NFPA 1951

Standard on Protective Ensemble for USAR Operations

2001 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

IMPORTANT NOTICE ABOUT THIS DOCUMENT

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

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

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

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

NOTICES

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

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

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

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

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

NFPA 1951

Standard on

Protective Ensemble for USAR Operations

2001 Edition

This edition of NFPA 1951, *Standard on Protective Ensemble for USAR Operations*, 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 May Association Technical Meeting held May 13–17, 2001, in Anaheim, CA. It was issued by the Standards Council on July 13, 2001, with an effective date of August 2, 2001.

This edition of NFPA 1951 was approved as an American National Standard on August 2, 2001.

Origin and Development of NFPA 1951

The Technical Committee on Special Operations Protective Clothing and Equipment began work on this document 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 to complete the mission.

The Committee developed this new standard, NFPA 1951, *Standard on Protective Ensemble for USAR Operations*, with the goal of establishing personal protection requirements for protective ensembles to reduce the safety risks and health risks associated with exposure to the hazards of technical rescue to personnel during search, rescue, extrication, treatment, recovery, site stabilization, and other mitigation operations at or involving USAR incidents.

The majority of performance criteria in this standard were based on the 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, U.S. Fire Administration, September 1993. This report documents 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.

The jurisdiction of this Committee does not include the respiratory protection that will be necessary for these operations, and the appropriate respiratory protection will need to be addressed by the emergency responder organizations.

Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment (FAE-ACC)

Richard M. Duffy, *Chair*
International Association of Fire Fighters, DC [L]

William M. Lambert, *Secretary*
Mine Safety Appliances Co., Pittsburgh, PA [M]
Rep. Compressed Gas Association

Leslie Anderson, USDA Forest Service, MT [E]
Richard W. Blocker, Jr., The DuPont Company, VA [M]
Dennis W. Browner, Scott Aviation, NC [M]
Rep. Industrial Safety Equipment Association
Nicholas J. Curtis, Lion Apparel, Inc., OH [M]
Robert A. Freese, Globe Manufacturing Co., NH [M]
William L. Grilliot, TFG/Morning Pride Manufacturing, LLC, OH [M]
Rep. Fire and Emergency Manufacturers and Services Association Inc.
William E. Haskell, III, U.S. Army SBCCOM, MA [U]
Virgil Hathaway, San Diego Fire Department, CA [U]
Rep. Southern Area Fire Equipment Research
James S. Johnson, Lawrence Livermore National Labs, CA [RT]
Cy Long, Texas Commission on Fire Protection, TX [E]
David G. Matthews, United Kingdom Fire Brigades Association, England [SE]
Jim Minx, Oklahoma State Firefighters Association, OK [C]
Stephen R. Sanders, Safety Equipment Institute, VA [RT]
Denise N. Statham, Southern Mills, Inc., GA [M]
Jeffrey O. Stull, International Personnel Protection, Inc., TX [SE]
Robert D. Tutterow, Jr., Charlotte Fire Department, NC [U]
Rep. Fire Industry Equipment Research Organization
Bruce H. Varner, City of Carrollton Fire Department, TX [U]
Rep. International Fire Service Training Association
Harry Winer, U.S. Navy, MA [RT]
Thomas L. Wollan, Underwriters Laboratories Inc., NC [RT]

Alternates

Janice C. Bradley, Industrial Safety Equipment Association, VA [M]
(Alt. to D. W. Browner)
Patricia A. Freeman, Globe Manufacturing Co., NH [M]
(Alt. to R. A. Freese)
Patricia A. Gleason, Safety Equipment Institute, VA [RT]
(Alt. to S. R. Sanders)
Mary I. Grilliot, TFG/Morning Pride Manufacturing, LLC, OH [M]
Rep. Fire and Emergency Manufacturers and Services Association, Inc.
(Alt. to W. L. Grilliot)
Tricia Hock, Springfield, LLC, SC [M]
(Alt. to D. N. Statham)
Steven B. Lumry, Oklahoma City Fire Department, OK [C]
Rep. Oklahoma State Firefighters Association
(Alt. to J. Minx)
Bob Montgomery Celanese Corporation, NC [M]
(Alt. to R. W. Blocker, Jr.)
Daniel P. Ryan, Underwriters Laboratories Inc., NC [RT]
(Alt. to T. L. Wollan)
Frank P. Taylor, Lion Apparel, Inc., OH [M]
(Alt. to N. J. Curtis)

Nonvoting

Donna P. Brehm, Virginia Beach Fire Department, VA [U]
Don R. Forrest, United Firefighters of Los Angeles City, CA [L]
Bryan C. Heirston, Oklahoma City Fire Department, OK [L]
Rep. International Association of Fire Fighters
Richard Mangan, USDA Forest Service, MT [RT]
James S. Nee, ARFF Working Group, PA [U]
Rep. Aircraft Rescue & Fire Fighting Working Group
Kirk H. Owen, Plano Fire Department, TX [U]
Rep. NFPA Fire Service Section
Ray F. Reed, Dallas Fire Department, TX [U]

Bruce W. Teele, NFPA Staff Liaison

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

Technical Committee on Special Operations Protective Clothing and Equipment

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

Jeffrey O. Stull, *Secretary*
International Personnel Protection, Inc., TX [SE]

Dean William Cox, Fairfax Fire and Rescue Department, VA [U]
Nicholas J. Curtis, Lion Apparel, Inc., OH [M]
Stephen L. Derynck, Underwriters Laboratories Inc., NC [RT]
James A. Frank, CMC Rescue, Inc., CA [M]
Hamid M. Ghorashi, E. I. DuPont de Nemours and Co., Inc., VA [M]
Daniel Gohlke, W. L. Gore & Associates, MD [M]
Diane B. Hess, Celanese Corporation, NC [M]
Steve Hudson, Pigeon Mountain Industries, Inc., GA [M]
Warren Isham, Nikiski Fire Department, AK [U]
James R. Lawson, National Institute of Standards and Technology, MD [RT]
Colin W. Lunas, Intertek Testing Services, NY [RT]
Kevin S. Malley, New York City Fire Department, NY [U]
Michael L. Martin, Dayton Fire Department Headquarters, OH [C]
H. Dean Paderick, Special Rescue International, VA [SE]
Jack Reall, City of Columbus Fire Division, OH [U]
Stephen R. Sanders, Safety Equipment Institute, VA [RT]
Jeffrey G. Scott, Altamonte Springs Fire/Rescue Department, FL [U]
Kelly Sisson, City of La Mesa Fire Department, CA [U]
Michael T. Stanhope, Southern Mills, Inc., GA [M]
Robert D. Steadman, Westinghouse SRS Fire Department, SC [U]
William F. Sullivan, Chelsea Fire Department, MA [L]
Rep. Chelsea Firefighters Association
Harry Winer, U.S. Navy, MA [RT]

Alternates

William R. Baer, Altamonte Springs Fire/Rescue Department, FL [U]
(Alt. to J. G. Scott)
Loui Clem, Pigeon Mountain Industries, Inc., CO [M]
(Alt. to S. Hudson)
Steven D. Corrado, Underwriters Laboratories Inc., NC [RT]
(Alt. to S. Derynck)
Andy Gbur, Intertek Testing Services, OH [RT]
(Alt. to C. W. Lunas)
Kimberly Henry, Celanese Corporation, NC [M]
(Alt. to D. B. Hess)
Stephen J. King, New York City Fire Department, NY [U]
(Alt. to K. S. Malley)
Denise N. Statham, Southern Mills, Inc., GA [M]
(Alt. to M. T. Stanhope)
Karen E. Strumlock, Lion Apparel, Inc., OH [M]
(Alt. to N. J. Curtis)
Robert Vettori, National Institute of Standards and Technology, MD [RT]
(Alt. to J. R. Lawson)

Bruce W. Teele, NFPA Staff Liaison

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.

These lists represent the membership at the time the Committees were balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

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

Contents

NFPA 1951

Standard on

Protective Ensemble for USAR Operations

2001 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.

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 USAR ensembles and ensemble elements, including garments, helmets, gloves, footwear, and eye and face protection devices designed to provide emergency response personnel limited protection from physical, environmental, thermal, chemical splash, and bloodborne hazards during USAR operations.

1.1.2 This standard shall apply to the design, manufacturing, and certification of new protective ensembles or new individual protective ensemble elements.

1.1.3 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.

1.1.4* This standard shall not apply to protective ensembles for any fire-fighting operations or hazardous materials emergencies. This standard shall not apply to protection from radiological agents, protection from all biological agents, or protection from all hazardous chemicals.

1.1.5 Certification of the USAR ensemble, or ensemble elements of the protective ensemble, to the requirements of this standard shall not preclude certification to additional appropriate standards where the protective ensemble or ensemble elements meet all the applicable requirements of each standard.

1.1.6 The requirements of this standard shall not apply to accessories that could be attached to any element of the USAR ensemble unless specifically addressed herein.

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

1.2* Purpose.

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

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

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

1.3* Units.

1.3.1 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.

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

Chapter 2 Referenced Publications

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

2.1.1 NFPA Publication. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

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

2.1.2 Other Publications.

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

AATCC 22, *Water Repellency: Spray Test*, 1996.

AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test*, 1988.

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

2.1.2.2 ANSI Publications. American National Standards Institute, Inc., 11 West 42nd Street, 13th floor, New York, NY 10036.

ANSI Z41, *Standard for Safety-Toe Footwear*, 1991.

ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection*, 1989.

ANSI Z89.1, *Standard for Industrial Head Protection*, 1997.

2.1.2.3 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117, *Standard Method of Salt Spray (Fog) Testing*, 1985.

ASTM B 152, *Specification for Copper Sheets, Strip Plate, and Rolled Bar*, 1986.

ASTM D 471, *Standard Test Method for Rubber Property — Effect of Liquids*, 1995.

ASTM D 1630, *Standard Test Method for Rubber Property — Abrasion Resistance (Footwear Abrader)*, 2000.

ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, 1990.

ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, 1992.

ASTM D 3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*, 1992.

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 4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics*, 1989.

ASTM D 5034, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Grab Method)*, 1995.

ASTM D 5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*, 1995.

ASTM D 5733, *Test Method for Tearing Strength of Nonwoven Fabrics by the Trapezoidal Procedure*, 1995.

ASTM E 809, *Standard Test Method for Measuring Photometric Characteristics of Retroreflectors*, 1994.

