tested in accordance with ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, with the following modifications:

(1) Sample specimens shall be tested using an exposure temperature of 280°C (536°F). The pressure applied during the test shall be 3.5 kPa (½ psi).
(2) The time in seconds to pain and to second-degree burn (blister), as predicted by the Stoll Human Tissue Burn Tolerance Criteria, shall be recorded.
(3) The section of the apparatus lowering the specimen, sensor, and weighed system shall travel at a constant rate of speed.
(4) The specimen shall be lowered parallel to the hotplate.
(5) The recorder/computer shall be activated automatically by a mechanical or electrical contact when the specimen contacts the hotplate.
(6) Specimen size shall be permitted to be larger than 100 mm × 150 mm (4 in. × 6 in.) to accommodate test apparatus.

8.25.4.2 Sample specimens shall be tested using an exposure temperature of 280°C (536°F). The pressure applied during the test shall be 3.5 kPa (½ psi).

8.25.4.3 The time in seconds to pain and to second-degree burn (blister), as predicted by the Stoll Human Tissue Burn Tolerance Criteria, shall be recorded.

8.25.5 Report.

8.25.5.1 The time to pain and time to second-degree burn for each specimen shall be reported.

8.25.5.2 The average time to pain and time to second-degree burn shall be calculated and recorded and reported.

8.25.5.3 If the time to pain or time to second-degree burn is greater than 30 seconds, then the time to pain or time to second degree burn shall be recorded and reported as ">30 s."

8.25.6 Interpretation. Pass or fail determinations shall be based on the average time to pain and average time to second-degree burn of all specimens tested.

8.25.7 Specific Requirement for Testing Gloves.

8.25.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.25.7.2 Specimens shall be representative of glove body composite construction at glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P as described in 8.1.14.

8.25.7.2.1 All variations in composite construction, including number of layers and the order of layering of composite materials shall constitute a new composite and shall be tested separately.

8.25.7.2.2 Where a composite is identical to another composite except for additional reinforcement layer(s) and the reinforcement layer(s) is the same as one or more of the base composite layers, the composite with no reinforcement layers shall be representative of the composite with the reinforcement layer(s).

8.25.7.2.3 Specimens shall not include seams except in the following cases:

(1) Ridged areas or similar areas where stitching is used to create specific performance characteristics rather than for glove assembly.
(2) Where there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

8.25.7.3 Glove specimens shall be tested before and after being subjected to the procedure specified in 8.1.9.

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

8.25.8 Specific Requirements for Testing Footwear Upper Materials.

8.25.8.1 Footwear specimens shall include the thinnest portions of the footwear upper.

8.25.8.2 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, excluding the tongue and gusset, with the layers arranged in proper order.

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

8.25.8.4 Specimens shall not include seams.

8.26 Cut Resistance Test.

8.26.1 Application.

8.26.1.1 This test method shall apply to glove and footwear upper materials.

8.26.1.2 Modifications to this test method for evaluation of glove materials shall be as specified in 8.26.7.

8.26.1.3 Modifications to this test method for evaluation of footwear upper materials shall be as specified in 8.26.8.

8.26.1.4 Modifications to this test method for the evaluation of external CBRN barrier layers shall be as specified in 8.26.9.

8.26.2 Sample Preparation.

8.26.2.1 Samples shall be as specified in 8.26.7, 8.26.8, or 8.26.9.

8.26.2.2 Samples shall be conditioned as specified in 8.1.2.

8.26.3 Specimens.

8.26.3.1 Specimens shall be the size specified in ASTM F 1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, consisting of all layers.

8.26.3.2 At least three specimens shall be tested.

8.26.4 Procedure. Specimens shall be evaluated in accordance with ASTM F 1790, *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 blade travel distance.

8.26.5 Report.

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

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

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

8.26.7 Specific Requirements for Testing Glove Materials.

8.26.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.26.7.2 Specimens shall be representative of glove body composite construction at glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B as described in 8.1.14.

8.26.7.2.1 All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately.

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

8.26.7.2.3 Specimens shall not include seams except in the following cases:

(1) Ridged areas or similar areas where stitching is used to create specific performance characteristics rather than for glove assembly.
(2) Where there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

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

8.26.7.4 Cut resistance testing shall be performed under a load of 150 g (5½ oz).

8.26.8 Specific Requirements for Testing Footwear Upper Materials.

8.26.8.1 Samples shall be footwear uppers or representative materials.

8.26.8.2 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, excluding the tongue and gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested. Specimens shall not include seams.

8.26.8.3 Cut resistance testing shall be performed under a load of 800 g.

8.26.9 Specific Requirements for Testing External CBRN Barrier Layers.

8.26.9.1 Specimens shall consist of only the CBRN barrier layer material, as specified by the manufacturer.

8.26.9.2 Cut resistance testing shall be performed under a load of 150 g (5½ oz).

8.27 Puncture Resistance Test 1.

8.27.1 Application.

8.27.1.1 This test shall be applied to glove and footwear upper materials and footwear wear surfaces where the CBRN terrorism agent protection option is applied.

8.27.1.2 Modifications to this test method for testing glove materials shall be as specified in 8.27.7.

8.27.1.3 Modifications to this test method for testing footwear upper material shall be as specified in 8.27.8.

8.27.1.4 Modifications to this test method for testing footwear wear surface materials shall be as specified in 8.27.9.

8.27.2 Sample Preparation.

8.27.2.1 Samples shall be as specified in 8.27.7, 8.27.8, or 8.27.9.

8.27.2.2 Samples shall be conditioned as specified in 8.1.2.

8.27.3 Specimens.

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

8.27.3.2 At least three specimens shall be tested.

8.27.4 Procedure. Specimens shall be tested in accordance with ASTM F 1342, *Standard Test Method for Protective Clothing Material Resistance to Puncture,* using Test Method A.

8.27.5 Report.

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

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

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

8.27.7 Specific Requirements for Testing Glove Materials.

8.27.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.27.7.2 Specimens shall be representative of glove body composite construction at glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P as described in 8.1.14. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately.

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

8.27.7.2.2 Specimens shall not include seams except in the following cases:

(1) Ridged areas or similar areas where stitching is used to create specific performance characteristics rather than for glove assembly.
(2) Where there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

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

8.27.8 Specific Requirements for Testing Footwear Upper Materials.

8.27.8.1 Samples shall be footwear uppers or representative materials.

8.27.8.2 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, excluding the tongue and gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested. Specimens shall not include seams.

8.27.9 Specific Requirements for Testing CBRN Footwear Upper Materials. Specimens shall consist of each material or composite representing the wear surface of the footwear, with layers arranged in proper order. Specimens shall be taken from the thinnest portion of the footwear wear surface material or composite.

8.28 Glove Hand Function Test.

8.28.1 Application. This test shall apply to gloves.

8.28.2 Sample Preparation.

8.28.2.1 Samples shall be whole glove pairs, sizes small and large.

8.28.2.2 Samples shall be conditioned as specified in 8.1.2.

8.28.3 Specimens.

8.28.3.1 Specimens shall be whole glove pairs, sizes small and large, in new, as-distributed condition.

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

8.28.3.3 Each glove pair shall be tested as a complete set of gloves in new, as-distributed condition.

8.28.3.4 Glove pair specimens shall not receive special softening treatments prior to tests.

8.28.4 Apparatus. The apparatus shall conform to the requirements specified in ASTM F 2010, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test,* with the following modification: The stainless

steel pins shall be with a medium knurled 30 degree (25 teeth per in.) surface.

8.28.5 Procedures. Testing shall be conducted in accordance with ASTM F 2010, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test,* with the following modifications:

(1) Each size of gloves shall be evaluated with at least one separate test subject with the same pair of gloves.
(2) A minimum of three different glove pairs shall be evaluated for each size specified in 8.28.2.1.

8.28.6 Report.

8.28.6.1 The average percent of barehanded control shall be recorded and reported for each test subject.

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

8.28.7 Interpretation. The average percent of barehanded control for size small and size large shall be used to determine pass or fail performance.

8.29 Grip Test.

8.29.1 Application. This test method shall apply to protective gloves.

8.29.2 Sample Preparation.

8.29.2.1 Samples shall be whole glove pairs, sizes small and large, in new, as-distributed condition.

8.29.2.2 Samples shall be conditioned as specified in 8.1.2.

8.29.3 Specimens.

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

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

8.29.3.3 Glove pair specimens shall not receive special softening treatments prior to tests.

8.29.3.4 Specimens shall be tested for each material and construction combination.

8.29.3.5 Specimen glove pairs shall be tested after being conditioned for wet conditions as specified in 8.1.7.

8.29.4 Apparatus. The apparatus shall consist of a pulling device that is a 31.7 mm (1¼ in.) diameter fiberglass pole attached to an overhead calibrated force measuring device in such a fashion that pulls on the pole will be perpendicular to the ground and downward in direction. This pole shall be used until surface degradation occurs.

8.29.5 Procedure.

8.29.5.1 Test subjects shall be selected such that their hand dimensions are as close as possible to those specified in accordance with manufacturing glove-sizing guidelines. At least three test subjects shall be selected for both size small and size large.

8.29.5.2 The gloves shall be conditioned by the wetting procedure specified in 8.1.7 before each set of three pulls by the test subject as described below.

8.29.5.3 The pulling device shall be wet conditioned before each individual pull by wiping with a damp rag.

8.29.5.4 The test subject shall then make three pulls on the pulling device with gloves, with peak and minimum pull force values measured.

8.29.5.5 Pulls shall be performed as described in 8.29.5.5.1 through 8.29.5.5.6.

8.29.5.5.1 The test subject shall stand with feet together, firmly planted on the ground, and knees slightly bent.

8.29.5.5.2 The stand shall be adjusted such that the cushioned bar is touching the test subject's chest. The stand shall prevent the test subject's forward movement during the pull.

8.29.5.5.3 The test subject shall extend the arms in front of the body at shoulder height to grab the pulling device for pulling vertically down from the ceiling. The test subject shall stand in a comfortable pulling position with the arms bent at an angle of approximately 90 degrees, and in any case, the arms shall not be completely extended or touching the body.

8.29.5.5.4 The test subject shall grasp the pulling device with hands next to each other. Thumbs shall not overlap the fingers.

8.29.5.5.5 The test subject shall pull the rope or pole with as much pulling force as possible in a smooth, steady, swift, and non-jerking action. The test subject shall not bend the knees further or pull down with body weight during the pull.

8.29.5.5.6 The test subject shall continuously pull on the pulling device for a minimum of 5 seconds, +1/−0 seconds. The test subject shall continue to pull until the test facilitator observes a peak pulling force and instructs the test subject to end the pull.

8.29.6 Report.

8.29.6.1 The peak pull force value for each individual pull shall be recorded and reported.

8.29.6.2 The minimum pull force value occurring after the peak pull force value shall be recorded and reported.

8.29.6.3 The percentage drop between the peak pull force value and the minimum pull force value shall be calculated, recorded, and reported.

8.29.7 Interpretation.

8.29.7.1 The individual percentage drop between the peak pull force value and the minimum pull force value shall be used to determine pass or fail performance.

8.29.7.2 Failure during any pull shall constitute failure of the test.

8.30 Glove Donning Test.

8.30.1 Application. This test shall apply to protective gloves.

8.30.2 Sample Preparation.

8.30.2.1 Samples shall be whole glove pairs, sizes small and large.

8.30.2.2 Samples shall be conditioned as specified in 8.1.2.

8.30.2.3 All glove opening configurations shall be considered for testing.

8.30.3 Specimens.

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

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

8.30.4 Procedure.

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

8.30.4.2 Each donning trial shall start with the glove lying in front of the test subject and shall end when the test subject's fingers are seated in the glove sample.

8.30.4.3 The time to don one glove of the glove pair specimen shall be determined by measuring the time it takes for the test subject to don the single glove on three consecutive trials without altering the sample glove linings between donnings.