ASTM F 489, *Standard Test Method for Static Coefficient of Friction of Shoe Sole and Heel Materials as Measured by the James Machine*, 1997.

ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 1995.

ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, 1987.

ASTM F 1116, *Standard Test Method for Determining Dielectric Strength of Overshoe Footwear*, 1988.

ASTM F 1342, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture*, 1991.

ASTM F 1359, *Standard Practice for Determining Liquid-Tight Integrity of Chemical Protective Suits or Ensembles under Static Conditions*, 1996.

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*, 1995.

ASTM F 1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, 1997.

ASTM F 1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials using a Sweating Hot Plate*, 1998.

ASTM F 1939, *Test Method for Radiant Protective Performance of Flame Resistant Clothing Materials*, 1999.

2.1.2.4 CSA Publication. Canadian Standards Association, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3, Canada.

CSA Z195 M-92, *Standard for Protective Footwear, Occupational Health and Safety*, 1984.

2.1.2.5 EN Publication. European Standard, BSI, Linford Wood, Milton Keynes MK14 6LE, UK.

EN 471, *Specification for High Visibility Warning Clothing*, 1994.

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

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

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

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

2.1.2.8 ISO Publications. International Standards Organization, 1 rue de Varembé, Case Postale 56 CH-1211, Geneve 20, Switzerland.

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

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

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

2.1.2.9 SAE Publication. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J211, *Instrumentation for Impact Test.*

2.1.2.10 U.S. Department of Defense Publications. Standardization Document Order Desk, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111.

A-A-55126, *Commercial Stem Description, Fastener Tapes, Hook and Pile, Synthetic*, 1998.

A-A-55634, *Commercial Stem Description, Zippers (Fasteners, Slide Interlocking)*, 1998.

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

2.1.2.11 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 29, *Code of Federal Regulations*, Part 1910.132.

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 included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction. The organization, office, or individual responsible 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. This term 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 shall be located in an appendix, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Accessories. An item, or items, that is attached to the certified product that is not necessary to meet the requirements of the standard.

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

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

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

3.3.5 Body Fluids. Fluids 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.

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

3.3.7 Brim Line. A horizontal plane intersecting the point of the front opening of the helmet at the mid-sagittal plane.

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

3.3.9 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 manufacturer to determine compliance with the requirements of this standard.

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

3.3.11 Chin Strap. An adjustable strap, fitting under the chin, to help secure the helmet to the head.

3.3.12 Coat. A protective garment; an element of the protective ensemble designed to provide minimum protection to upper torso and arms, excluding the hands and head.

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

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

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

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

3.3.17 Confined Space Entry. The activity of rescue that takes place in a space which is large enough and so configured that an employee can bodily enter and perform assigned work, that has limited restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, and pits), and is not designed for continuous employee occupancy.

3.3.18 Coverall. A protective garment; an element of the protective ensemble configured as a single-piece garment and designed to provide minimum protection to the torso, arms, and legs, excluding the head, hands, and feet.

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

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

3.3.21 Dielectric Test Plane. A plane that runs diagonally through the headform from the intersection of the test line and mid-sagittal plane in the front of the headform to the intersection of the reference plane and mid-sagittal plane in the rear of the headform.

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

3.3.23 Element(s). The parts or items that comprise the protective ensemble.

3.3.24 Energy Absorbing System. A material, suspension system, or combination thereof incorporated into the design of the helmet to attenuate impact energy.

3.3.25 Ensemble. See USAR Ensemble.

3.3.26 Eye and Face Protection Device. An element of the protective ensemble intended to protect the wearer's eyes and face.

3.3.27 Faceshield. A helmet component intended to help protect a portion of the wearer's face in addition to the eyes, not intended as primary eye protection.

3.3.28 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; flame resistance can be an inherent property of the material, or it can be imparted by specific treatment.

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

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

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

3.3.32 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.

3.3.33 Footwear. An element of the protective ensemble designed to provide minimum protection to the foot, ankle, and lower leg.

3.3.34 Functional Capability. A learned ability involving skills of specialized activities.

3.3.35 Garment. The coat, trouser, or coverall elements of the protective ensemble designed to provide minimum protection to the upper and lower torso, arms, and legs, excluding the head, hands, and feet.

3.3.36 Garment Closure. The garment component designed and configured that allows the wearer to enter (don) and exit (doff) garment.

3.3.37 Garment Closure Assembly. The combination of the garment closure and the seam attaching the garment closure to the garment, excluding any protective flap or cover.

3.3.38 Garment Material. The primary protective material(s) used in the construction of urban technical rescue garments.

3.3.39 Glove. An element of the protective ensemble designed to provide minimum protection to fingers, thumb, hand, and wrist.

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

3.3.41 Glove Gauntlet. The circular, flared, or otherwise expanded part of the glove that extends beyond the opening of the glove body. *(See also Glove Wristlet.)*

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

3.3.43 Glove Wristlet. The circular, close-fitting part of the glove usually made of knitted material, that extends beyond the opening of the glove body. *(See also Glove Gauntlet and Wristlet.)*

3.3.44 Goggles. A helmet component intended to help protect the wearer's eyes and a portion of the wearer's face, not intended as primary eye protection.

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

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

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

3.3.48 Helmet. An element of the protective ensemble designed to provide minimum protection to the head.

3.3.49 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.

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

3.3.51 Insole. The inner part of the protective footwear upon which the foot rests and that conforms to the bottom of the foot.

3.3.52 Interface Area. An area of the body where the protective garments, helmet, gloves, footwear, or SCBA facepiece meet (i.e., the protective coat/helmet/ SCBA facepiece area, protective coat/protective trouser area, the protective coat/glove area, and the protective trouser/footwear area).

3.3.53 Interface Component(s). Any integral material, part, or subassembly of the compliant product which is designed to provide limited protection to interface areas.

3.3.54 Ladder Shank. See Shank.

3.3.55 Liquidborne Pathogen. An infectious bacteria or virus carried in human, animal, or clinical body fluids, organs, or tissues.

3.3.56 Lower Torso. The area of body below the waist including the legs but excluding the ankles and feet.

3.3.57 Major A Seams. See Seam.

3.3.58 Major B Seams. See Seam.

3.3.59 Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for turning the raw materials or components into a "certified product for use."

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

3.3.61 Mid-Sagittal 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.

3.3.62 Minor Seams. See Seam.

3.3.63 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.

3.3.64 Outer Shell. The outermost layer of the composite with the exception of trim, hardware, reinforcing material, and wristlet material.

3.3.65 Package. The wrapping or enclosure directly containing the emergency medical glove or face protection device.

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

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

3.3.68 Protective Clothing. See Protective Ensemble.

3.3.69 Protective Coat. See Coat.

3.3.70 Protective Coverall. See Coverall.

3.3.71 Protective Ensemble. See USAR Ensemble.

3.3.72 Protective Footwear. See Footwear.

3.3.73 Protective Garment. See Garment.

3.3.74 Protective Glove. See Gloves.

3.3.75 Protective Helmet. See Helmet.

3.3.76 Protective Trouser. See Trouser.

3.3.77 Protective Wristlet. See Wristlet.

3.3.78 Puncture-Resistant Device. A reinforcement to the bottom of protective footwear that is designed to provide puncture resistance and is located between the sole (with heel) and the insole.

3.3.79 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.

3.3.80 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.

3.3.81 Recovery Operations. Those nonemergency activities directed at retrieving property or the remains of victims.

3.3.82 Reference Plane. A headform term for the plane that is 60 mm, ± 1 mm above and parallel to the basic plane.

3.3.83 Rescue Operations. 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.

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

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

3.3.86 Retroreflective Markings. A material that reflects and returns a relatively high proportion of light in a direction close to the direction from which it came.

3.3.87 Safety Glasses. An eye and face protection device intended to help protect the wearer's eyes.

3.3.88 Sample. An amount of the material, product, or assembly to be tested that is representative of the item as a whole. *(See also Specimen.)*

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

3.3.89.1 Major A Seams. Outer shell layer seam assemblies where rupture could reduce the protection of the garment by exposing the inner layers such as the moisture barrier, the thermal barrier, the wearer's station/work uniform, other clothing, or skin.

3.3.89.2 Major B Seams. Moisture barrier or thermal barrier 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.

3.3.89.3 Minor Seams. Remaining seam assemblies that are not classified as Major A or Major B seams.

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

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

3.3.92 Shank. Reinforcement to the area of footwear that is designed to provide additional support to the instep.

3.3.93 Shell. See Outer Shell.

3.3.94 Site Stabilization. Those activities directed at mitigating the dangerous elements of an emergency incident.

3.3.95 Specimen. The conditioned element, item, component, or opposite that is tested. Specimens are taken from samples. *(See also Sample.)*

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

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

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

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

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

3.3.101 Top. A helmet term for the intersection between the mid-sagittal plane and the bitragion-coronal arc extended to the helmet surface.

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

3.3.103 Trench/Excavation Functional Capability. The activity of removing a victim from a man-made cut, cavity, or depression in an earth surface, formed by earth removal.

3.3.104 Trim. Retroreflective and fluorescent material for visibility enhancement; retroreflective materials enhance nighttime visibility, and fluorescent materials enhance daytime visibility.

3.3.105 Trouser. A protective garment; an element of the protective ensemble that is designed to provide minimum protection to the lower torso and legs, excluding the ankles and feet.

3.3.106 Upper. That part of the protective footwear including but not limited to the toe, vamp, quarter, shaft, collar, and throat, but not including the sole with heel, puncture-resistant device, and insole.

3.3.107 Upper Torso. The area of body above the waist and extending to the shoulder, including the arms and wrists but excluding the hands.

3.3.108 USAR Device. See Eye and Face Protection Device.

3.3.109 USAR Ensemble. The combination or assembly of multiple elements that are individually compliant with the USAR requirements of this standard and that are designed to provide limited protection from the physical, environmental, thermal, chemical flash fire, chemical splash, and bloodborne hazards encountered during USAR operations.

3.3.110 USAR Footwear. See Footwear.

3.3.111 USAR Garment. See Garment.

3.3.112 USAR Gloves. See Gloves.

3.3.113 USAR Helmet. See Helmet.

3.3.114 USAR Operations. Those technical incidents requiring at least one of the following: structural collapse functional capability, rope functional capability, confined space functional

capability, trench/excavation functional capability, and vehicle/machinery functional capability, but not wilderness functional capability or water functional capability.

3.3.115 Vehicle/Machinery Functional Capability. The activity of removing a victim from a vehicle or machine at an emergency incident.

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

3.3.117 Winter Liner. An optional component layer designed to provide added insulation against cold.

3.3.118 Wristlet. The tubular, close-fitting extension of the garment sleeve, usually made of knitted material, designed to provide limited protection to the coat/glove interface area.

Chapter 4 Certification

4.1 General.

4.1.1 All 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. Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard, NFPA 1951, in any statements about their respective products unless the product is certified to this standard.

4.1.2 All certification shall be performed by an approved certification organization that meets at least the requirements specified in Section 4.2, and that is accredited for personal protective equipment in accordance with ISO Guide 65, *General requirements for bodies operating product certification systems.*

4.1.3 All compliant ensembles and ensemble elements shall be labeled and listed. All compliant ensembles and ensemble elements shall also have a product label. The product label shall meet the applicable requirements in Section 5.1.

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

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

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

4.2.3* 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. There shall be no conditional, temporary, or partial certifications. Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not manufactured in compliance with all applicable requirements of this standard.

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

4.2.5 The certification organization shall require the manufacturer to establish and maintain a program of production inspection and testing that at least meets the requirements of Section 4.5 or Section 4.6. The certification organization shall audit the manufacturer's quality assurance program to ensure the quality assurance program provides continued product compliance with this standard.

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

4.2.7* The certification organization shall have a follow-up inspection program of the manufacturing facilities of the certified product, with at least two random and unannounced visits per 12-month period. As part of the follow-up inspection program, the certification organization shall select sample product at random from the manufacturer's production line, from the manufacturer's in-house stock, or from the open market. Sample product shall be inspected and tested by the certification organization to verify the product's continued compliance.

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

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

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

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

4.3 Inspection and Testing.

4.3.1 For both certification and recertification of ensembles, ensemble elements, and components, 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 the certification organization or a facility accredited by the certification organization for inspections, evaluations, conditioning, and testing in accordance with all requirements pertaining to testing laboratories in ISO Guide 17025, *General requirements for the competence of calibration and testing laboratories.*

4.3.3 All inspections, evaluations, conditioning, or testing conducted by a product manufacturer shall not be used in the certification or recertification process unless the facility for inspections, evaluations, conditioning, or testing has been accredited by the certification organization in accordance with all requirements pertaining to testing laboratories in ISO

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

4.3.4 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to assure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified to this standard are compliant unless such samples levels are specified herein. This information shall be provided to the purchaser upon request.

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 specific element in Section 5.1.

4.3.6 Inspection by the certification organization shall include a review of any graphic representations used on product labels, as permitted by 5.1.5 to ensure that the systems are consistent with the worded statements, readily understood, and clearly communicate the intended message.

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 conducted by the certification organization in accordance with the testing requirements of Chapter 8, for determining product compliance with the applicable requirements specified in Chapter 7 of this standard, shall be performed on samples representative of materials and components used in the actual construction of the ensemble or ensemble elements. The certification organization shall also be permitted to use sample materials cut from a representative product.

4.3.10 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 products as being compliant with this standard.

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. 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. The certification organization shall accept, from the manufacturer for evaluation and testing for certification, only product or product components that are the same in every respect to the actual final product or product component. The certification organization shall not allow the substitution, repair, or modification, other than as specifically permitted herein, of any product or any product component during testing.

4.3.12 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 Recertification.

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) When 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 4.2.7 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 Manufacturer's Quality Assurance Program.

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

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

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

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

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

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

4.5.7 The manufacturer shall establish and maintain a system for controlling nonconforming material, including procedures for the identification, segregation, and disposition of rejected material. All nonconforming materials or products shall be identified to prevent use, shipment, and intermingling with conforming materials or products.

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

4.6* ISO Registration for Manufacturers.

4.6.1 The manufacturer shall provide and operate a quality assurance program that meets the requirements of this section and that includes a product recall system as specified in 4.2.9.

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

4.6.3 The ISO registration requirements shall have an effective date of 1 March 2003.

4.6.4 Until 1 March 2003, or until the date the manufacturer becomes ISO registered, whichever date occurs first, the manufacturer shall comply with Section 4.5.

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 comprising the product label shall be located adjacent to each other.

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

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

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

5.1.6 The following statement shall be printed legibly on the product label. The appropriate term for the element type (garment, helmet, glove, footwear, eye/face protection) shall be inserted in this compliance statement text where indicated. All letters shall be at least 2.5 mm (3⁄32 in.) in height.

"THIS USAR [*insert appropriate element term here*]
MEETS THE [*insert appropriate element term here*]
REQUIREMENTS OF NFPA 1951, STANDARD ON
PROTECTIVE ENSEMBLE FOR USAR OPERATIONS,
2001 EDITION.

DO NOT REMOVE THIS LABEL."

5.1.7 The following information shall also be printed legibly on the product label. All letters shall be at least 1.6 mm (1⁄16 in.) high.

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

5.1.8 Supplementary Product Labels.

5.1.8.1 Where the garment's outer shell and linings can be separated from each other, each separable layer shall have a supplementary product label permanently attached.

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 USAR Garments. For USAR garment labels, additional blank space at least 38 mm (1½ in.) high by the full width of the label shall be provided for the organization's use.

5.1.10 Specific Requirements for Eye and Face Protective Devices.

5.1.10.1 For eye and face protection devices only, the product label shall be permitted to be placed on the package.

5.1.10.2 The package containing the smallest number of eye and face protective device 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 eye and face protective devices 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 eye and face protective device. All letters and numbers shall be at least 3.0 mm (1⁄8 in.) high.

"MEETS NFPA 1951 (2001 ED.)"

5.2 User Information.

5.2.1 The manufacturer shall provide user information including, but not limited to, warnings, information, and instructions with each garment 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 NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and 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

Chapter 6 Design Requirements

6.1 USAR Garment Element Design Requirements.

6.1.1 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 and Testing.

6.1.2 USAR garments shall be permitted to be single-layer or multiple-layer garments.

6.1.3 All garment collars shall remain upright after extension into a vertical position.

6.1.4 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 while wearing a technical rescue glove.

6.1.5 USAR garments shall have a means for securing the liquid barrier to the outer shell.

6.1.6 Patch pockets and upper torso inserted pockets shall have cover flaps with a closure system.

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

6.1.8 All garment hardware finish shall be free of rough spots, burrs, or sharp edges.

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

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

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

6.1.12 Cargo pockets, where provided, shall have a means to drain water and shall have a means of fastening in the closed position.

6.1.13 All upper torso garments shall have closures systems at the neckline.

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

6.1.15 Any metallic closure systems shall not come in direct contact with the body.

6.1.16 Any metal components of the garments shall not come in direct contact with the body.

6.1.17 Garment knees and elbows shall be reinforced with an additional layer of material.

6.1.18 Garment trim shall be not less than 50 mm (2 in.) wide and shall have both retroreflective and fluorescent surfaces.

6.1.18.1 The retroreflective surface of trim shall be not less than 16 mm (⅝ in.) wide.

6.1.18.2 Trim shall have a minimum fluorescent surface of 50 mm^2/linear mm (2 $in.^2$ /linear in.) of trim.

6.1.18.3 The fluorescent and retroreflective areas of trim shall appear to be continuous for the length of the trim, with gaps between areas of retroreflectivity of not more than 3 mm (⅛ in.).

6.1.18.4 Trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figure 6.1.18.6 and Figure 6.1.18.7 shall be permitted to not meet the minimum fluorescent surface of 50 mm^2/linear mm (2 $in.^2$/linear in.) of trim.

6.1.18.5 Trim used in excess of that required by the optional minimum trim pattern requirements specified and illustrated in Figure 6.1.18.6 and Figure 6.1.18.7 shall be permitted to be obscured by components including, but not limited to, pockets, storm flaps, and reinforcing patches as long as the minimum trim pattern is not obscured.

6.1.18.6 The trim configuration for the upper torso garment shall be in accordance with Figure 6.1.18.6. The minimum trim pattern for the upper torso garment shall consist of one circumferential band of trim or a staggered 360-degree visibility pattern meeting or exceeding the surface areas of a continuous circumferential band around the bottom of the upper torso garment. The lower edge of the circumferential band on the lower part of the upper torso garment shall be within 25 mm (1 in.) of the coat hem's highest point. No vertical strips of trim shall be permitted on the front of the upper torso garment. The back of the coat shall also have a minimum of either two vertical strips of trim, perpendicular to the bottom band with one strip located on both the left and right sides of the back of the upper torso garment, or a minimum of one horizontal band of trim at the chest/shoulder blade level. The minimum trim configuration for each sleeve shall be one circumferential band, or a staggered 360-degree visibility pattern meeting or exceeding the surface area of a continuous circumferential band, between the wrist and elbow area. Where trim on the upper torso garment intersects a zipper, a maximum gap in the trim of 25 mm (1 in.) shall be permitted.

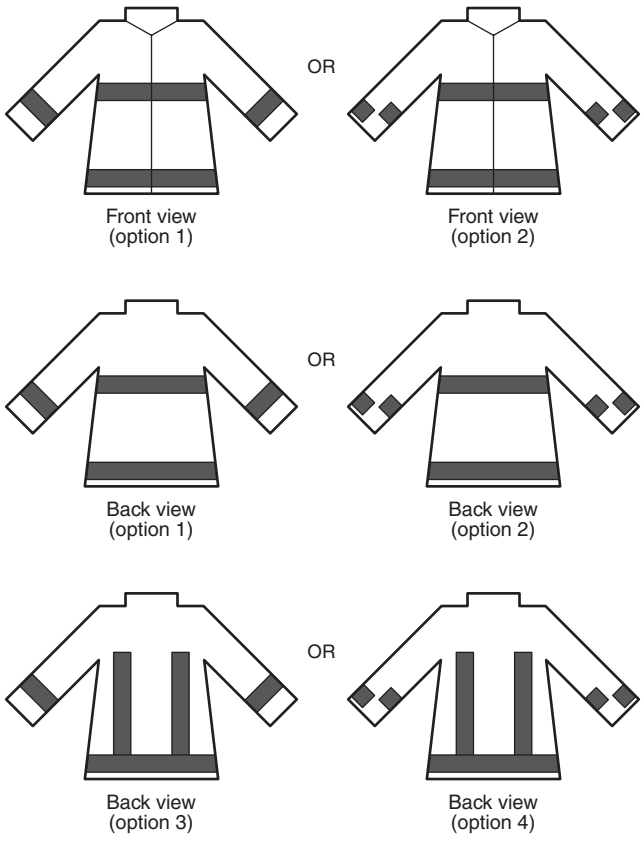

FIGURE 6.1.18.6 Minimum required coat trim patterns.