8.30.4.4 The glove shall be donned in accordance with the manufacturer's donning procedure. The glove shall then be removed by grasping the fingertip of the middle finger and pulling the hand out of the glove.

8.30.4.5 The test subject shall be permitted to don either the right-hand glove or left-hand glove according to individual preference.

8.30.4.6 The test subject shall wear the glove of the opposite handing during the test.

8.30.4.7 Where the glove cannot be donned because of detachment of the inner liner or moisture barrier, the trial for that glove shall be stopped. If any fingers cannot be fully inserted into the glove, the trial for that glove shall be stopped.

8.30.4.8 The baseline donning time shall be the average of the first three donning times as determined in 8.30.4.3.

8.30.4.9 The test subject shall repeat the trial specified in 8.30.4.3 for each pair of gloves.

8.30.4.10 Glove pair specimens shall then be conditioned as specified in 8.1.9.

8.30.4.11 Specimens shall be donned once after removal from the conditioning specified in 8.30.4.10 before continuing testing.

8.30.4.12 The test subject shall then don one glove of the pair specimen. The test subject shall do this for three consecutive trials for each specimen pair of gloves, as specified in 8.30.4.3 and 8.30.4.9. The times shall be recorded.

8.30.4.13 The final donning time shall be the average of the times for the first three donnings after removal from the final drying cycle as specified in 8.30.4.8.

8.30.5 Report.

8.30.5.1 The final donning time and the baseline donning time shall be reported to the nearest 0.1 second for each trial.

8.30.5.2 The average final and average baseline donning times shall be calculated, recorded, and reported for each specimen glove size.

8.30.5.3 Any inner liner or barrier layer separations shall be recorded and reported.

8.30.5.4 Any glove digits that do not allow full insertion shall be recorded and reported.

8.30.6 Interpretation.

8.30.6.1 Pass or fail determinations shall be made using the average final and average baseline donning times for each specimen glove size.

8.30.6.2 Any detachment of the inner liner or barrier layer shall constitute failing performance.

8.31 Overall Liquid Integrity Test 2.

8.31.1 Application. This test method shall apply to protective gloves.

8.31.2 Sample Preparation.

8.31.2.1 Samples shall be whole glove pairs, sizes small and large.

8.31.2.2 Samples shall be conditioned as specified in 8.1.9, followed by conditioning as specified in 8.1.2.

8.31.3 Specimens.

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

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

8.31.4 Apparatus.

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

8.31.4.2 Water used for integrity testing shall be at a temperature of 20°C ± 3°C (68°F ± 5°F) and treated with a nonfoaming surfactant to lower its surface tension to 35 dynes/cm ± 5 dynes/cm.

8.31.4.3 The following equipment shall be used for the test procedure:

(1) A clear container(s) for submerging gloved hand(s)
(2) A stopwatch

8.31.5 Procedure.

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

8.31.5.2 After the conditioning described in 8.31.2.2, the wrist crease location shall be marked as described in 6.1.3.3 on each specimen around the entire glove +0/−3 mm (+0/−0.25 in.).

8.31.5.2.1 Then, in the same manner, the maximum water height line shall also be marked on each specimen 25 mm (1 in.) +0/−3 mm (+0/−0.25 in.) below (toward the fingers) the location of the wrist crease around the entire glove.

8.31.5.2.2 Then, in the same manner, the minimum water height line shall also be marked on each specimen 25 mm (1 in.) +0/−3 mm (+0/−0.25 in.) below (toward the fingers) the location of the wrist crease around the entire glove.

8.31.5.3 The test subject shall don the specimen(s) over the water-markable glove(s).

8.31.5.4 The test subject shall then immerse the donned specimen(s) straight down into the surfactant-treated water to between the minimum and maximum water height lines for 5 minutes, +30/−0 seconds.

8.31.5.4.1 An observer shall be present to ensure that the specimen(s) is not immersed beyond the maximum water height line. If the test subject immerses the specimen(s) beyond the maximum water height line, the specimen(s) shall be retested after air drying and conditioning as specified in 8.1.2.

8.31.5.4.2 The test subject shall flex the specimen in a gentle, complete fist-closing motion every 10 seconds with each fist-closing motion taking 10 seconds, +/−2 seconds to complete. A complete fist-closing motion shall be when the ends of the glove fingertips make contact with the palm surface of the glove.

8.31.5.5 The specimen(s) shall then be removed from the test subject's hand, and the water-markable glove(s) shall be inspected for water marks.

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

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

8.32 Flame Resistance Test 4.

8.32.1 Application. This test method shall apply to protective footwear.

8.32.2 Sample Preparation.

8.32.2.1 Samples shall be whole footwear.

8.32.2.2 Samples shall be conditioned as specified in 8.1.2.

8.32.3 Specimens.

8.32.3.1 Specimens shall be whole footwear.

8.32.3.2 At least three specimens shall be tested.

8.32.4 Apparatus.

8.32.4.1 The test apparatus shall consist of a fuel pan, movable shutter(s), specimen holder, n-heptane, ignition source, and timing device.

8.32.4.1.1 The fuel pan shall be 305 mm × 457 mm × 63.5 mm (12 in. × 18 in. × 2.5 in.).

8.32.4.1.2 The movable shutter(s) shall be located at a height of 255 mm (10 in.) +/−13 mm (½ in.) above the surface of the water and n-heptane fluid as measured before ignition. The shutter(s) shall be of a size sufficient to cover the surface area of the fuel pan and shall be capable of being fully retracted or fully extended within 1 second.

8.32.4.1.3 The specimen holder shall be capable of suspending the specimen over the flame in a manner such that the holder does not impede the flames.

8.32.4.1.4 The stopwatch or other device shall measure the burning time to the nearest 0.1 second.

8.32.5 Procedure.

8.32.5.1 The test shall be conducted in a draft-free area.

8.32.5.2 The fuel pan shall be level.

8.32.5.3 Water shall be placed in the fuel pan to a height of 13 mm (½ in.).

8.32.5.4 Then, 400 mL to 500 mL of n-heptane shall be added to the fuel pan such that it will burn freely for 1.5 minutes to 2.0 minutes.

8.32.5.5 The specimen shall be mounted in the specimen holder as follows:

(1) The toe shall be at a 7.5 degree, +/−2.5 degree angle above the heel.
(2) The height of the lowest edge of the specimen shall be 305 mm (12 in.), +/−25 mm (+0/−1 in.) from the surface of the water and n-heptane fluid as measured before ignition.
(3) The heel-toe axis of the specimen shall be parallel with the 457 mm (17.9 in.) side of the fuel pan.

8.32.5.6 With the shutter retracted, the n-heptane shall be ignited using a suitable ignition source.

8.32.5.6.1 Where paper or other material is used to ignite the n-heptane, it shall not be left in the fuel pan where it can disturb the flame pattern.

8.32.5.7 The n-heptane shall burn freely for 1 minute +/−5 seconds.

8.32.5.8 The shutter shall be positioned above the flame.

8.32.5.9 The specimen shall be positioned above the shutter(s) over the approximate center of the flame area.

8.32.5.10 The shutter(s) shall be retracted and specimen flame exposure shall commence not longer than 1 minute + 15 seconds from ignition.

8.32.5.11 The specimen shall be exposed to the flame for 12 seconds, +/−0.2 second.

8.32.5.12 Following flame exposure, the shutter(s) shall be repositioned above the flame.

8.32.5.13 The afterflame time shall be measured as the time, in seconds, to the nearest 0.1 second that the specimen continues to flame after the shutter is repositioned over the flame.

8.32.5.14 Following the flame exposure, the specimen shall be visually examined for melting, dripping, and burn-through.

8.32.6 Report.

8.32.6.1 The afterflame time shall be reported for each specimen. The average afterflame time shall also be calculated and reported. The afterflame time shall be reported to the nearest 0.1 second.

8.32.6.2 Observations of melting, dripping, and burn-through for each specimen shall be reported.

8.32.7 Interpretation. Pass or fail performance shall be based on the average afterflame time and any observed melting, dripping, or burn-through.

8.33 Ladder Shank Bend Resistance Test.

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

8.33.2 Sample Preparation.

8.33.2.1 Samples shall be complete footwear ladder shanks.

8.33.2.2 Samples shall be conditioned as specified in 8.1.2.

8.33.3 Specimens.

8.33.3.1 Specimens shall be complete footwear ladder shanks.

8.33.3.2 At least three specimens shall be tested.

8.33.4 Apparatus. The apparatus shall consist of a tensile testing machine, such as an Instron or equivalent, that challenges a specimen with a simulated ladder rung. A 32 mm diameter × 50 mm long (1¼ in. diameter × 2 in. long) noncompressible probe shall be mounted on the movable arm. 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 8.33.4.

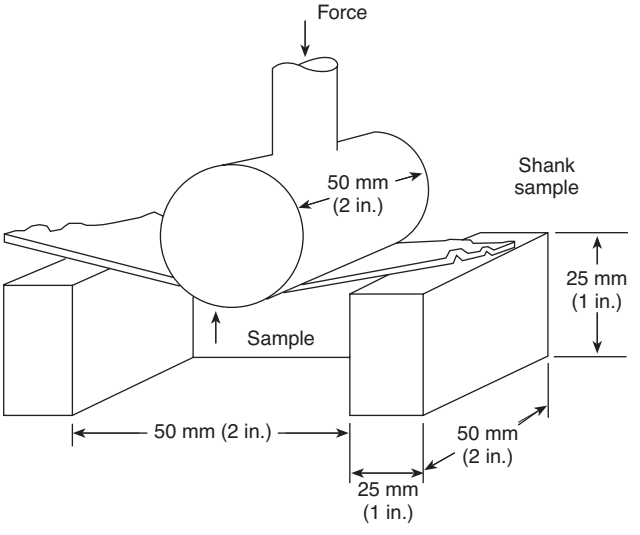


FIGURE 8.33.4 Shank Bend Test Setup.

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

8.33.6 Report. Deflection at 1780 N (400 lbf) shall be reported to the nearest 1 mm (1/32 in.). The average deflection shall be calculated and reported to the nearest 1 mm (1/32 in.).

8.33.7 Interpretation. Pass or fail performance shall be determined using the average deflection for all specimens tested.

8.34 Abrasion Resistance Test 3.

8.34.1 Application. This test method shall apply to footwear soles and heels.

8.34.2 Sample Preparation.

8.34.2.1 Samples shall be uniform cylinders of footwear sole and heel material.

8.34.2.2 Samples shall be conditioned as specified in 8.1.2.

8.34.3 Specimens.

8.34.3.1 Specimens shall be footwear sole and heel material.

8.34.3.2 At least three specimens shall be tested.

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

8.34.5 Report. The relative volume loss of each specimen shall be reported.

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

8.35 Slip Resistance.

8.35.1 Application. This test method shall apply to footwear.

8.35.2 Sample Preparation.

8.35.2.1 Samples shall be the whole footwear in men's size 9D, medium width.

8.35.2.2 Samples shall be conditioned as specified in ISO 13287, *Personal Protective Equipment — Footwear — Test Method for Slip Resistance.*

8.35.3 Specimens.

8.35.3.1 Specimens shall be the whole footwear in men's size 9D, medium width.

8.35.3.2 At least three specimens shall be tested.

8.35.4 Procedure. Slip resistance shall be performed in accordance with ISO 13287, *Personal Protective Equipment — Footwear — Test Method for Slip Resistance*, in the configurations in 8.35.4.1 through 8.35.4.3. References to any other flooring and/or contaminant within ISO13287 shall not apply.

8.35.4.1 Footwear shall be tested both in the forepart and heel positions.

8.35.4.2 Footwear shall be tested in the wet condition. The wet condition shall be achieved using distilled or de-ionized water. The water shall be applied to thoroughly wet the testing surface and make a pool at least as wide and long as the test portion of the footwear in the area of initial contact.