6.1.18.7 The trim configuration for the lower torso garments shall be in accordance with Figure 6.1.18.7. The minimum trim pattern for the lower torso garments shall consist of one circumferential band of trim around each leg at the bottom hem area.

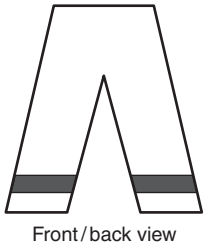

FIGURE 6.1.18.7 Minimum required trouser trim patterns.

6.1.19* Garment Sizing.

6.1.19.1 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.

6.1.19.2 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.

6.1.19.3 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.

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

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

6.2 USAR Helmet Element Design Requirements.

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

6.2.3 Helmets shall be of either the hat type or the cap type. Hat-type helmets shall have a full brim. Cap-type helmets shall have no brim, but shall be permitted to include a peak.

6.2.4 Helmets of both types shall be designed to consist of a shell and a means of absorbing energy within the shell. Provisions shall be made for ventilation between the headband and the shell.

6.2.5 The helmet shell shall be generally dome shaped. The area under the peak or the front of the brim shall be permitted to be covered with a nonconducting, nonflammable, antiglare material.

6.2.6 There shall be no openings penetrating the shell other than those provided by the manufacturer for mounting energy absorbing systems, retention systems, and accessories.

6.2.7 Suspension shall contain a nape device and shall be removable and replaceable. Suspension shall be adjustable in at least 3 mm (⅛ in.) hat size increments. The size range that can be accommodated shall be marked on a product label. When the suspension is adjusted to the maximum designated size, there shall be sufficient clearance between the shell and the headband to provide ventilation.

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

6.2.9 Crown straps shall be provided and, when assembled, they 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.

6.2.10 Chin straps shall be provided and shall be attached to the helmet shell. Nape straps shall also be permitted. Both chin and nape straps shall not be less than 13 mm (½ in.) in width.

6.2.11 Helmets shall have retroreflective markings on the exterior of the shell. A minimum of 2580-mm^2 (4-in.^{2}) retroreflective markings shall be visible when the helmet is viewed from either side or rear.

6.2.12 Accessories shall be permitted to be mounted through the use of openings in the shell, when provided, and shall be designed with an inner wall that shall extend below the electrical test line as determined in Section 8.22, Electrical Insulation Test One.

6.2.13 The openings in helmet shells provided for mounting of accessories shall be permitted to be filled by gasketing or other means provided the helmet will continue to meet the requirements specified in Section 8.5, Heat and Thermal Resistance Shrinkage Test.

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

6.2.15 Helmets shall meet the requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Head Protection.*

6.3 USAR Glove Element Design Requirements.

6.3.1 Sample 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.

6.3.2 The sample glove shall consist of a composite meeting the performance requirements of Section 7.3, USAR Glove Element Requirements Performance. The composite shall be permitted to be configured as a continuous or joined single layer or continuous or joined multiple layers. If the glove is made up of multiple layers, all layers of the glove shall be individually graded per size.

6.3.3 Sample gloves shall be designed with a cut- and puncture-resistant palm area to minimize the effects of flame, heat, sharp or abrasive objects, hand tool operation, and other hazards that are encountered during technical rescue incidents. Sample gloves shall have a wristlet that allows the glove material to fit closely around the wearer's wrist.

6.3.4 The sample glove body shall extend circumferentially not less than 25 mm (1 in.) beyond the wrist crease where measured from the tip of the finger. The location of the wrist crease shall be determined as shown in Figure 6.3.4.

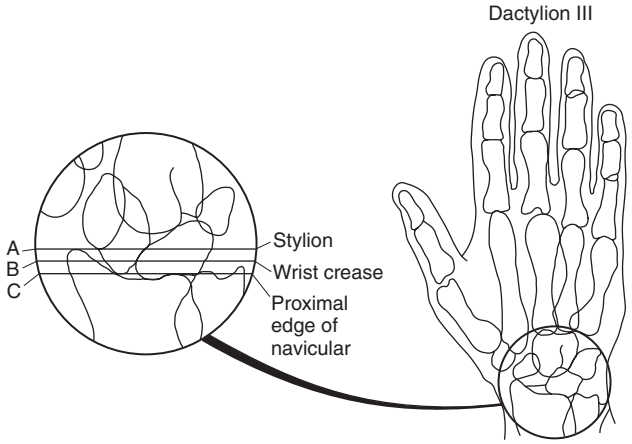

FIGURE 6.3.4 Anatomical landmarks at base of hand.

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

6.4 USAR Footwear Element Design Requirements.

6.4.1 Sample 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.

6.4.2 The sample footwear shall consist of a composite meeting the performance requirements of Section 7.4, USAR Footwear Element Performance Requirements. 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.

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

6.4.4 Footwear height shall be a minimum of 200 mm (8 in.). The height shall be determined by measuring inside the boot from the center of the insole at the heel up to a perpendicular reference line extending across the width of the boot at the lowest point of the top line. Removable insole inserts shall be removed prior to measurement.

6.4.5 Footwear heel breast shall not be less than 13 mm (½ in.) nor more than 25 mm (1 in.). The heel breasting angle shall not be less than 90 degrees nor more than 135 degrees. The edges shall not be less than or extend more than 13 mm (½ in.) laterally from the upper at any point.

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

6.4.7 Footwear shall have a toe cap not less than 50 mm (2 in.) from the front edge of the footwear.

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

6.4.9 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.

6.4.10 When used, there shall be a minimum of four metal stud hooks on each side of the eyebrow.

6.4.11 Eyelets, if used, shall be constructed of coated steel, solid brass, brass-coated nickel, or nickel.

6.4.12 Protective Footwear Sizing.

6.4.12.1 Footwear shall be available in all the following sizes:

(1) *Mens.* 5–13, including half sizes, and a minimum of three widths
(2) *Womens.* 5–10, including half sizes, and a minimum of three widths

6.4.12.2 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 Bannock Scientific Foot Measuring Device.

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

6.5 USAR Eye and Face Device Element Design Requirements.

6.5.1 Eye and face protective devices shall meet ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection*, requirements.

6.5.2 Eye and face protective devices shall be permitted to be attached to the helmet or be separate.

Chapter 7 Performance Requirements

7.1 USAR Garment Element Performance Requirements.

7.1.1 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 of not less than or equal to 450 W/m^2.

7.1.2 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 23 N (5 lbf).

7.1.3 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 320 N (70 lbf).

7.1.4 Outer shell fabric shall be tested for abrasion resistance as specified in Section 8.9, Abrasion Resistance Test One, and shall have an ending breaking strength of not less than 230 N (50 lbf).

7.1.5 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 5.0 percent in direction.

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

7.1.6.1 Garment seam assemblies shall demonstrate a sewn 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.

7.1.6.2 All combination woven and knit or stretch knit seam assemblies shall meet the requirements as specified in 7.1.6.1.

7.1.7 Textile fabrics, linings, collar linings, trim, lettering, and other materials used in garment construction, including, but not limited to, padding, reinforcement, interfacing, binding, hanger loops, emblems, and patches shall be individually tested for flame resistance as specified in Section 8.4, Flame Resistance Test One, and shall not have a char length of more than 100 mm (4 in.), shall not have an afterflame of more than 2.0 seconds, and shall not melt or drip.

7.1.7.1 Labels shall meet the performance requirement specified in 7.1.7 only where placed on the exterior of the garment.

7.1.7.2 Zippers and seam-sealing materials shall meet the performance requirements specified in 7.1.7 only where located on the exterior of the garment or located where they will directly contact the wearer's body.

7.1.7.3 Elastic and hook and pile fasteners shall meet the performance requirements specified in 7.1.7 only where located where they will directly contact the wearer's body.

7.1.7.4 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 8.4.1.3 of Section 8.4, Flame Resistance Test One, and shall not have an afterflame of more than 2.0 seconds, and shall not melt or drip.

7.1.8 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.

7.1.9 Textile fabrics, linings, hardware, and other materials used in garment construction including, but not limited to, padding, reinforcements, wristlets, collars, garment labels, hanger hooks, buttons, fasteners, and closures, but excluding hook and pile fasteners when 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. In addition, garment outer shells shall not char. Hardware items shall remain functional.

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

7.1.11 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.16, Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show no more than light surface-type corrosion or oxidation. Ferrous metals shall show no corrosion of the base metal. Hardware items shall remain functional.

7.1.12 Garment composite shall be tested for radiant protective performance as specified in Section 8.2, Radiant Protective Performance Test, and shall have an average radiant protective performance (RPP) of 8.0 or greater.

7.1.13 Garment composite shall be tested for water repellency as specified in Section 8.13, Water Repellency Test, and shall have a spray rating of 80 or greater.

7.1.14 Garment composite and seams shall be tested for liquid penetration resistance as specified in Section 8.17, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.1.15 Garment composite and seams shall be tested for biopenetration resistance as specified in Section 8.18, Viral Penetration Resistance Test, and shall show no viral penetration.

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

7.1.17 Reflective trim used on garments shall be tested for retroreflectivity and fluorescence as specified in Section 8.15, Trim High Visibility Test, and shall have a total Coefficient of Retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2) and be designated as fluorescent.

7.1.18 Specimens of all garment product labels shall be tested for legibility as specified in Section 8.43, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.2 USAR Helmet Element Performance Requirements.

7.2.1 Helmets shall be tested for flame resistance as specified in Section 8.19, Flame Resistance Test Two, and shall not have afterflame with a duration greater than 5.0 seconds.

7.2.2 Any antiglare material, when used, shall be tested for flame resistance as specified in Section 8.19, Flame Resistance Test Two, and shall not have afterflame with a duration greater than 5.0 seconds.

7.2.3 Helmets shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not have any deformation of the brim or peak exceed 25 percent of the length of the brim or peak, and shall have hardware items remain functional.

7.2.4 Helmets shall be tested for top impact resistance as specified by Section 8.20, Top Impact Resistance Test (Force), and shall not transmit an average force of more than 3783 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf).