8.35.4.3 Footwear shall be tested on a quarry tile surface that meets the following specifications:

(1) Is a flat and unglazed clay tile that is wider than the test specimen and long enough to allow a sliding distance of at least 75 mm (2.9 in.) without crossing a joint
(2) Is sufficiently flat to allow the tile to be secured on the mounting table such that no movement occurs between the tile and mounting table during the test
(3) Has a ribbed profile or directional marking on the underside to identify the direction in which the tile should be aligned (with the ribs parallel to the sliding direction)
(4) Conforms to the coefficient of friction values specified in Table 8.35.4.3 when calibrated by the Slider 96 method

8.35.4.3.1* Calibration of the tiles shall be checked after every 10 tests or prior to each day of testing, whichever is the less frequent, to ensure that they are not being worn smooth or otherwise damaged.

Table 8.35.4.3 Calibration Values for Quarry Tile

	Dry CF	Wet CF
Minimum	0.57	0.43
Maximum	0.63	0.49

8.35.5 Report.

8.35.5.1 The coefficient of friction of each specimen shall be reported.

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

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

8.36 Electrical Insulation Test 2.

8.36.1 Application. This test shall apply to protective footwear.

8.36.2 Sample Preparation.

8.36.2.1 Samples shall be whole footwear.

8.36.2.2 Samples shall be conditioned as specified in 8.1.2.

8.36.3 Specimens.

8.36.3.1 Specimens shall be whole footwear.

8.36.3.2 At least three specimens shall be tested.

8.36.4 Procedure. Protective footwear shall be tested to 14,000 V (rms) in accordance with Section 9 of ASTM F 2412, *Standard Test Methods for Foot Protection.*

8.36.5 Report. Any current leakage or evidence of breakdown shall be recorded for each footwear item.

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

8.37 Eyelet and Stud Post Attachment Test.

8.37.1 Application. This test method shall apply to protective footwear eyelets and stud posts.

8.37.2 Sample Preparation.

8.37.2.1 Samples shall be whole footwear.

8.37.2.2 Samples shall be conditioned as specified in 8.1.2.

8.37.3 Specimens.

8.37.3.1 Specimens shall be 25 mm × 50 mm (1 in. × 2 in.) containing two eyelets and two stud posts.

8.37.3.2 At least three specimens from separate footwear items shall be tested.

8.37.4 Apparatus. A tensile testing machine shall be used with a traverse rate of 50 mm/min (2 in./min). Clamps measuring 25 mm × 38 mm (1 in. × 1½ in.) shall have gripping surfaces that are parallel, flat, and capable of preventing slippage of the specimen during the test.

8.37.5 Procedure.

8.37.5.1 The stud post or eyelet puller shall be inserted or attached to the upper position of the tensile machine.

8.37.5.2 The traverse rate shall be set at 50 mm/min (2 in./min).

8.37.5.3 The test eyelet or stud post shall be attached using the appropriate puller fixture.

8.37.5.4 The eyelet stay shall be clamped, but clamping the metal portion of the eyelets or stud hook in the lower clamps shall not be permitted.

8.37.5.5 The distance between the clamps and the stud hooks or eyelets shall be 1.6 mm to 3.2 mm (0.063 in. to 0.125 in.).

8.37.5.6 The test shall then be started.

8.37.6 Report.

8.37.6.1 The force shall reach a peak, decline slightly, and then increase to complete failure; however, the value at which the force first declines shall be recorded and reported as the initial failure point, as this is the separation point of the material around the eyelet or stud post.

8.37.6.2 The average force shall be calculated, recorded, and reported.

8.37.7 Interpretation. The average force shall be used to determine pass or fail.

8.38 Label Durability and Legibility Test.

8.38.1 Application.

8.38.1.1 This test method shall apply to labels on protective garments, helmets, gloves, and footwear.

8.38.1.2 Modifications to this test method for testing garment labels shall be as specified in 8.38.7.

8.38.1.3 Modifications to this test method for testing helmet labels shall be as specified in 8.38.8.

8.38.1.4 Modifications to this test method for testing glove labels all be as specified in 8.38.9.

8.38.1.5 Modifications to this test method for testing footwear labels shall be as specified in 8.38.10.

8.38.2 Sample Preparation.

8.38.2.1 Samples shall be as specified in 8.38.7, 8.38.8, 8.38.9, and 8.38.10.

8.38.2.2 Samples shall be conditioned as specified for the respective tests.

8.38.3 Specimens.

8.38.3.1 At least three specimens of each type of label shall be tested in each test.

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

8.38.4 Procedures.

8.38.4.1 Laundering Durability Test.

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

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

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

8.38.4.2 Abrasion Durability Test.

8.38.4.2.1 Specimens shall be subjected to abrasion in accordance with ASTM D 4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics*, with the following modifications:

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

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

8.38.4.3 Heat Durability Test.

8.38.4.3.1 Specimens shall be subjected to convective heat as specified in 8.1.8.

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

8.38.5 Report. The legibility for each specimen shall be recorded and reported as acceptable or unacceptable.

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

8.38.7 Specific Requirements for Testing Garment Labels.

8.38.7.1 For testing label legibility after laundering, specimens shall include individual labels sewn onto a 1 m (1 yd) square of ballast material no closer than 50 mm (2 in.) apart in parallel strips. The ballast material shall be as specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

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

8.38.7.3 For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 380 mm ± 13 mm (15 in. ± ½ in.) square of material that meets the outer shell requirements of this standard.

8.38.7.4 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability as specified in 8.38.4.1, 8.38.4.2, and 8.38.4.3, respectively.

8.38.8 Specific Requirements for Testing Helmet Labels.

8.38.8.1 Samples for conditioning shall be whole helmets with labels attached.

8.38.8.2 Specimens shall be conditioned as specified in 8.1.4, 8.1.5, and 8.1.6 with the label examined legibility to the unaided eye by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 305 mm (12 in.) in a well-illuminated area.

8.38.8.3 Specimens shall also be tested separately for legibility after heat durability as specified in 8.38.4.3.

8.38.9 Specific Requirements for Testing Glove Labels.

8.38.9.1 For testing label legibility after laundering and heat durability, specimens shall include gloves with labels attached.

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

8.38.9.3 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability as specified in 8.38.4.1, 8.38.4.2, and 8.38.4.3, respectively.

8.38.10 Specific Requirements for Testing Footwear Labels.

8.38.10.1 For testing label legibility after heat durability, specimens shall include footwear with labels attached.

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

8.38.10.3 Specimens shall be tested separately for legibility after abrasion and heat durability as specified in 8.38.4.2 and 8.38.4.3, respectively.

8.39 Burst Strength Test.

8.39.1 Application. This test shall apply to knit materials used in gloves.

8.39.2 Sample Preparation.

8.39.2.1 Samples shall be a 0.5 m (20 in.) long section of knit material.

8.39.2.2 Samples shall be conditioned as specified in 8.1.2.

8.39.3 Specimens.

8.39.3.1 Specimens shall be the size specified in ASTM D 3787, *Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics — Ball Burst Testing Method.*

8.39.3.2 At least 10 specimens shall be tested.

8.39.3.3 Specimens shall include all layers of the wristlet used in glove construction.

8.39.4 Procedure. Specimens shall be tested as specified in ASTM D 3787, *Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics — Ball Burst Testing Method.*

8.39.5 Report.

8.39.5.1 The burst strength of each specimen shall be reported.

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

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

8.40 Man-in-Simulant Test (MIST).

8.40.1 Application. This test shall apply to CBRN protective ensembles.

8.40.2 Samples.

8.40.2.1 Samples shall consist of CBRN protective ensembles, including the ensemble garment, helmet, glove, and footwear elements, and the respirator specified for the ensemble by the ensemble manufacturer. The hood interface component shall

also be tested where the hood is not part of the CBRN ensemble garment elements.

8.40.2.2 The ensemble shall be tested with each style of the respirator specified by the manufacturer.

8.40.2.3 Garment, glove, and hood elements shall be conditioned as specified in 8.1.9.

8.40.2.4 Where the ensemble garment element does not include booties and the chemical/CBRN barrier material is incorporated into the footwear, the footwear shall be conditioned by flexing for 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:

(1) Water shall not be used.
(2) The flex speed shall be 60 cycles/min, +/−2 cycles/min.
(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/min, +/−2 cycles/min
   (c) Is capable of providing a means of securing the footwear during flexing

8.40.2.5 Samples shall be conditioned at 21°C ± 6°C and 50 percent ± 30 percent relative humidity for at least 4 hours.

8.40.3 Specimens.

8.40.3.1 Specimens shall consist of the garment, helmet, glove, and footwear elements, and the respirator specified for the ensemble by the ensemble manufacturer. The hood interface component shall also be tested where the hood is not part of the CBRN ensemble garment elements.

8.40.3.2 A minimum of four specimens shall be tested. The specimens shall represent a minimum of two different ensemble sizes.

8.40.3.3 Specimens shall be provided to fit or be adjustable to fit the selected test subjects in accordance with the manufacturer's sizing provisions that are specific to each ensemble.

8.40.3.4* None of the ensembles or components of the ensemble to be tested shall have been previously subjected to MIST testing unless it can be demonstrated that the ensemble or components are free of contamination.

8.40.3.5 Underclothing and socks shall be permitted to be reused, provided they have been laundered with a detergent that has been demonstrated not to cause interference with the analytical method.

8.40.4 Apparatus.

8.40.4.1 Test Facility.

8.40.4.1.1 The test facility shall include areas for dressing, a first-stage undressing area adjacent and accessible to the chamber, and a second-stage undressing area adjacent and accessible to the first-stage undressing area.

8.40.4.1.2 The test shall be conducted in a sealed chamber with a minimum volume of sufficient dimensions to permit free movement of the test subject(s) fully dressed in the ensemble and for the test subject(s) to carry out the physical exercise routine specified in 8.40.5.8.

8.40.4.1.3 More than one test subject shall be permitted in the chamber at the same time, provided that they can complete all tasks completely in the appropriate time period and that they have an unobstructed direct path to the wind stream.

8.40.4.1.4 The test chamber shall have a temperature of 25°C ± 2°C; relative humidity of 55 percent ± 10 percent; and a nominal wind speed of 0.9 m/sec to 2.2 m/sec (2 mph to 5 mph). The average wind speed shall be 1.6 m/sec ± 0.2 m/sec (3.5 mph ± 0.5 mph).

8.40.4.2 Test Chemical and Analytical Equipment.

8.40.4.2.1 The test simulant shall be methyl salicylate (MeS; $C_8H_8O_3$) CAS 119-36-8, more commonly known as oil of wintergreen. The MeS minimum purity shall be 95 percent. Vapor doses shall be measured using passive adsorbent dosimeters (PADs).

8.40.4.2.2* The standard concentration of MeS in the vapor chamber shall be 100 mg/m^3 ± 5 mg/m^3, as measured by a real-time infrared analysis of the chamber air or other validated real-time analytical technique.

8.40.4.2.3 Infrared readings shall be taken every 60 seconds to verify compliance with the concentration requirement, and an air sample shall be taken at least every 10 minutes for validation of infrared readings.

8.40.4.2.4 Every step shall be taken to avoid generation of liquid aerosol.

8.40.4.2.5 The sensitivity of the analytical technique used for the measurement of MeS in the PADs shall provide a detection limit of 30 ng MeS per PAD. The analytical technique shall have an upper limit of quantification of 31,500 ng.

8.40.4.3* Test Subjects.

8.40.4.3.1 All test subjects shall be medically and physically suitable to perform these tests without danger to themselves. A medical certificate for each test subject shall have been issued within 12 months prior to testing.

8.40.4.3.2 Test subjects shall be familiar with the use of chemical protective ensembles and with the selected CBRN SCBA.

8.40.4.4 Passive Adsorbent Dosimeters (PADs) The test shall be conducted using PADs that affix directly to the skin of the test subjects, with the following characteristics:

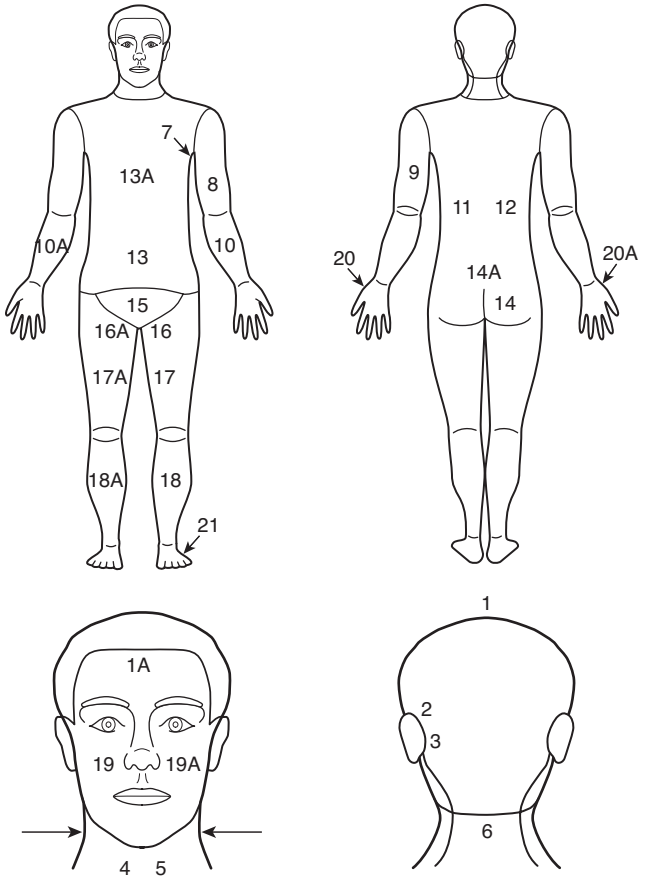
(1) The PADs shall be a foil packet, which contains an adsorbent material covered by a high-density polyethylene film that acts as a pseudo-skin barrier.
(2) The PADs shall have an uptake rate of 3 cm/min or greater.

8.40.5 Procedure.

8.40.5.1 Test subjects shall have followed pretrial procedures that include proper hydration and avoiding personal hygiene products that could contain MeS.

8.40.5.2 PADs shall be placed on test subjects at the body region locations shown in Figure 8.40.5.2.

8.40.5.2.1 All PADs shall be applied in a clean dressing area by personnel who have followed pretrial procedures to minimize contamination. Test subjects shall also follow pretrial procedures to minimize contamination.



PAD locations

1:	scalp (SCA)	13A:	chest (C)
1A:	forehead (F)	14:	right buttock (RB)
2:	behind left ear upper (LED)	14A:	lower back (LB)
3:	behind left ear (LE)	15:	groin (GR)
4:	neck right (NED)	16:	crotch (LCR)
5:	neck left (NE)	16A:	crotch (RCR)
6:	nape (NA)	17:	left inner thigh (LIT)
7:	left armpit (LA)	17A:	right inner thigh (RIT)
8:	left inner upper arm (LIU)	18:	left inner shin (LIS)
9:	left outer upper arm (LOU)	18A:	right inner shin (RIS)
10:	left forearm (LFA)	19:	cheek (RM)
10A:	right forearm (RFA)	19A:	cheek (LM)
11:	middle back (MB)	20:	left hand (G)
12:	middle back dup. (MBD)	20A:	right hand (GD)
13:	abdomen (AB)	21:	foot (B)

FIGURE 8.40.5.2 Locations of Passive Adsorption Dosimeters (PADs) on Test Subjects.

8.40.5.2.2 Cheek PADs shall be located entirely within the respirator facepiece, and all other PADs shall be located entirely outside the seal of the respirator facepiece.

8.40.5.3 Three additional PADs shall be used to conduct background sampling and for quality control during the trial. These PADs shall be located in the dressing area, the Stage 1 undress area, and the Stage 2 undress area.

8.40.5.4 The test subject shall don the protective ensemble and respirator in accordance with the manufacturer's instructions in an area located away from the test chamber. The test subject shall wear clothing under the CBRN protective ensemble as specified by the manufacturer. If no undergarments are specified or required by the manufacturer as part of the certified ensemble, the test subject shall wear a short-sleeve cotton shirt and shorts or underwear.

8.40.5.5 After sealing the ensemble, the test subject shall enter the test chamber, and the test chamber shall be sealed.

8.40.5.6 The test duration shall be 30 minutes in the chamber with an additional 5-minute decontamination period.

8.40.5.7 The start of the test, in which the test subject enters the MIST chamber, shall be initiated within 60 minutes after removal of the ensemble from conditioning environment.

8.40.5.8 Physical Exercise Routine.

8.40.5.8.1 Once the chamber concentration has been established, the test subject(s) shall perform the following physical activity protocol. The chamber concentration shall remain within acceptable limits during the exercise protocol.

(1) Drag 70 kg (154 lb) human dummy using both hands a distance of 10 m (33 ft) over 15-second period. Stop and rest for 15 seconds. Repeat exercise twice.
(2) Duck squat, pivot right, pivot left, stand. Rotate orientation 90 degrees to wind stream between each repetition. Repeat exercise twice in each orientation for a total of 1 minute.
(3) Stand erect. With arms at sides, bend body to left and return, bend body forward and return, bend body to right and return. Rotate orientation 90 degrees to wind stream between each repetition. Repeat exercise twice in each orientation for a total of 1 minute.
(4) Stand erect. Extend arms overhead in the lateral direction, then bend elbows. Extend arms overhead in the frontal direction, then bend elbows. Rotate orientation 90 degrees to wind stream between each repetition. Repeat exercise twice in each orientation for a total of 1 minute.
(5) Stand erect. Extend arms perpendicular to the sides of torso. Twist torso left and return, twist torso right and return. Rotate orientation 90 degrees to wind stream between each repetition. Repeat exercise twice in each orientation for a total of 1 minute.
(6) Stand erect. Reach arms across chest completely to opposite sides. Rotate orientation 90 degrees to wind stream between each repetition. Repeat exercise twice in each orientation for a total of 1 minute.
(7) Climb two steps of the ladder and touch the ceiling with one hand (use alternate hand each time). Climb down, squat, and touch the floor with both hands. Repeat exercise three times within 1 minute.
(8) Crawl in place for 1 minute. Rotate orientation 90 degrees to wind stream every 15 seconds.
(9) Sit on stool (facing wind) for 1 minute.
(10) Sit on stool (back to wind) for 1 minute.

8.40.5.8.2 Physical activities and rest periods shall be performed in a chamber location that provides an unobstructed exposure of the protective ensemble to the required wind stream.

8.40.5.8.3 Each physical activity and rest cycle shall be 10 minutes. The cycle of exercise and rest shall be completed a total of three times, for a total chamber exposure of 30 minutes. Each exercise cycle shall consist of eight 1-minute activities followed by a 2-minute rest (sitting) period.

8.40.5.8.4 The test subject shall begin the first repetition of each activity facing the wind stream and shall rotate 90 degrees between each repetition until the time period for that exercise has ended.

8.40.5.8.5 For activities in 8.40.5.8.1(7) (walking in place) and 8.40.5.8.1(8) (crawling in place), the test subject shall rotate 90 degrees on 15-second intervals during the 1-minute period.

8.40.5.8.6 All physical activities shall be a full range of motion and shall be performed at a moderate speed.

8.40.5.9 Decontamination and Doffing.

8.40.5.9.1 After completion of the 30-minute MIST exposure, the test subjects shall move to a decontamination area, where they shall remain for at least 5 minutes. This area shall be well-ventilated to assist in off-gassing of the outside of the ensemble.

8.40.5.9.2 In the decontamination area, all exposed ensemble surfaces, including such items as the respirator, boots, gloves, and helmets shall be washed with a liquid soap solution.

8.40.5.9.2.1 If the garment is designed for wet decontamination, it shall be washed with the liquid soap solution as well.

8.40.5.9.2.2 Alternative decontamination methods, such as an air wash, shall be permitted if the selected decontamination method can be demonstrated to remove MeS to levels that do not result in contamination of the test subjects during the doffing of the protective ensemble.

8.40.5.9.3 The decontaminated test subject shall move to the first-stage undressing room, where all remaining items of clothing, except for underclothes, shall be doffed. The undress process shall not exceed 5 minutes.

8.40.5.9.4 As soon as the garment is unsealed and the PADs on the test subject's body are exposed to the ambient atmosphere in the first-stage undressing room, 3 fresh PADs shall be placed near the test subject to detect background MeS concentrations.

8.40.5.9.5 As soon as all items of clothing except underwear are removed, the decontaminated test subject shall proceed to the second-stage undressing room and the background PADs shall be collected and handled as specified in 8.40.5.9.7. The exposure time for the first-stage undressing room background PADs shall be recorded.

8.40.5.9.6 When the test subject enters the second-stage undressing room, 3 additional PADs shall be placed near the test subject and the exposure PADs shall be removed from the test subject's body. Both the second-stage undressing room background PADs and the exposure PADs taken off the test subject's body shall be handled as specified in 8.40.5.9.7. The exposure time for the second-stage undressing room PADs shall be recorded.

8.40.5.9.7 Where an adhesive is used on the back of the PADs, each PAD shall be backed with aluminum foil, placed in individual sealed glass vials with a nonadsorbent lid liner, and shall remain at room temperature of 25°C ± 3°C (77°F ± 5°F) for 30 minutes ± 5 minutes, immediately after exposure.

8.40.6 PAD Qualification and Analysis.

8.40.6.1 The uptake rate for each lot of PADs shall be determined in accordance with 8.40.6.2 using a minimum of 7 PADs selected randomly from the lot.

8.40.6.2* Measurement of PAD Uptake Rate.

8.40.6.2.1 PAD uptake rate shall be measured by exposing PADs in a small-scale chamber under the following conditions:

(1) The concentration of MeS shall be 1 mg/m^3 ± 0.5 mg/m^3.
(2) The temperature shall be 35°C ± 2°C (94°F ± 4°F).
(3) The relative humidity shall be 55 percent ± 20 percent.
(4) The flow of MeS in the humidified air or nitrogen shall be at a rate of 1 cm/sec ± 0.2 cm/sec over the PAD.
(5) The exposure shall be conducted for a period of 30 minutes +1/–0 minutes.

8.40.6.2.2 The PAD uptake rate shall be calculated in accordance with the procedures provided in 8.40.6.2.1. The average of all PAD uptake rates shall be calculated and used in the calculation of MeS dosage on the test subject PADs.

8.40.6.3 After their initial 30 minutes at room temperature, the PADs shall be subjected to one of the following handling and analysis procedures:

(1) The PADs shall be stored at a cold temperature sufficient to prevent the migration of MeS from the adhesive until extraction or analysis.
(2) The PADS shall be extracted within 4 hours.
(3) The adsorbent shall be removed and thermally desorbed within 4 hours.

8.40.6.3.1 The determination of a sufficiently low temperature that prevents migration of the MeS from the adhesive shall be made by exposing 12 PADs simultaneously in the test chamber in a vertical position to a concentration of 100 mg/m^3 of MeS for 30 minutes, +5/–0 minutes. After this exposure, the PADs shall be covered in foil and each placed in a sealed container and stored at 25°C ± 3°C (77°F ± 5°F) for 30 minutes ± 5 minutes. Four of these PADs shall then be packed in dry ice for 24 hours, four placed in the proposed cold storage temperature for 24 hours, and 4 extracted or analyzed within 4 hours. The average mass absorbed on the four PADs stored at the proposed storage temperature shall equal with 95 percent accuracy the average mass absorbed on the four PADs stored for 24 hours in dry ice and the four PADs analyzed immediately after exposure.