7.2.5 Helmets shall be tested for physical penetration resistance as specified in Section 8.21, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration striker and the headform.

7.2.6 Helmets shall be tested for electrical insulation as specified in Section 8.22, Electrical Insulation Test One, and shall not have electrical leakage current exceeding 3 milliamperes.

7.2.7 Helmets shall be tested for suspension system separation as specified in Section 8.23, 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 2.3 kg (5 lb).

7.2.8 Helmets shall be tested for retention system and chin strap efficiency as specified in Section 8.24, Retention System Test, and shall not show any failure.

7.2.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.16, Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show not more than light surface-type corrosion or oxidation. Ferrous metals shall show no corrosion of the base metal. Hardware items shall remain functional.

7.2.10 Reflective trim used on helmets shall be tested for retroreflectivity and fluorescence as specified in Section 8.15, Trim High Visibility Test, and shall have a total Coefficient of Retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2) and be designated as fluorescent.

7.3 USAR Glove Element Performance Requirements.

7.3.1 Glove composites shall be tested for resistance to cut as specified in Section 8.27, Cut Resistance Test, and shall have a cut distance of blade travel not less than 25 mm (1 in.).

7.3.2 Glove composites shall be tested for puncture resistance as specified in Section 8.28, Puncture Resistance Test One, and shall not puncture under an applied force of 45 N (10 lbf).

7.3.3 Glove composites shall be tested for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test Two, and shall show no wear through.

7.3.4 Gloves shall be tested for hand function as specified in Section 8.29, Glove Hand Function Test, and shall not have an average percent of barehand control exceeding 200 percent.

7.3.5 Gloves shall be tested for grip as specified in Section 8.30, Grip Test, and shall have a weight-pulling capacity not less than 80 percent of the barehand control values.

7.3.6 Gloves shall be tested for ease of donning as specified in Section 8.31, Liner Retention Test, and shall not have a final donning time exceed the baseline donning time plus 20.0 seconds.

7.3.7 Gloves shall be individually tested for flame resistance as specified in Section 8.25, Flame Resistance Test Three, and shall have an average char length of not more than 100 mm (4 in.), an average afterflame of not more than 2.0 seconds, and shall not melt or drip.

7.3.8 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. The glove shall be measured in both length and width and shall not shrink more than 10 percent in either direction. The glove shall be measured from the tip of the middle finger to the bottom of the glove body and the width shall be from side to side. Where the glove is made with a wristlet of a different material, the wristlet shall be measured separately.

7.3.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.16, Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show not more than light surface-type corrosion or oxidation. Ferrous metals shall show no corrosion of the base metal. Hardware shall remain functional.

7.3.10 Glove composites, excluding any optional removable liners, shall be tested for radiant protective performance as specified in Section 8.2, Radiant Protective Performance Test, and shall not have an average radiant protective performance (RPP) of less than 7.0.

7.3.11 Glove composites shall be tested for conductive heat resistance as specified in Section 8.26, 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.

7.3.12 Glove composites and seams shall be tested for liquid penetration resistance as specified in Section 8.17, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.3.13 Glove composites and seams shall be tested for biopenetration resistance as specified in Section 8.18, Viral Penetration Resistance Test, and shall show no viral penetration.

7.3.14 Gloves shall be tested for overall watertight integrity as specified in Section 8.32, Overall Liquid Integrity Test Two, and shall show no water penetration.

7.4 USAR Footwear Element Performance Requirements.

7.4.1 Footwear upper shall be tested for abrasion resistance as specified in Section 8.11, Abrasion Resistance Test Two, and shall show no wear through.

7.4.2 Footwear upper shall be tested for resistance as specified in Section 8.27, Cut Resistance Test, and shall have a cut distance of blade travel not less than 25 mm (1 in.).

7.4.3 Footwear upper shall be tested for puncture resistance as specified in Section 8.28, Puncture Resistance Test One, and shall not puncture under an applied force of 45 N (10 lbf).

7.4.4 Footwear toes shall be tested for resistance to impact and compression as specified in Section 8.34, Impact and Compression Resistance Test, and shall have an impact requirement of 101.7 J (75 ft-lb), and shall have a compression requirement of 11,121 N (2500 lbf) with a minimum clearance of 13 mm (½ in.).

7.4.5 Footwear ladder shanks shall be tested for resistance to bending as specified in Section 8.35, Ladder Shank Bend Resistance Test, and shall not defect more than 6 mm (¼ in.).

7.4.6 Footwear sole and heel shall be tested for abrasion resistance as specified in Section 8.36, Abrasion Resistance Test Three, and shall not have an abrasion index of less than 65.

7.4.7 Footwear sole and heel shall be tested for penetration (physical) resistance as specified in Section 8.37, Puncture Resistance Test Two, and shall not have a puncture force of less than 1210 N (272 lbf).

7.4.8 Footwear outersole shall be tested for flex fatigue resistance as specified in Section 8.38, Flex Fatigue Test, and shall not exceed 350 percent cut growth.

7.4.9 Footwear outersole shall be tested for slip resistance as specified in Section 8.39, Slip Resistance Test, and shall have a static coefficient friction of 0.75 or greater under dry conditions.

7.4.10 Footwear shall be tested for electrical conduction as specified in Section 8.40, Electrical Insulation Test Two, and shall not have any electrical leakage exceed 3 milliamperes.

7.4.11 Eyelets and stud hooks shall be tested for detachment strength as specified in Section 8.41, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 300 N (66 lbf).

7.4.12 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.16, Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show not more than light surface-type corrosion or oxidation. Ferrous metals shall show no corrosion of the base metal. Hardware items shall remain functional.

7.4.13 Footwear shall be individually tested for flame resistance as specified in Section 8.33, Flame Resistance Test Four, and shall not have a char length of more than 100 mm (4 in.), shall not have an afterflame of more than 2.0 seconds, and shall not melt or drip.

7.4.14 Footwear shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not have any part of the footwear melt, other than the laces, and shall have all hardware remain functional.

7.4.15 Footwear upper shall be tested for radiant protective performance as specified in Section 8.2, Radiant Protective Performance Test, and shall not have an average radiant protective performance (RPP) of less than 8.0.

7.4.16 Footwear upper shall be tested for conductive heat resistance as specified in Section 8.26, 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.

7.4.17 Footwear upper material composite, upper seams, and vamp seams shall be tested for liquid penetration resistance as specified in Section 8.17, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.4.18 Footwear upper material composite, upper seams, and vamp seams shall be tested for biopenetration resistance as specified in Section 8.18, Viral Penetration Resistance Test, and shall show no viral penetration.

7.4.19 Footwear shall be tested for overall watertight integrity as specified in Section 8.42, Overall Integrity Test Three, and shall show no water penetration.

7.5 USAR Eye and Face Element Performance Requirements.

7.5.1 Eye and face protective elements shall be tested for flame resistance as specified in Section 8.19, Flame Resistance Test Two, and shall not show any visible afterflame 5.0 seconds after removal of the test flame.

7.5.2 Eye and face protective elements shall be tested for heat resistance as specified in Section 8.5, Heat and Thermal Shrinkage Resistance Test, and shall not drip.

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 Eye and Face Protective Devices. 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 Garments and Gloves. 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. Sample helmets shall be conditioned by exposing them to a temperature of −32°C, ±1°C (−25°F, ±2°F) for at least 4 hours, but not more than 24 hours.

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 tested within 10 minutes after removal from water.

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.

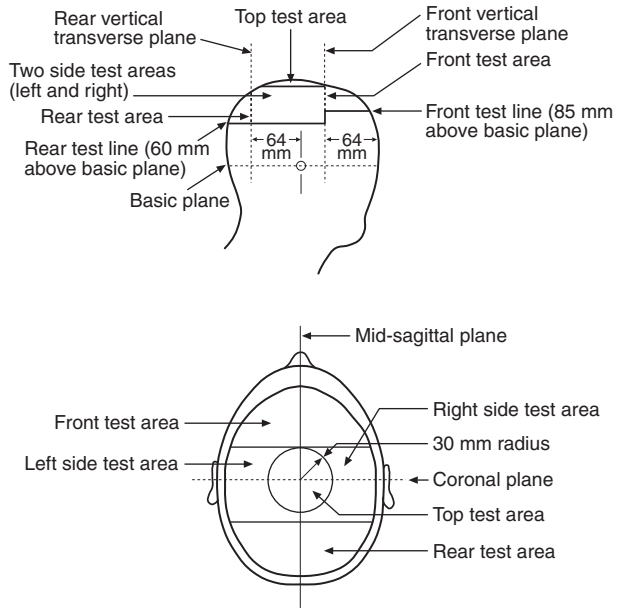

FIGURE 8.1.6.1 Helmet test areas and landmarks.

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 before testing.

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 (0.00004 in. to 0.0004 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., ±¼ in.) square. The spectral radiant emittance curve of the radiant panel shall be that of a blackbody at a temperature between 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 Sheets, 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 is a Type J thermocouple that shall be used in conjunction with appropriate instrumentation to monitor the heat exposure to which the helmet is to be subjected.

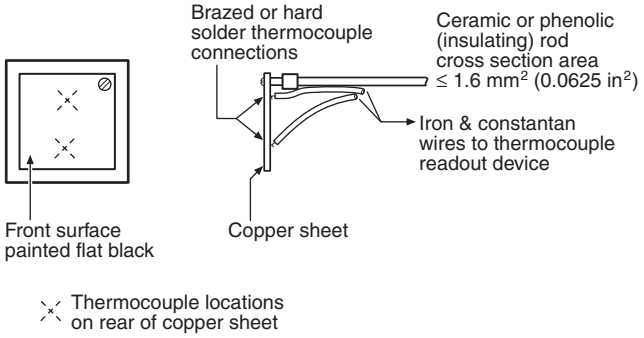

FIGURE 8.1.6.5 Radiant heat transducer.