8.40.6.3.2 Where liquid extraction of the PADs samples is performed, the liquid extracts shall be stored at 0°C to 4°C (32°F to 39°F) for up to 14 days following their exposure before analysis.

8.40.6.4 The actual MeS vapor exposure concentration and the actual time of exposure shall be used to determine the uptake rate from the following equation:

$$u = \frac{m}{ACt}$$

where:
u = the uptake rate in cm/min
m = the total mass of MeS measured on the PAD in mg
A = the average active area of the PAD in cm^2
Ct = the exposure vapor dosage in mg/min/cm^3

8.40.6.5 The range of the analytical technique shall be sufficient to measure the expected range of MeS dosage on the test subject PADs.

8.40.6.5.1 When liquid extraction is used as the analytical technique, the calibration curve used for determining the

equipment response to MeS shall be established using at least four MeS concentration standards accounting for the proper density of the extraction solvent.

8.40.6.6 For the test results to be considered valid for a given ensemble, no more than one PAD from each of the body region locations tested (i.e., no more than one PAD out of the four replicates for any particular region) shall be permitted to be lost to analysis over the course of the four test subjects.

8.40.7 Calculations.

8.40.7.1 The dosage measured by each PAD ($Ct_{inside,i}$) shall be determined using the average uptake rate determined for the PAD lot used in the evaluation of a specific ensemble using the following equation:

$$Ct_{inside,i} = \frac{m_i}{u_{avg}\ A}$$

where:

$Ct_{inside,i}$ = the MeS vapor dosage at the specific PAD in mg/min/cm^3
m_i = the total mass of MeS measured on the specific PAD in mg
u_{avg} = the average uptake of the PAD lot in cm/min
A = the average active area of the PA in cm^2

8.40.7.1.1 The protection factor at each PAD location shall be calculated using the following equation, where the $Ct_{outside}$ shall be determined from the measured chamber vapor dosage of the individual trial over the entire exposure. The value for $Ct_{outside}$ shall be the average of the chamber MeS concentration readings taken during the course of the test subject exposure period.

$$PF_i = \frac{Ct_{outside}}{Ct_{inside}}$$

8.40.7.1.2 Where the measured total mass of MeS for a given PAD falls below 30 ng, the value of 30 ng shall be used for that specific PAD.

8.40.7.2 All results for each PAD location shall be expressed in terms of the local physiological protective dosage factor (*PPDF*) value and shall be calculated according to the following equation:

$$PPDF_{sys} = \frac{\sum_i \frac{dz_i}{ED_{50i}}}{\sum_i \left(\frac{dz_i}{ED_{50i}\ PF_i} \right)}$$

8.40.7.2.1* The site-specific onset of symptoms exposure dosages (OSED) for each PAD shall be based on ECt_{10} values for mustard blistering/ulceration according to Table 8.40.7.2.1.

8.40.7.2.2 The average local physiological protective dosage factor (*PPDF*) values at each PAD location for all specimens tested shall be calculated.

8.40.7.3 A systemic *PPDF* shall also be calculated from the PAD data. The systemic protection analysis shall use the systemic weighting body region hazard analysis values from Defence Research Establishment Suffield Report and National Research Council Report listed in 2.3.9 to calculate the systemic physiological protective dosage factor for each ensemble test ($PPDF_{sys}$). The $PPDF_{sys}$ for each specimen is calculated as follows, where each of the terms is calculated using the information in Table 8.40.7.3:

$$PPDF_{sys} = \frac{\sum_i \frac{dz_i}{ED_{50i}}}{\sum_i \frac{dz_i}{ED_{50i} PF_i}}$$

8.40.7.3.1 The average $PPDF_{sys}$ for all specimens tested shall be calculated.

Table 8.40.7.2.1 Site-Specific Onset of Symptoms Exposure Dosage (OSED) by PAD Location

Body Region	PAD Locations*	OSED (mg·min·m^{-3})
Head, neck	1, 1A, 2, 3, 4, 5, 6, 19, 19A	100
Torso, buttocks (excluding crotch)	11, 12, 13, 13A, 14, 14A, 15	50
Arm, hand	7, 8, 9, 10, 10A, 20, 20A	50
Leg, foot	17, 17A, 18, 18A, 21	100
Crotch	16, 16A	25

*See Figure 8.40.5.2.

8.40.8 Report.

8.40.8.1 The individual specimen and average local physiological protective dosage factor ($PPDF_i$) values for each PAD location shall be recorded and reported.

8.40.8.2 The physiological protective dosage factor ($PPDF_{sys}$) value for each specimen and the average systemic physiological protective dosage factor ($PPDF_{sys}$) value for the ensemble tested shall be recorded and reported.

8.40.8.3 A spreadsheet shall be prepared that shows all test measurements and calculations including at least the following:

(1) The MeS vapor exposure concentration for PAD lot qualification
(2) The exposure time used for PAD lot qualification
(3) The measured MeS mass on each PAD used for PAD lot qualification
(4) Each individual and the average PAD uptake rate
(5) The measured MeS mass on each PAD using in the dressing room, first-stage undressing room, and second-stage undressing room
(6) The measured MeS mass on each PAD placed on the test subject
(7) The calculated vapor dosage for each PAD placed on the test subject

8.40.9 Interpretation. The average local physiological protective dosage factor ($PPDF_i$) values at each PAD location and the average physiological protective dosage factor ($PPDF_{sys}$) value shall be used to determine pass or fail performance.

8.41 Chemical Permeation Resistance Test.

8.41.1 Application.

8.41.1.1 This method shall apply to the CBRN barrier layer and the CBRN barrier layer's seams used in ensembles and ensemble elements for CBRN terrorism agent protection.

Table 8.40.7.3 ED_{50i} Values by PAD and Body Location

Body Region *i* for BRHA Model	PADs Mapped to this Region (Average Dosage from Each PAD, and then Calculate PF_i)*	Area of Body Region (dz_i, cm^2)	ED_{50i} for Severe Effects (VX) for Body Region (mg/individual)
Scalp	1,1A	350	0.76
Ears	2,3	50	0.46
Face, cheeks, and neck	4,5,19,19A	300	0.48
Chin and neck	4,5	200	0.36
Nape	6	100	1.72
Abdomen	13A	2858	2.23
Back	11,12,14A	2540	2.65
Axillae	7	200	2.07
Upper arm medial	8	488	6.57
Upper arm lateral	9	706	2.8
Elbow fold	8,9,10,10A	50	2.09
Elbow	8,9,10,10A	50	2.25
Forearm extensor	10,10A	487	2.8
Forearm flexor	10,10A	706	6.57
Hands dorsum	20,20A	200	2.91
Hands palmar	20,20A	200	9.24
Buttocks	14	953	4.26
Groin	13,15	300	1.22
Scrotum	16,16A	200	0.11
Thigh anterior	17,17A	2845	6.57
Thigh posterior	17,17A	1422	4.26
Knee	17,17A,18,18A	200	7.14
Popliteal space (back of knees)	17,17A,18,18A	100	2.09
Shins	18,18A	1897	2.8
Calves	18,18A	948	6.57
Feet dorsum	21	500	6.6
Feet plantar	21	300	7.14

*See Figure 8.40.5.2.

8.41.1.2 Specific requirements for testing the garment, hood, and bootie CBRN layer shall be as specified in 8.41.10.

8.41.1.3 Specific requirements for testing the garment, hood, and bootie CBRN barrier seams shall be as specified in 8.41.11.

8.41.1.4 Specific requirements for testing the glove CBRN barrier layer and seams shall be as specified in 8.41.12.

8.41.1.5 Specific requirements for testing the footwear CBRN barrier layer and seams shall be as specified in 8.41.13.

8.41.2 Samples.

8.41.2.1 Samples for conditioning shall be as specified according to the specific requirements in 8.41.10, 8.41.11, 8.41.12, and 8.41.13, as appropriate.

8.41.2.2 Samples shall be conditioned as specified according to the specific requirements in 8.41.10, 8.41.11, 8.41.12, and 8.41.13, as appropriate.

8.41.2.3 Samples shall then be cut to the specimen size.

8.41.2.4 All layers of the samples during conditioning shall be present and configured in the order and orientation as worn.

8.41.3 Specimens.

8.41.3.1 Specimens shall be the CBRN barrier layer or the CBRN barrier layer's seam of the size required to fit the permeation test cell.

8.41.3.2 A minimum of three specimens shall be tested against each challenge chemical.

8.41.3.3 Any outer shell or other composite layers normally worn over the specimen shall be permitted to be included on top of the specimen in the test. The outer shell or other composite layers shall be placed on the test specimen through the cell top cap port after the test cell has been assembled.

8.41.3.4 If the specimen is the outermost layer of the composite, then it shall be tested without any additional layers on top.

8.41.3.5 Any separable layers normally worn underneath the specimen shall not be permitted to be included in the test.

8.41.3.6 Specimens with non-uniform surfaces shall be permitted to be treated with an impermeable nonreactive sealant outside the area of the specimen exposed to the challenge chemical, in order to allow sealing of the test cell to a uniform surface of the specimen.

8.41.3.7 Following any sample preparation, the specimens shall be conditioned at a temperature of 32°C, +/−1°C (90°F, +/−2°F) and at a relative humidity of 80 percent, +/−5 percent, for at least 24 hours prior to testing in accordance with 8.41.7.1.1.

8.41.4 Apparatus.

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

8.41.4.2* The test cell shall be a two-chambered cell for contacting the specimen with the challenge chemical on the specimen's normal outside surface and for flowing a collection medium on the specimen's normal inside surface, consisting of parts shown in Figure 8.41.4.2(a) and individual part detail shown in Figure 8.41.4.2(b) through Figure 8.41.4.2(f).

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

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

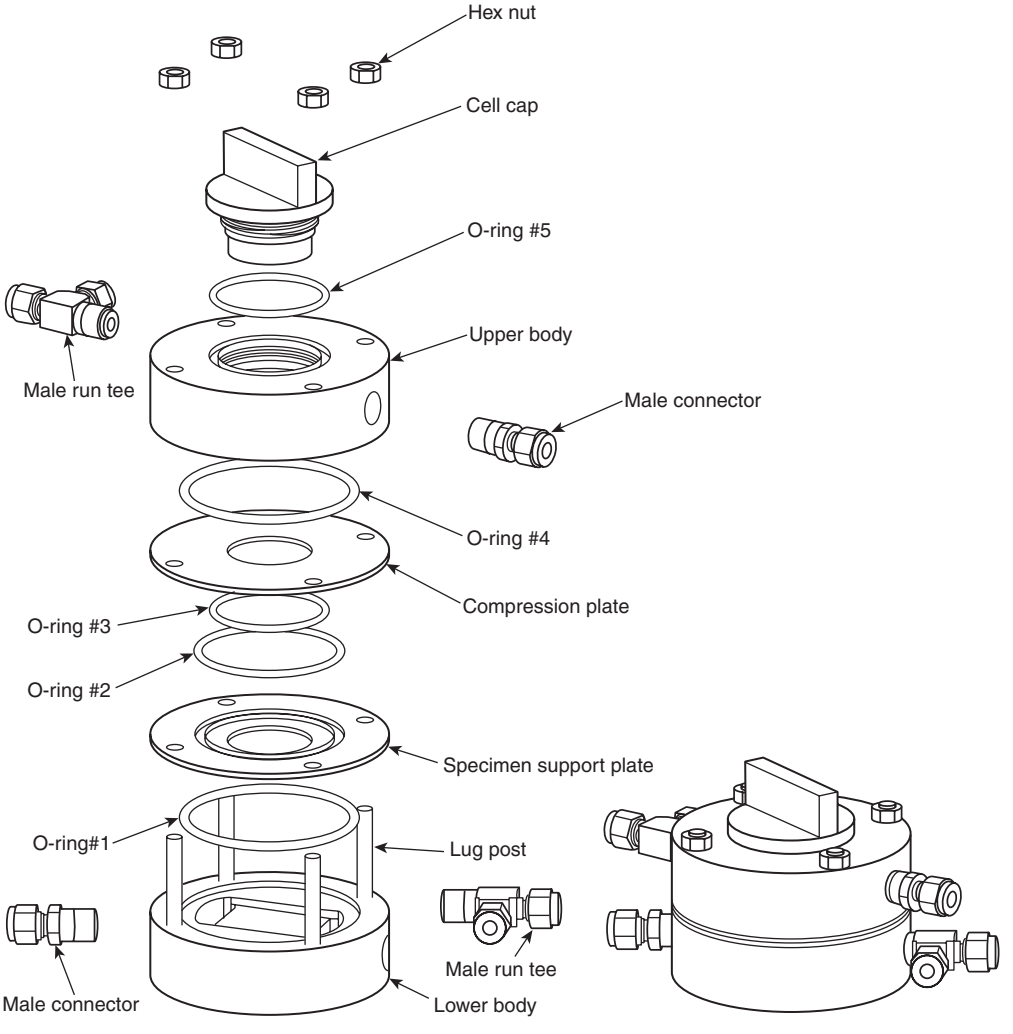


FIGURE 8.41.4.2(a) Diffusion Test Cell Assembly. *(Copyright © 2006, W. L. Gore & Associates, Inc. Used by permission.)*