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 above 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 260°C (500°F) shall be recorded. That time shall be 2.5 minutes, ±15.0 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 Gloves. Specimens shall be conditioned by complete immersion in water at a temperature of 21°C, ±3°C (70°F, ±5°F) for 2 minutes. Specimens shall be removed from water, hung in a vertical position for 5 minutes, laid horizontal with AATCC textile blotting paper both under and over the specimen, under a weight of 3.5 kPa, ±0.35 kPa (0.50 psi, ±0.05 psi) for a period of 20 minutes in accordance with paragraph 7.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test.*

8.1.8 Convective Heat Conditioning for Labels and Trim. 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.

8.2 Radiant Protective Performance Test.

8.2.1 Application.

8.2.1.1 This test method shall apply to protective garment composites, glove composites, and footwear upper materials.

8.2.1.2 Modifications to this test method for testing garment composites shall be as specified in 8.2.8.

8.2.1.3 Modifications to this test method for testing glove composites 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 Specimens. Radiant protective performance testing shall be conducted on three specimens. Specimens shall measure 75 mm × 250 mm, ±6 mm (3 in. × 10 in., ±¼ in.) with the long dimension in the warp or wale direction and shall consist of all layers representative of the clothing item to be tested.

8.2.3 Sample Preparation. Specimens shall be tested after preconditioning as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

8.2.4 Apparatus. The test apparatus specified in ASTM F 1939, *Test Method for Radiant Protective Performance of Flame Resistant Clothing Materials,* shall be used at an exposure heat flux of 21 kW/m^2 (0.5 cal/cm^{2}s).

8.2.5 Procedure. Radiant protective performance testing shall be performed in accordance with ASTM F 1939, *Test Method for Radiant Protective Performance of Flame Resistant Clothing Materials.*

8.2.6 Report.

8.2.6.1 The individual test RPP rating of each specimen shall be reported. The average RPP rating shall be calculated and reported.

8.2.6.2 Where a RPP rating is greater than 60, then the RPP rating shall be reported as ">60."

8.2.7 Interpretation.

8.2.7.1 Pass/fail determinations shall be separately based on the average reported RPP rating of all specimens.

8.2.7.2 If 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.

8.2.8 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.

8.2.9 Specific Requirements for Testing Glove Composites.

8.2.9.1 Specimens shall consist of the composite used in the actual glove construction, with the layers arranged in proper order. Specimens shall not include seams where multiple layers are involved. Specimens shall not be stitched to hold individual layers together.

8.2.9.2 Samples for conditioning shall include glove material that is a minimum of 75 mm × 250 mm, ±6 mm (3 in. × 10 in., ±¼ in.) with the long dimension in the warp or wale direction, consisting of the composite used in the actual glove construction, with the layers arranged in proper order and stitched using the same thread used in the construction of the glove.

8.2.9.3 Testing shall be performed as described 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 the footwear upper used in the actual footwear construction, with the layers arranged in proper order. Specimens shall not include seams where multiple layers are involved. Specimens shall not be stitched to hold individual layers together.

8.2.10.2 Samples for conditioning shall include footwear upper material that is a minimum of 75 mm × 250 mm, ±6 mm (3 in. × 10 in., ±¼ in.) with the long dimension in the warp or wale direction, consisting of the material used in the actual footwear construction, with the layers arranged in proper order and stitched using the same thread used in the construction of the footwear upper.

8.2.10.3 Testing shall be performed as described in 8.2.2 through 8.2.7.

8.3 Overall Liquid Integrity Test One.

8.3.1 Application. This test method shall apply to complete garments.

8.3.2 Specimens.

8.3.2.1 A minimum of three specimens shall be tested. Specimens shall consist of the entire suit with all layers assembled that are required for the garment to be compliant.

8.3.2.2 The size of the suit comprising the specimens shall be chosen to conform with the dimensions of the mannequin for proper fit of the specimen on the mannequin in accordance with the manufacturer's sizing system. The size of the suits comprising the specimens shall be the same size of the mannequin in terms of chest circumference, waist circumference, and in seam height.

8.3.3 Sample Preparation.

8.3.3.1 Specimens shall be tested after preconditioning as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

8.3.3.2 Samples for conditioning shall be complete garments.

8.3.4 Apparatus. The apparatus and supplies for testing shall be those specified in ASTM F 1359, *Standard Practice for Determining Liquid-Tight Integrity of Chemical Protective Suits or Ensembles under Static Conditions,* using the following modifications:

(1) The surface tension of the water used in testing shall be 32 dynes/cm, ±2 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 Practice for Determining Liquid-Tight Integrity of Chemical Protective Suits or Ensembles under Static Conditions,* with the following modifications:

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

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

8.4 Flame Resistance Test One.

8.4.1 Application.

8.4.1.1 This test method shall apply to protective garment textiles, hoods, and trim materials.

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 trim materials shall be as specified in 8.4.11.

8.4.1.6 Modifications to this test method for testing lettering that is transfer film shall be as specified in 8.4.12.

8.4.1.7 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 8.4.13.

8.4.2 Samples.

8.4.2.1 Samples 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, or the filling direction, cross machine or wales, of the material.

8.4.2.2 Each individual layer of multilayer material systems or composites shall be separately tested.

8.4.3 Specimens Preparation.

8.4.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.3.

8.4.3.2 All specimens to be tested shall be conditioned as specified in 8.1.2.

8.4.4 Apparatus. The test apparatus specified in Method 5903.1, "Flame Resistance of Cloth; Vertical," of Federal Test Method Standard 191A, *Textile Test Methods,* shall be used.

8.4.5 Procedure.

8.4.5.1 Flame resistance testing shall be performed in accordance with Method 5903.1, "Flame Resistance of Cloth; Vertical," of Federal Test Method Standard 191A, *Textile Test Methods.*

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. The average afterflame time and char length for each material shall be calculated and reported. The afterflame time shall be reported to the nearest 0.2 second, and the char length to the nearest 3 mm (⅛ in.).

8.4.6.2 Observations of melting or dripping for each specimen shall be reported.

8.4.7 Interpretation.

8.4.7.1 Pass/fail performance shall be based on any observed melting or dripping, the average afterflame time, and 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. No two warp specimens shall contain

the same warp yarns, and no two filling specimens shall contain the same filling yarns.

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 two 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 Trim Materials.

8.4.11.1 Five trim specimens for flammability testing shall be at least 50 mm (2 in.) wide and no more than 75 mm (3 in.) wide. When trim material specimens are not wide enough to fit into the test frame, a narrower test frame of sufficient width to accommodate the available trim width shall be constructed. The cut edge of the trim specimen shall be oriented such that it is exposed directly to the burner flame.

8.4.11.2 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.

8.4.11.3 Testing shall be performed as described in 8.4.2 through 8.4.7.

8.4.12 Specific Requirements for Testing Lettering Transfer Film.

8.4.12.1 Lettering that is transfer film shall be applied to outer shell material meeting the requirements of this standard for testing as specified in 8.4.12.2.

8.4.12.2 Letter specimens for flammability testing shall be at least 50 mm (2 in.) wide and no more than 75 mm (3 in.) in width. Samples shall be selected where lettering is most dense.

8.4.12.3 Samples for conditioning shall be outer shell material 1 m (1 yd) square.

8.4.12.4 Testing shall be performed as described in 8.4.2 through 8.4.7, other than char length shall not be measured.

8.4.13 Specific Requirements for Testing Small Materials.

8.4.13.1 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.

8.4.13.2 Samples for conditioning shall be 1 m (1 yd) square of the textile layer on which the small specimens are attached.

8.4.13.3 Testing shall be performed as described in 8.4.2 through 8.4.7, other than char length 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; trim; protective helmets, protective gloves, protective footwear, and eye and face protective devices.

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 garment, trim, 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 eye and face protective devices shall be as specified in 8.5.14.

8.5.2 Specimens.

8.5.2.1 Only heat resistance testing shall be conducted on a minimum of three specimens for each hardware item, label material, helmet, footwear, eye and face device, and other protective garment materials not listed in 8.5.2.2.

8.5.2.2 Both heat and thermal shrinkage resistance testing shall be conducted on a minimum of three specimens for each garment textile, and on whole gloves. Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

8.5.3 Sample Preparation.

8.5.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.3.

8.5.3.2 Specimens to be tested shall be conditioned as specified in 8.1.2.

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 the specimens can be suspended and be at least 50 mm (2 in.) from any interior oven surface or other specimens.

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 air flow 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 air 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 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/fail. Knit fabric shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement to determine pass/fail.

8.5.6 Report.

8.5.6.1 Observations of ignition, melting, dripping, or separation shall be reported for each specimen.

8.5.6.2 The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be reported as the average of all three specimens in each dimension.

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/fail performance. Failure in any one dimension 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, Trim, 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.), other than 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 one yard 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 Hardware shall not be conditioned.

8.5.10.4 Observations of hardware condition following heat exposure shall be limited to ignition.

8.5.10.5 Hardware shall be evaluated for functionality within 10 minutes following removal from the oven.

8.5.10.6 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.11 Specific Testing Requirements for Helmets.

8.5.11.1 Helmet specimens shall include complete helmets with accessories.

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 mounted in accordance with the helmet positioning index 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 After 5 minutes, +15/–0 seconds, the sample helmet mounted on the headform shall be removed from the test oven and 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/fail.

8.5.11.8 Hardware shall be evaluated to determine functionality.

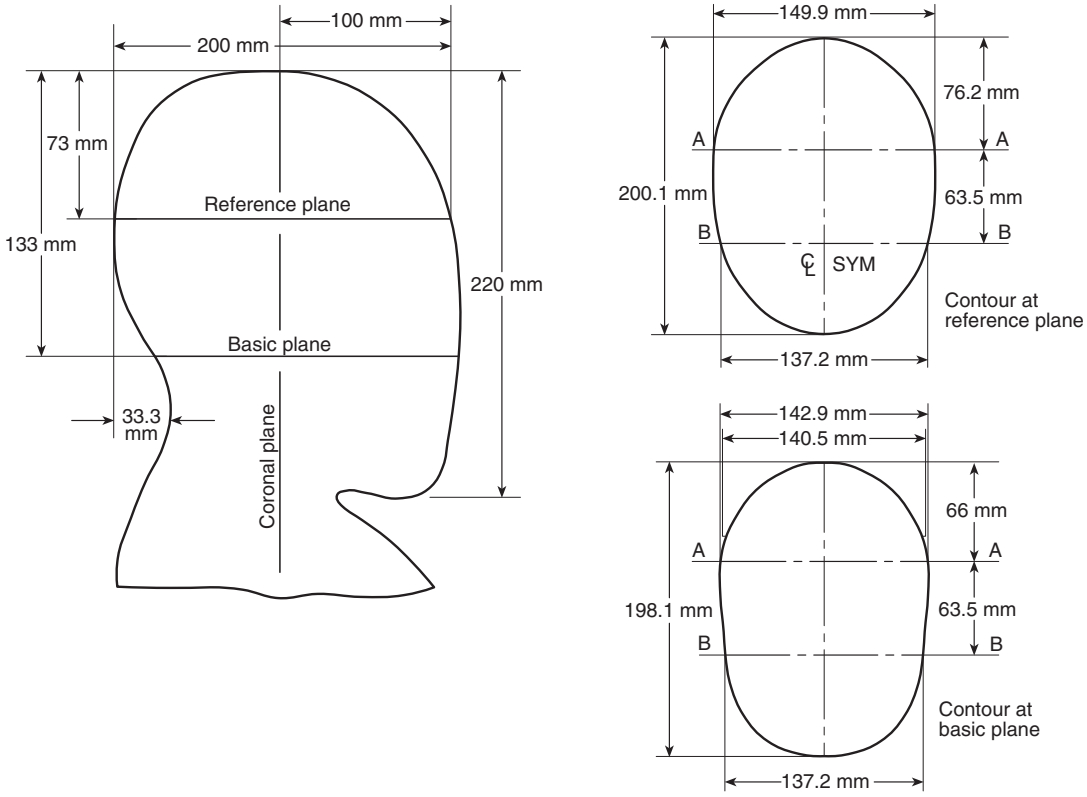

FIGURE 8.5.11.4 Thermal headform.