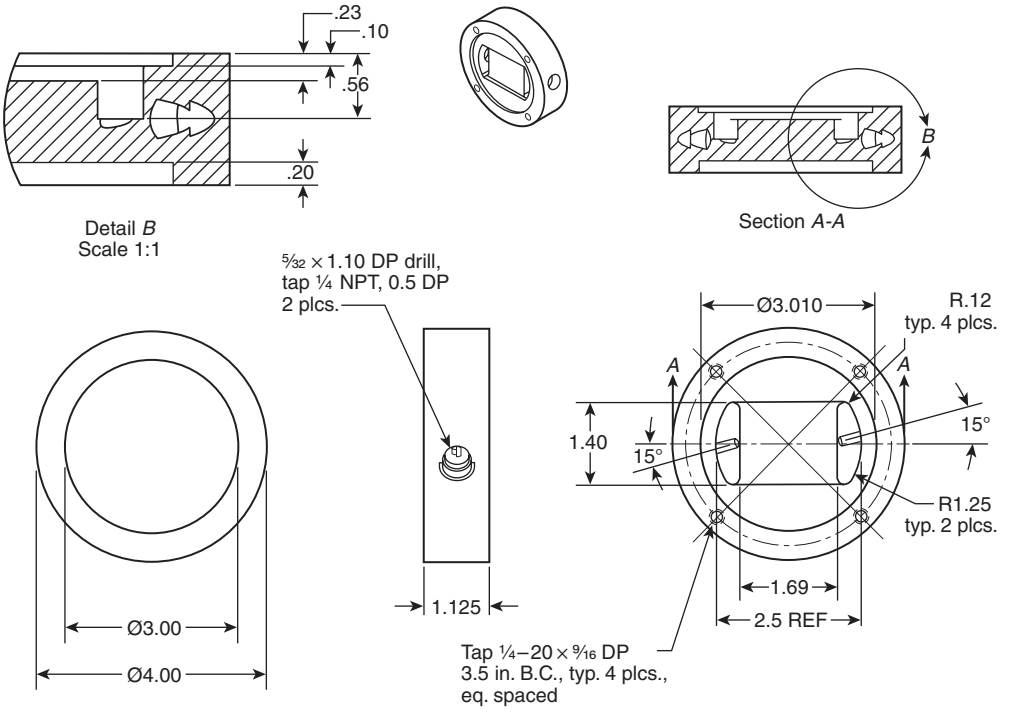


FIGURE 8.41.4.2(b) Lower Body (Collection Side). *(Copyright © 2006, W. L. Gore & Associates, Inc. Used by permission.)*

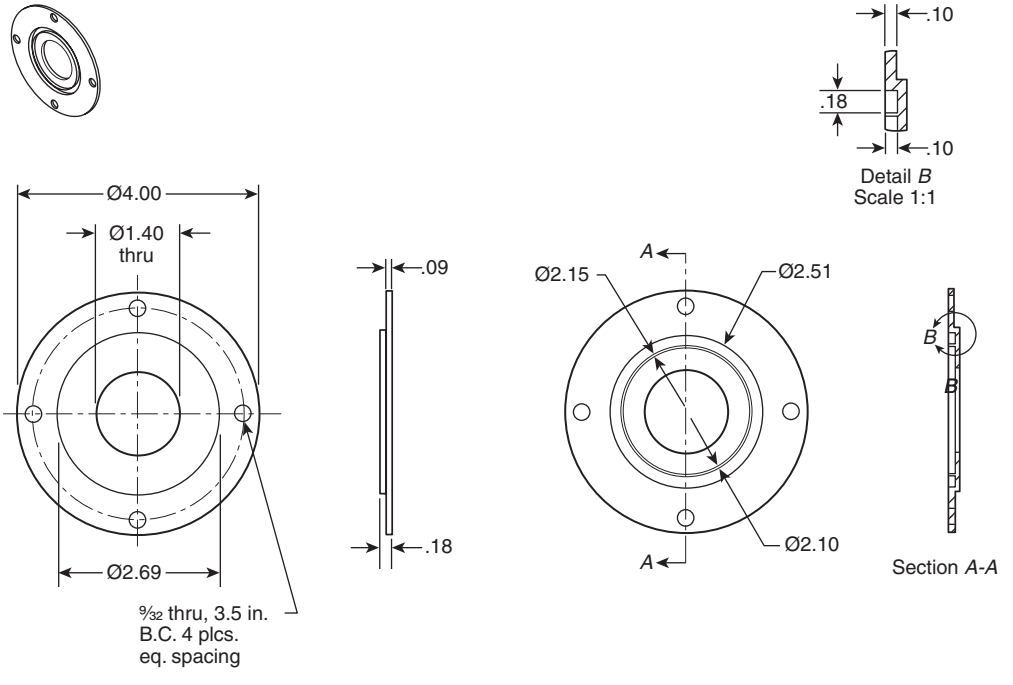


FIGURE 8.41.4.2(c) Sample Support Plate. *(Copyright © 2006, W. L. Gore & Associates, Inc. Used by permission.)*

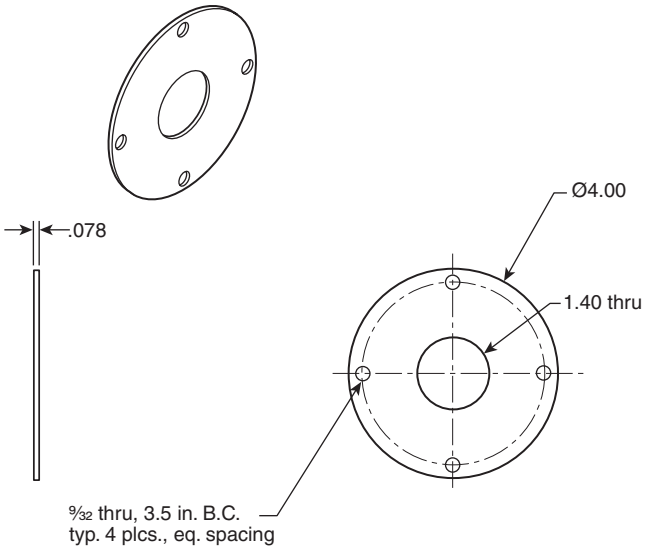


FIGURE 8.41.4.2(d) Compression Plate. *(Copyright © 2006, W. L. Gore & Associates, Inc. Used by permission.)*

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

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

8.41.5 Supplies.

8.41.5.1 Syringe needles, capable of delivering one-microliter droplets, +/−1 percent, of the challenge chemical, shall be used for dispensing liquid challenge chemical onto the surface of the specimen in the test cell.

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

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

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

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

8.41.6 Chemicals.

8.41.6.1 The following challenge chemicals shall be tested as liquids:

(1) Liquid chemical warfare agents
   (a) Sulfur mustard, distilled [HD, or bis (2- chloroethyl) sulfide, CAS 505-60-2]
   (b) Soman [GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-64-0]

(2) Liquid toxic industrial chemical
   (a) Dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1)

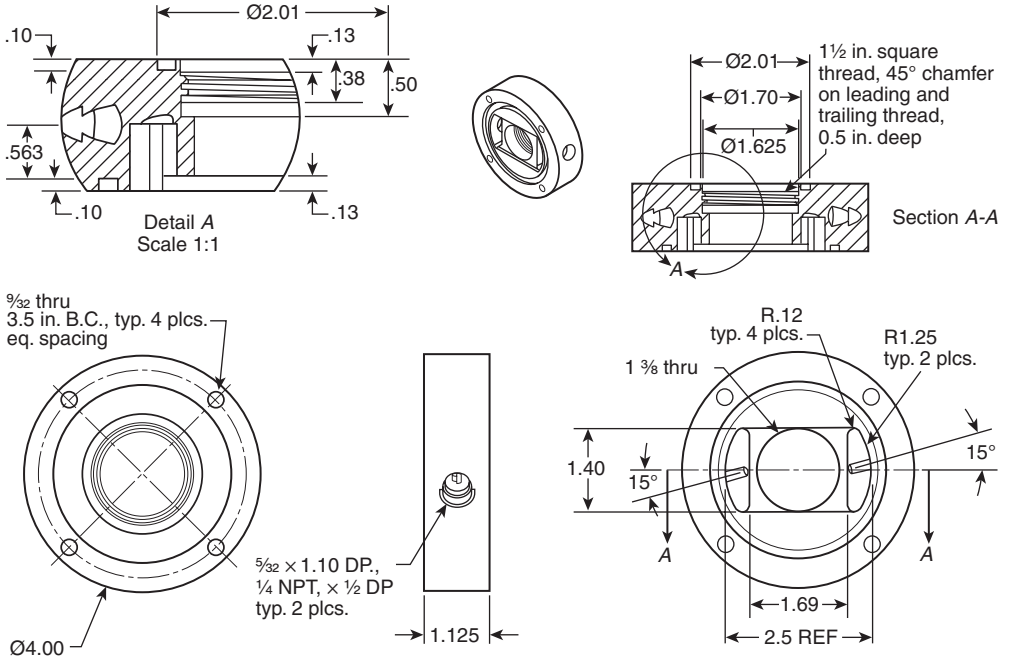


FIGURE 8.41.4.2(e) Upper Body (Challenge Side). *(Copyright © 2006, W. L. Gore & Associates, Inc. Used by permission.)*

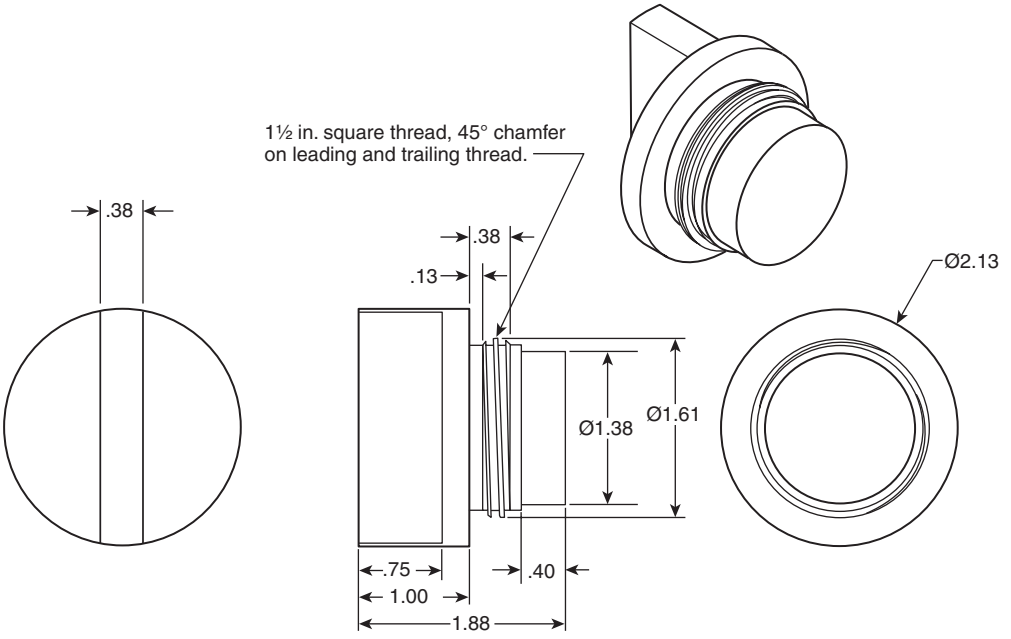


FIGURE 8.41.4.2(f) Top Cap. *(Copyright © 2006, W. L. Gore & Associates, Inc. Used by permission.)*

8.41.6.2 Process for Determining the Mass of Liquid Chemical Challenge Applied.

8.41.6.2.1 Prior to assembling the test cell and conducting the test, the mass of the applied challenge chemical shall be determined using the procedure 8.41.6.2.2 through 8.41.6.2.6.