8.5.11.9 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.12 Specific Requirements for Testing Gloves.

8.5.12.1 Specimens shall include complete gloves with labels.

8.5.12.2 The glove body shall be filled with dry vermiculite, with care taken to tightly pack the vermiculite into the fingers of the glove and glove body. The opening of the glove shall be clamped together, and 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 The glove specimen shall also be measured to determine pass/fail. The length measurement of the glove specimen shall be from the tip of the middle finger to the end of the glove body on the palm side. The width measurement of the glove specimen shall be the width measurement on the palm side 25 mm (1 in.) below the base of the fingers.

8.5.12.4 The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be reported as the average of all three specimens in each dimension.

8.5.12.5 Testing shall be performed as described in 8.5.2 through 8.5.7.

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.

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 Footwear specimens shall include sole, heel, and upper. Footwear specimens shall be filled with dry vermiculite. Any closures shall be fastened.

8.5.13.5 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 air flow enters the test chamber.

8.5.13.6 The specimen shall be placed in the center of the test oven with the centerline of the front of the specimen facing the air flow.

8.5.13.7 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 2 minutes.

8.5.13.8 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.5.13.9 Each tested specimen shall be reconditioned as specified in 8.1.2 and then shall be reexamined inside and outside for separation and functionality.

8.5.14 Specific Testing Requirements for Eye and Face Protective Devices.

8.5.14.1 Only the conditioning specified in 8.1.2 shall be required prior to testing.

8.5.14.2 Where provided, eye and face protective device specimens shall include straps or headbands and attachment devices.

8.5.14.3 Sample 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 helmet facing the air flow.

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 air flow enters the test chamber.

8.5.14.5 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.

8.5.14.6 Testing shall be performed as described in 8.5.2 through 8.5.7. Thermal shrinkage shall not be measured.

8.6 Total Heat Loss Test.

8.6.1 Application. This test method shall apply to the protective garment composites.

8.6.2 Specimens. Total heat loss testing shall be conducted on at least three specimens. Specimens shall consist of all layers in the protective garment composite arranged in the order and orientation as worn.

8.6.3 Sample Preparation.

8.6.3.1 Specimens to be tested shall be conditioned as specified in 8.1.2.

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

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.

8.6.6 Report.

8.6.6.1 The average intrinsic thermal resistance (R_{cf}) of the sample shall be reported.

8.6.6.2 The average apparent intrinsic evaporative resistance (AR_{ef}) of the sample shall be reported.

8.6.6.3 The average total heat loss (Q_t) of the sample shall be determined and reported.

8.6.7 Interpretation. Pass/fail determination shall be based on the average reported total heat loss measurement of all specimens 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 including any supplemental liners shall be individually tested.

8.7.2 Specimens.

8.7.2.1 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.

8.7.2.2 If the material is nonanisotropic, then 10 specimens shall be tested.

8.7.3 Sample Preparation.

8.7.3.1 Specimens shall be tested after preconditioning as specified in 8.1.3 followed by the conditioning specified in 8.1.2.

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

8.7.4 Procedure. Specimens shall be tested in accordance with ASTM D 5733, *Test Method for Tearing Strength of Nonwoven Fabrics by the Trapezoidal Procedure.*

8.7.5 Report.

8.7.5.1 The tear resistance of each specimen shall be reported to the nearest 0.2 N (0.1 lbf).

8.7.5.2 An average tear resistance shall be calculated for warp and filling directions.

8.7.6 Interpretation.

8.7.6.1 Pass/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 constitutes 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 Specimens.

8.8.2.1 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.

8.8.2.2 If the material is nonanisotropic, then 10 specimens shall be tested.

8.8.3 Sample Preparation.

8.8.3.1 Specimens shall be tested after preconditioning as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

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

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 reported to the nearest 0.2 N (0.1 lb) of force.

8.8.5.2 An average breaking strength shall be calculated for warp and filling directions.

8.8.6 Interpretation.

8.8.6.1 Pass/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 One.

8.9.1 Application. This test shall apply to garment outer shell materials.

8.9.2 Specimens.

8.9.2.1 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.

8.9.2.2 Where the material is nonanisotropic, 10 specimens shall be tested.

8.9.3 Sample Preparation.

8.9.3.1 Specimens shall be conditioned as specified in 8.1.3.

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

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 reported to the nearest 0.2 N (0.1 lbf).

8.9.5.2 An average breaking strength after abrasion shall be calculated for warp and filling directions.

8.9.6 Interpretation.

8.9.6.1 Pass/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 constitutes 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 Specimens. Cleaning shrinkage resistance testing shall be conducted on three specimens of each material, and each material shall be tested separately.

8.10.3 Sample Preparation. Specimens to be tested shall be conditioned as specified in 8.1.2.

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.*

8.10.4.4 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.

8.10.5 Report. The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be reported as the average of all three specimens in each dimension.

8.10.6 Interpretation. The average percent change in both dimensions shall be used to determine pass/fail performance. Failure in any one dimension constitutes 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.

8.11 Abrasion Resistance Test Two.

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 Specimens. A minimum of five specimens shall be tested.

8.11.3 Sample Preparation. Specimens shall be conditioned as specified in 8.1.2.

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 Calibrase H-18 wheel using 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 showing wear through shall constitute failure of this test.

8.11.7 Requirements for Testing Glove Composites.

8.11.7.1 Specimens shall be taken from the palm area of the gloves and shall not include seams.

8.11.7.2 Samples for conditioning shall be full gloves.

8.11.8 Requirements for Testing Footwear Upper Materials.

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

8.11.8.2 Samples for conditioning shall be complete footwear items.

8.12 Seam Breaking Strength Test.

8.12.1 Application. This test method shall apply to seam assemblies for garments.

8.12.2 Specimens.

8.12.2.1 A minimum of five seam specimens representative of the garment shall be tested for each seam type.

8.12.2.2 A straight seam shall be cut from the finished garment or shall be permitted to be prepared by joining 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 Sample Preparation.

8.12.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.12.3.2 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.

8.12.4 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 reported. The average seam breaking strength for each seam type shall also be reported.

8.12.5.2 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/fail performance.

8.13 Water Repellency Test.

8.13.1 Application. This test shall apply to garment outer shell materials.

8.13.2 Specimens. A minimum of three specimens shall be tested. Specimens shall consist of three 180-mm (7-in.) squares of the outermost, separable layer of the garment composite.

8.13.3 Sample Preparation. Specimens to be tested shall be conditioned as specified in 8.1.3.

8.13.4 Procedure.

8.13.4.1 Liquid penetration resistance testing shall be conducted in accordance with AATCC 22, *Water Repellency: Spray Test.*

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

8.13.5 Report. The spray rating for each specimen shall be reported.

8.13.6 Interpretation. The lowest spray rating for the material shall be used to determine pass/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 protective garments.

8.14.2 Specimens. A total of three different determinations shall be made.

8.14.3 Sample Preparation.

8.14.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.14.3.2 Samples for conditioning shall be 150 mm (6 in.) or greater lengths of thread.

8.14.4 Procedure. Specimens shall be tested to a temperature of 260°C (500°F) in accordance with Method 1534, "Melting Point of Synthetic Fibers," of Federal Test Method Standard 191A, *Textile Test Methods.*

8.14.5 Report. The pass/fail results for each specimen tested shall be reported.

8.14.6 Interpretation. One or more thread specimens failing this test shall constitute failing performance for the thread type.

8.15 Trim High Visibility Test.

8.15.1 Application.

8.15.1.1 This test method shall apply to trim materials used on protective garments and helmets.

8.15.1.2 Trim materials shall be tested for each procedure specified in 8.15.4.

8.15.2 Specimens.

8.15.2.1 A minimum of three trim test specimens shall be tested.

8.15.2.2 Each trim test specimen shall be 100 mm × 100 mm (4 in. × 4 in.) of the finished trim product.

8.15.3 Sample Preparation.

8.15.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.15.3.2 Samples for the conditioning specified in 8.15.4.5 shall be a minimum of 305 mm (12 in.) long sections of trim.

8.15.4 Procedures.

8.15.4.1 Measurement of Coefficient of Retroreflection.

8.15.4.1.1 The Coefficient of Retroreflection (R_a) shall be measured in accordance with ASTM E 809, *Standard Test Method for Measuring Photometric Characteristics of Retroreflectors,* using the following modifications:

(1) Test distance = 15.2 m (50 ft).
(2) Observation angle = 0.2 degree.
(3) Entrance angle = –4.0 degrees.
(4) The receiver shall be provided with an entrance aperture of 25 mm (1 in.), ±5 percent, in diameter, which is equivalent to 0.1 degree angular aperture.
(5) The exit aperture of the source shall be circular and 25 mm (1 in.), ±5 percent, in diameter, which corresponds to 0.1 degree angular aperture.
(6) Retroreflector reference angle = 90 degrees.
(7) Datum mark shall be placed as specified by the trim manufacturer.