8.41.6.2.2* The challenge chemical shall be applied to an inert impermeable surrogate specimen in the pattern described in 8.41.7.4.

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

8.41.6.2.4 The inert impermeable surrogate specimen with the applied liquid chemical challenge shall be placed in a closed large vial containing a known volume of solvent compatible with the following analysis procedure:

(1) The large vial with solvent and impermeable surrogate specimen with the applied liquid challenge chemical shall be agitated for at least 1 hour to ensure complete extraction of the challenge chemical.
(2) After agitation, the solvent vial shall be removed and submitted for analysis of the liquid challenge chemical using a procedure capable of detecting 1.0 mg of the liquid challenge chemical.

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

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

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

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

8.41.7 Procedures.

8.41.7.1 Preconditioning.

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

8.41.7.2 Test Cell Assembly.

8.41.7.2.1 The test cell shall be assembled in the environmental chamber at 32°C, +/–1°C (90°F, +/–2°F) and at a relative humidity of 80 percent, +/–5 percent.

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

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

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

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

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

8.41.7.2.7 The upper body (challenge side) of the test cell with O-ring #4 and the compression plate shall be inverted,

aligned with the lug posts, and joined with the lower body (collection side) of the test cell.

8.41.7.2.8 Using the four cell sealing lugs, the cell halves shall be clamped together and 51.8 cm-kg (41 in.-lb) of torque shall be applied to each lug to ensure a proper cell seal.

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

8.41.7.2.10 The integrity of the test cell assembly shall be verified using the procedure in 8.41.7.3.

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

8.41.7.3 Verification of Test Cell Integrity.

8.41.7.3.1 Test cell integrity shall be performed in the environmental chamber at 32°C, +/−1°C (90°F, +/−2°F) and at a relative humidity of 80 percent, +/−5 percent.

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

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

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

8.41.7.3.5 If the test cell pressure drops below 50 mm (2 in.) of water column within 2 minutes, the test cell shall be reassembled according to the steps in 8.41.7.2.

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

8.41.7.4 Determination of Procedure for Applying Liquid Challenge Chemicals.

8.41.7.4.1 The liquid chemical challenge concentration shall be 10 g/m^2 (+1.0 /−0.0 g/m^2).

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

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

8.41.7.4.1.3 When testing any liquid chemical, a quality control trial shall be conducted to verify that the application process delivers 10 g/m^2 (+1.0 /−0.0 g/m^2) using the procedures in 8.41.6.2.

8.41.7.5 Procedure for Liquid Chemical Challenge.

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

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

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

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

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

8.41.7.5.4 With the cell top cap removed, 1 µL droplets shall be placed through the agent challenge port of the test cell on the specimen's outer surface within 20 seconds, according to the procedure determined in 8.41.7.4.

8.41.7.5.5 After placing the liquid challenge chemical on the specimen in the test cell, the cell top cap shall be sealed within 5 seconds. The filtered air at a temperature of 32°C, +/−1°C (90°F, +/−2°F) and at a relative humidity of 80 percent, +/−5 percent, shall be flowed to the challenge side of the test cell at a rate of 0.3 L/min, +/−0.03 L/min, and to the collection sides of the test cell at a rate of 1.0 L/min, +/−0.1 L/min.

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

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

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

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

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

8.41.7.6 Procedure for Gas or Vapor Challenge Chemicals.

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

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

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

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

8.41.7.6.4.1 The supply of the gas or vapor challenge chemical shall be sufficient to maintain the gas or vapor challenge

chemical concentration during the exposure period of 60 minutes, + 1/−0.0 minutes.

8.41.7.6.4.2 The gas or vapor challenge chemical shall be at a temperature of 32°C, +/−1°C (90°F, +/−2°F).

8.41.7.6.4.3 The concentration of the gas or vapor challenge chemical shall be 40 ppm, +10 /−0 ppm.

8.41.7.6.5 The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes, +1/−0 minutes.

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

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

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

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

8.41.7.7 Test Conclusion, Test Cell Cleaning, and Specimen Disposal.

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

8.41.7.7.2 Each cell shall be disassembled one at a time.

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

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

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

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

8.41.8 Report.

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

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

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

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

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

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

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

8.41.10 Specific Requirements for Testing Garment, Hood, and Bootie Materials.

8.41.10.1 Samples for conditioning shall be at least 380 mm (15 in.) square and shall consist of all layers of the composite arranged in the order used in the construction of the garment, hood, or bootie.

8.41.10.2 Composite samples prepared as described in 8.41.10.1 shall be tested after being twice subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.9.
(2) Specimens shall then be conditioned as specified in 8.1.2, following conditioning as specified in 8.1.8.

8.41.10.3 Footwear samples shall be subjected to the following sequence a total of two times prior to permeation testing:

(1) Samples shall first be conditioned as specified in 8.1.8.
(2) Samples shall then be conditioned by flexing 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:
    (a) Water shall not be used.
    (b) The flex speed shall be 60 cycles/min, +/−2 cycles/min.
    (c) Alternative flexing equipment shall be permitted to be used when the flexing equipment meets the following parameters:
        i. Be capable of providing the angle of flex as described in FIA 1209
        ii. Be capable of a flex speed of 60 cycles/min, +/−2 cycles/min
        iii. Provide a means of securing the footwear during flexing

8.41.10.4 Following flexing, samples of the CBRN barrier layer shall be removed from the flexed, trimmed composite sample cut to the dimensions specified in 8.41.10.3 with the long dimension of the sample parallel to the 280 mm (11 in.) dimension.

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

8.41.10.6 The CBRN barrier layer samples prepared as specified as 8.41.10.4 and the other samples retained as specified in 8.41.10.5 shall be subjected to abrasion as specified 8.1.11.

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

8.41.10.8 Use of exterior layers with the CBRN barrier layer specimen shall be permitted. Exterior layer specimens shall be

removed from the composite samples that are conditioned as specified in 8.41.10.2.

8.41.10.9 The specimens shall be oriented in the permeation test cell with the exterior surfaces facing the challenge chemical.

8.41.10.10 Specimens shall be tested for permeation resistance as specified in 8.41.2 through 8.41.9.

8.41.11 Specific Requirements for Testing Garment, Hood, and Bootie Seams.

8.41.11.1 Samples for conditioning shall be at least 380 mm (15 in.) square and shall consist of all layers of the composite arranged in the order used in the construction of the garment, hood, or bootie. The CBRN barrier layer shall be constructed with one or more parallel seams that shall extend across the entire 380 mm (15 in.) width of the specimen. Seams shall be constructed in the CBRN barrier layer no closer than 75 mm (3 in.) to one another. The multilayer composite shall be stitched around the entire periphery.

8.41.11.2 Composite samples prepared as described in 8.41.11.1 shall be tested after being twice subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.9.
(2) Specimens shall then be conditioned as specified in 8.1.2, following conditioning as specified in 8.1.8.

8.41.11.3 The composite sample, including CBRN barrier layer seam, that was conditioned in 8.41.11.2 shall be trimmed to a sample size of 300 mm × 280 mm (12 in. × 11 in.) with the seam parallel to the 300 mm (12 in.) direction. The trimmed composite samples shall be subject to flexing conditioning as specified in 8.1.10 with the 280 mm (11 in.) direction parallel with the compression action of the machine. The trimmed samples shall be mounted such that the outer layer is visible with all layers in their normal "as worn" orientation.

8.41.11.4 Specimens for permeation testing shall be cut from the CBRN barrier layer of the flexed, trimmed sample such that the seam bisects the specimen.

8.41.11.5 Use of exterior layers with the CBRN barrier layer specimen shall be permitted. Exterior layer specimens shall be removed from the composite samples that are conditioned as specified in 8.41.11.2.

8.41.11.6 The specimens shall be oriented in the permeation test cell with the exterior surfaces facing the challenge chemical.

8.41.11.7 Specimens shall be tested for permeation resistance as specified in 8.41.2 through 8.41.9.

8.41.12 Specific Requirements for Testing Glove Materials and Seams.

8.41.12.1 This test shall apply to all types of glove configurations.

8.41.12.2 Samples for conditioning shall be whole gloves.

8.41.12.3 Glove samples shall be subjected to the following sequence a total of two times prior to permeation testing:

(1) Specimens shall first be subjected to the procedure specified in 8.1.9.
(2) Specimens shall then be conditioned as specified in 8.1.2, following conditioning as specified in 8.1.8.

8.41.12.4* Following the conditioning specified in 8.41.12.3, conditioned gloves shall be donned by a test subject and subjected to flexing by the test subject clenching his or her hands into a fist a total of 3000 times over a period not greater than 60 minutes. Test subjects shall be selected so that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference as specified in 6.1.3.4.

8.41.12.5 Following the flexing in 8.41.12.4, specimens for permeation resistance testing shall be taken from the CBRN barrier layer of the flexed glove. Where the CBRN layer includes seams, specimens shall include seams that bisect the specimens.

8.41.12.6 Use of exterior layers with the CBRN barrier layer specimen shall be permitted. Exterior layer specimens shall be removed from the composite samples that are conditioned as specified in 8.41.12.2.

8.41.12.7 Specimens shall be tested for permeation resistance as specified in 8.41.2 through 8.41.9.

8.41.13 Specific Requirements for Testing Footwear Materials.

8.41.13.1 This test shall not apply to footwear configurations that include booties that are subjected to the procedures in 8.41.10 and 8.41.11.

8.41.13.2 Samples for conditioning shall be whole footwear items.

8.41.13.3 Footwear samples shall be subjected to the following sequence a total of two times prior to permeation testing:

(1) Samples shall first be conditioned as specified in 8.1.8.
(2) Samples shall then be conditioned by flexing 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*.

8.41.13.4 Following flexing, samples shall be taken in areas from the footwear upper at the footwear quarter and vamp areas, cut to the dimensions specified in 8.41.10.3.

8.41.13.5 The cut samples shall then be conditioned by abrading as specified in 8.1.11 using silicon carbide, ultrafine, 600 grit sandpaper as the abradant in lieu of other specified layers.

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

8.41.13.7 Specimens shall be tested for permeation resistance as specified in 8.41.2 through 8.41.9.

8.42 Puncture Propagation Tear Resistance Test.

8.42.1 Application. This test shall apply to the CBRN barrier layer.

8.42.2 Sample Preparation.

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

8.42.2.2 Samples shall be conditioned as specified in 8.1.9.

8.42.3 Specimens.

8.42.3.1 Specimens shall be the size specified in ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting*.

8.42.3.2 A minimum of five specimens in each of the warp, machine or course, and filling, cross-machine or wales, directions shall be tested.

8.42.3.3 If the material is isotropic, then 10 specimens shall be tested.

8.42.4 Procedure. Specimens shall be tested in accordance with ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting*.

8.42.5 Report.

8.42.5.1 The puncture propagation tear resistance of each specimen shall be recorded and reported to the nearest 1 N (0.1 lbf).

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

8.42.6 Interpretation.

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

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

8.43 Cold Temperature Performance Test.

8.43.1 Application. This test method shall apply to the CBRN barrier layer.

8.43.2 Sample Preparation.

8.43.2.1 Samples for conditioning shall be at least 50 cm (18 in.) squares of material.

8.43.2.2 Samples shall be conditioned a specified in 8.1.9.

8.43.3 Specimens.

8.43.3.1 Specimens shall be the size specified in ASTM D 747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*.

8.43.3.2 A minimum of five specimens consisting of all layers in each of the warp, machine or course, and filling, cross-machine or wales, directions shall be tested.

8.43.3.3 If the material is isotropic, then 10 specimens shall be tested.

8.43.4 Preparation.

8.43.4.1 Samples for conditioning shall be at least 1 m (1 yd) squares of material.

8.43.4.2 Samples shall be conditioned as specified in 8.1.3.

8.43.5 Procedure. Specimens shall be tested in accordance with ASTM D 747, *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:
Bending moment = [(load scale reading) × (moment weight)] × 100
Bending moment (N) = Bending moment (in.-lbf) × 0.113

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

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

8.44 Abrasion Resistance Test 4.

8.44.1 Application. This test method shall apply to the CBRN barrier layer where configured as an exterior layer in protective footwear.

8.44.2 Sample Preparation.

8.44.2.1 Samples for conditioning shall be at least 50 cm (18 in.) squares of material.

8.44.2.2 Samples shall be conditioned as specified in 8.1.3.

8.44.3 Specimens.

8.44.3.1 Specimens shall be the size specified in ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*.

8.44.3.2 A minimum of five specimens shall be tested.

8.44.4 Procedure. Specimens shall be tested in accordance with ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, with the following modifications:

(1) The H-18 Calibrase wheels shall be used with a 1000 g load.
(2) The abrasion shall be continued until a hole, wear-through, or rupture in the film portion of the material is observed.

8.44.5 Report. The number of cycles required for the formation of a hole, wear-through, or rupture in the film portion of the material shall be recorded and reported.

8.44.6 Interpretation. The number of cycles required for the formation of a hole, wear-through, or rupture in the film portion of the material shall be used to determine pass or fail performance.

8.45 Torque Test.

8.45.1 Application. This test method shall apply to protective gloves.

8.45.2 Samples.

8.45.2.1 Samples for conditioning shall be whole gloves.

8.45.2.2 Sample glove pairs shall be preconditioned as specified in 8.1.2.

8.45.3 Specimens.

8.45.3.1 A minimum of three glove specimens each for size small and size large shall be used for testing.

8.45.3.2 Right-hand specimen gloves shall be used for right-hand dominant test subjects, while left-hand specimen gloves shall be used for left-hand dominant test subjects.

8.45.3.3 Each specimen glove shall be tested in new, as distributed, condition.

8.45.3.4 Specimen gloves shall be tested for each material and construction combination.

8.45.4 Apparatus.

8.45.4.1 Torque testing shall be evaluated with the use of a 1⅝ in. diameter solid acrylic cylinder securely centered on a calibrated digital torque meter capable of measuring up to 10.00 N-m (88.5 lb-in.).

8.45.5 Procedure.

8.45.5.1 Test subjects with the proper hand size shall be selected for testing size small and large gloves.

8.45.5.2 While standing, each test subject shall grasp the cylinder so that the elbow is against the side of the body and the arm bend creates a right angle.

8.45.5.3 For right-hand dominant test subjects, the direction mode on the torque device shall be set to "open" or counterclockwise and set to "close" or clockwise for left-hand dominant test subjects.

8.45.5.4 Each test subject shall make five successive attempts to twist the cylinder in the appropriate direction, exerting as much force as possible. The range of motion of the subject's arm shall indicate the end of the twisting cycle. The average maximum force over the five attempts shall be the barehanded control value.

8.45.5.5 Each test subject shall test a minimum of three sample gloves using the method specified in 8.45.5.2 through 8.45.5.4. Test subjects shall attempt one trial with each glove. A trial shall consist of five successive attempts. The average maximum twisting force over the five attempts shall be the twisting force with the glove. The average twisting force shall be calculated, recorded, and reported for each glove.

8.45.5.6 The average maximum twisting force with gloves over the three trials for each size shall be calculated, recorded, and reported. The average twisting force shall be compared with the barehanded control value.

8.45.5.7 The percentage of barehanded control value shall be calculated as follows: Percentage of barehanded control value =

$$\frac{TF_g}{CV_b} \times 100$$

where:
TF_g = average twisting force with glove
CV_b = barehanded control value

8.45.6 Report. The percentage of barehanded control value shall be recorded and reported for each specimen glove size.

8.45.7 Interpretation.

8.45.7.1 The percentage of barehanded control value for size small and size large shall be used to determine pass or fail performance.

8.45.7.2 Failure of either size shall constitute failure of the test.

8.46 Fastener Tape Strength Tests.

8.46.1 Application. This test shall apply to fastener tape used in the construction of garments.

8.46.2 Samples.

8.46.2.1 Sample size shall be defined as defined in A-A 55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic.*

8.46.2.2 Samples shall be washed for three washings per AATCC 61, *Colorfastness to Laundering, Home and Commercial: Accelerated*, using the laundering conditions established for Test 3A.

8.46.3 Specimens. A minimum of five specimens shall be evaluated.

8.46.4 Procedures.

8.46.4.1 Fastener tape breaking strength shall be measured in accordance with ASTM D 5034, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Grab Method)*, with the following modifications:

(1) Specimens shall be tested in the provided width only in lieu of the specified 100 mm width.
(2) Only specimens parallel to the length of the tape shall be tested.

8.46.4.2 Fastener tape shear strength shall be measured in accordance with ASTM D 5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners.*

8.46.4.3 Fastener tape shear strength shall be measured in accordance with ASTM D 5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners.*

8.46.5 Report. The average breaking strength, shear strength, and peel strength shall be calculated and recorded.

8.46.6 Interpretation. Pass or fail determinations shall be based on the average breaking strength, shear strength, and peel strength specified for Type 2, Class 1 and 4 fastener tapes as established in Table 1 of A-A 55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic.*

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 The majority of performance criteria in this standard are based on the U.S. Fire Administration study, FA 136, "Protective Clothing and Equipment Needs of Emergency Responders for Urban Search and Rescue Missions." That report documented the protective clothing and equipment needs for emergency responders engaged in technical rescue activities. Input was obtained from an emergency responder user requirements committee and resulted in proposed criteria based on a needs and risk analysis. The report contains survey results and test data for a number of materials.

A.1.1.3 Users are cautioned that exposure of ensembles to chemical, biological, and radiological terrorism agents should require disposal, particularly if the effectiveness of decontamination cannot be assessed.

A.1.1.6 Because this standard does not specify or establish requirements for visibility enhancement, the authority having jurisdiction should conduct a risk assessment and determine the level of visibility required in an ensemble for technical rescue incidents based on the anticipated use of such garments.

Where the authority having jurisdiction anticipates the presence of visibility hazards, such as proximity to traffic, moving machinery, or heavy equipment in operation, the author-

ity having jurisdiction should be aware that the appropriate high-visibility clothing specified in ANSI/ISEA 107, *American National Standard for High Visibility Safety Apparel and Headwear*, is the type of garments that should be used.

A.1.1.9 Emergency services organizations are cautioned that accessories are not a part of the certified product but could be attached to the certified product by a means not engineered, manufactured, or authorized by the manufacturer.

Emergency services organizations are cautioned that if the accessory or its means of attachment causes the structural integrity of the certified product to be compromised, the certified product might not comply with the standard for which it was designed, manufactured, and marketed. Additionally, if the accessory or its attachment means are not designed and manufactured from materials suitable for the hazardous environments of emergency incidents, the failure of the accessory or its attachment means could cause injury to the emergency responder.

Because the aftermarket for certified product accessories is so broad, emergency services organizations are advised to contact both the manufacturer of the accessory and the manufacturer of the certified product and verify that the accessory and its means of attachment are suitable for use in the intended emergency response environment. Emergency services organizations should seek and receive written documentation from both the accessory manufacturer and the manufacturer of the certified product to validate the following information:

(1) The accessory for a certified product and its attachment method will not degrade the designed protection or performance of the certified product below the requirements of the product standard to which it was designed, manufactured, tested, and certified.
(2) The accessory, when properly attached to the certified product, should not interfere with the operation or function of the certified product or with the operation or function of any of the certified product's component parts.

Emergency services organizations are also cautioned that if the means of attachment of the accessory fail to safely and securely attach the accessory to the certified product, the accessory can inadvertently dislodge from the certified product, creating a risk to the wearer or other personnel in the vicinity.

A.1.2 This standard is not designed to be utilized as a purchase specification. It is prepared, as far as practicable, with regard to required performance, avoiding restriction of design wherever possible. Purchasers should specify departmental requirements for such items as color, markings, closures, pockets, and visibility markings. Tests specified in this standard should not be deemed as defining or establishing performance levels for protection from all technical rescue environments or in all CBRN terrorism incident environments, where the CBRN terrorism agent protection is applied to ensembles.

A.1.2.1 The authority having jurisdiction should perform a risk assessment to identify the hazards present and to determine the suitability of protective ensembles specified by this standard. For each of the activities described as technical rescue incidents, the authority having jurisdiction should determine if the protection provided by compliant technical rescue protective ensembles meeting this standard is commensurate with the level of protection needed as deemed by the hazards present. For example, in an automobile extrication, the decision for using technical rescue protective ensembles versus structural fire fighting protective ensembles can depend on the level of fire risk at the incident.

A.1.2.2.1 Specific design and performance criteria are established in this standard to demonstrate limited protection against physical and thermal hazards to permit emergency services personnel to provide response and limited rescue.

A.1.2.2.2 Specific design and performance criteria are established in this standard to demonstrate limited protection against physical, thermal, liquid splash, and body fluid–borne pathogen hazards to permit emergency services personnel to provide response, limited rescue, and limited recovery.

A.1.2.2.3 Specific design and performance criteria are established in this standard to demonstrate limited protection against CBRN terrorism agents to permit emergency services personnel to escape and provide limited rescue while escaping the contaminated environment when they encounter terrorism incidents. The criteria are not intended to provide for re-entry of emergency services personnel into the contaminated environment. Radiological and nuclear protection is limited to the hazards associated with radiological particulates. This standard does not establish criteria for protection from ionizing radiation. Moreover, this standard does not establish criteria for protection from all chemical warfare agents, protection from all biological agents, protection from all weapons of mass destruction, or protection from all toxic industrial chemicals.

A.1.2.3 The testing requirements in Chapter 8 of this standard are not intended to establish the limitations of the working environment for technical rescue but are intended to establish material performance.

Users should be advised that if unusual conditions prevail, 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 could be reduced.

Users should be advised that the protective properties in new technical rescue protective ensemble elements, as required by this standard, can diminish as the product is worn and ages.

A.1.3.5 See A.1.1.9.

A.1.3.6 Nothing in this standard is intended to imply that fire service responders cannot engage in urban technical rescue incidents while wearing protective clothing and equipment meeting NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

Organizations responsible for fire-fighting applications should use protective clothing and equipment specifically designed for those activities. Applicable standards include the following:

(1) NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*
(2) NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*

Organizations responsible for hazardous chemical emergencies should use protective clothing and equipment specifically designed for those activities. Applicable standards include the following:

(1) NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*