8.15.4.1.2 The Coefficient of Retroreflection (R_a) shall be calculated by the following equation:

$$R_a = \frac{R_1}{A_r}$$

where:
R_1 = coefficient of luminous intensity measured as specified in 8.15.4.1.1
A_r = retroreflective surface area of the trim test specimen's surface area

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

8.15.4.2 Evaluation of Fluorescence.

8.15.4.2.1 Trim fluorescence shall be determined by examining the material under a black light at a distance of 305 mm (12 in.) for a period of 30 seconds.

8.15.4.2.2 Specimens that exhibit fluorescence shall be designated as fluorescent. Specimens that do not exhibit fluorescence shall be designated as nonfluorescent.

8.15.4.3 Rainfall Test.

8.15.4.3.1 Specimens of trim shall be tested for retroreflectivity when wet as specified in Annex A of EN 471, *Specification for High Visibility Warning Clothing,* at a rate of 109 mm/hr (4.3 in./hr).

8.15.4.3.2 The Coefficient of Retroreflectivity shall be measured as specified in 8.15.4.1 while the rainfall test is in progress.

8.15.4.3.3 The fluorescence shall be evaluated as specified in 8.15.4.2.

8.15.4.4 Convective Heat Exposure Test.

8.15.4.4.1 Specimens of trim shall be tested for retroreflectivity after convective heat exposure as specified in 8.1.8.

8.15.4.4.2 The Coefficient of Retroreflectivity shall be measured as specified in 8.15.4.1.

8.15.4.4.3 The fluorescence shall be evaluated as specified in 8.15.4.2.

8.15.4.5 Laundering Test.

8.15.4.5.1 Specimens of garment trim shall be tested for retroflectivity after laundering as specified in 8.1.3.

8.15.4.5.2 Samples for the laundering conditioning shall include material sewn onto a 1 m (1 yd) square ballast material 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.

8.15.4.5.3 The Coefficient of Retroreflectivity shall be measured as specified in 8.15.4.1.

8.15.4.5.4 The fluorescence shall be evaluated as specified in 8.15.4.2.

8.15.5 Report.

8.15.5.1 The Coefficient of Retroreflection (R_a) shall be reported for each specimen. The average Coefficient of Retroreflection (R_a) of all specimens shall be calculated and reported separately for each of the test procedures specified in 8.15.4.1 and 8.15.4.3.

8.15.5.2 The number of fluorescent and nonfluorescent specimens shall be reported separately for each of the test procedures specified in 8.15.4.2, 8.15.4.3, 8.15.4.4, and 8.15.4.5.

8.15.6 Interpretation.

8.15.6.1 For trim retroreflectivity, pass/fail performance shall be determined using the average Coefficient of Retroreflection (R_a) of each group of specimens tested for the procedures in 8.15.4.1, 8.15.4.3, 8.15.4.4, and 8.15.4.5.

8.15.6.2 For trim fluorescence, any nonfluorescent specimens in any test procedure shall constitute failing performance.

8.16 Corrosion Resistance Test.

8.16.1 Application.

8.16.1.1 This test method shall apply to hardware items on garments, helmets, gloves, and footwear.

8.16.1.2 Modifications to this test method for testing garment and glove hardware shall be as specified in 8.16.7.

8.16.1.3 Modifications to this test method for testing helmet hardware shall be as specified in 8.16.8.

8.16.1.4 Modifications to this test method for testing footwear hardware shall be as specified in 8.16.9.

8.16.2 Specimens. A total of five different items of each hardware type shall be tested.

8.16.3 Sample Preparation. Specimens shall be conditioned as specified in 8.1.2.

8.16.4 Procedure.

8.16.4.1 Specimens shall be tested in accordance with ASTM B 117, *Standard Method of Salt Spray (Fog) Testing.* Salt spray shall be 5 percent saline solution, and test exposure shall be for 20 hours.

8.16.4.2 Immediately following the test exposure and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

8.16.4.3 Specimens shall then be examined visually with the unaided eye to determine pass/fail.

8.16.4.4 The functionality of each specimen shall be evaluated.

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

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

8.16.7 Specific Requirements for Testing Garment and Glove Hardware. Samples for conditioning shall be whole hardware items.

8.16.8 Specific Requirements for Testing Helmets. Samples for conditioning shall be whole helmets with accessories.

8.16.9 Specific Requirements for Testing Footwear. Samples for conditioning shall be whole footwear.

8.17 Liquid 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 gloves 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 Specimens. Specimens to be conditioned according to 8.1.2 and 8.1.3 shall be 1 m (1 yd) square. Specimens to be tested shall be cut from these larger specimens. Specimens to be tested 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 Sample Preparation. Specimens to be tested, other than footwear specimens, shall be conditioned as specified in 8.1.3, and then conditioned as specified in 8.1.2. Footwear shall only be subjected to the conditioning specified in 8.1.2 prior to testing.

8.17.4 Procedure.

8.17.4.1 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,* using exposure procedure C.

8.17.4.2 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)
(6) Water

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

8.17.5 Report. The pass/fail result for each specimen shall be reported.

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

8.17.7 Specific Requirements for Testing Garment Materials. Specimens shall consist of the barrier layer, which is intended to prevent the penetration of liquids.

8.17.8 Specific Requirements for Testing Glove Materials. Three specimens each shall be taken from sample gloves at the palm, back, and seam areas. Only that portion of the glove intended to prevent the penetration of liquids shall be tested.

8.17.9 Specific Requirements for Testing Footwear Materials. Three specimens shall be taken from the footwear upper and any upper seam areas. Only that portion of the footwear item intended to prevent the penetration of liquids shall be tested.

8.18 Viral Penetration Resistance Test.

8.18.1 Application.

8.18.1.1 This test shall apply to garments, gloves, and footwear materials.

8.18.1.2 Modifications to this test method for testing garment materials shall be as specified in 8.18.7.

8.18.1.3 Modifications to this test method for testing glove materials shall be as specified in 8.18.8.

8.18.1.4 Modifications to this test method for testing footwear materials shall be as specified in 8.18.9.

8.18.2 Specimens. A minimum of three specimens shall be tested. Specimens shall consist of three 75 mm (3 in.) squares for each material type.

8.18.3 Sample Preparation. Specimens to be tested shall be conditioned as specified in 8.1.3.

8.18.4 Procedure.

8.18.4.1 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.*

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

8.18.5 Report. The pass/fail result for each specimen shall be reported.

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

8.18.7 Specific Requirements for Testing Garment Materials. Specimens shall consist of the barrier layer, which is intended to prevent the penetration of liquids.

8.18.8 Specific Requirements for Testing Glove Materials. Three specimens each shall be taken from sample gloves at the palm, back, and seam areas. Only that portion of the glove intended to prevent the penetration of liquids shall be tested.

8.18.9 Specific Requirements for Testing Footwear Materials. Three specimens shall be taken from the footwear upper and any upper seam areas. Only that portion of the footwear item intended to prevent the penetration of liquids shall be tested.

8.19 Flame Resistance Test Two.

8.19.1 Application. This test method shall apply to protective helmets and eye and face protective devices.

8.19.1.1 Helmets shall be tested to Procedures A and B only.

8.19.1.2 Eye and face protective devices shall be tested to Procedure C only.

8.19.2 Specimens. A minimum of three complete helmets shall be tested for each of the tests in this section.

8.19.3 Sample Preparation. No sample conditioning shall be performed.

8.19.4 Apparatus.

8.19.4.1 A standard Bunsen burner shall be used.

8.19.4.2 The Bunsen burner shall be fueled by a bottled methane gas, lab grade or better, of 3.72×10^7 J/m^3, $\pm 1.8 \times 10^6$ J/m^3 (1000 Btu/ft^3, ±50 Btu/ft^3).

8.19.4.3 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.

8.19.4.4 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.

8.19.5 Procedures.

8.19.5.1 Procedure A.

8.19.5.1.1 Sample helmets shall be seated on the reference headform specified in Figure 8.20.4.1(a) through Figure 8.20.4.1(c) according to the manufacturer's positioning index, as specified in the manufacturer's instruction for the specific helmet. The test set up shall be as shown in Figure 8.19.5.1.1.

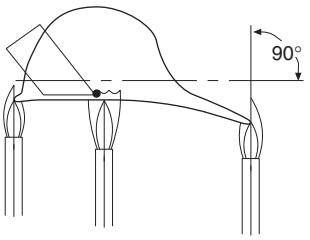

FIGURE 8.19.5.1.1 Test Procedure A.

8.19.5.1.2 The tip of the inner cone of a Bunsen burner flame of 25 mm to 38 mm (1 in. to 1½ in.) in length shall be placed at the outer edge of the helmet shell, at the front, sides, and rear. When a helmet hanger is provided, the test flame shall be applied off the edge of the helmet hanger, at the shell edge.

8.19.5.1.3 After 15 seconds +1/0 seconds, the flame shall be removed and the duration of the afterflame and afterglow shall be measured.

8.19.5.2 Procedure B.

8.19.5.2.1 The specimen shall be attached to the laboratory test stand so that it is held in the "as worn" position. The stand and specimen shall be placed in a draftfree fume hood. The flame of the Bunsen burner shall be applied so that the tip of the inner cone is 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.

8.19.5.2.2 The flame shall be applied to the test surface for 5 seconds, +1/−0 seconds. After removal of the flame, any afterflame shall be measured.

8.19.5.3 Procedure C.

8.19.5.3.1 The 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 8.19.5.3.1.

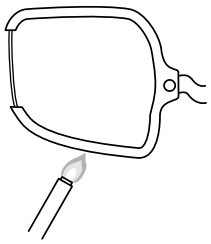

FIGURE 8.19.5.3.1 Test Procedure C.

8.19.5.3.2 The tip of the inner cone of the Bunsen burner flame 25 mm to 38 mm (1 in. to 1½ in.) in length shall be placed 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.

8.19.5.3.3 After 15 seconds, +1/−0 second, the flame shall be removed and the duration of the afterflame measured.

8.19.6 Report. Afterflame times shall be reported for each specimen at each flame impingement location. The average afterflame times shall be calculated and reported for each flame impingement location. The afterflame times shall be reported to the nearest 0.2 second.

8.19.7 Interpretation. Pass/fail performance shall be based on the longest measured afterflame times.

8.20 Top Impact Resistance Test (Force).

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

8.20.2 Specimens. A minimum of one helmet shall be tested as specified for each environmental condition.

8.20.3 Sample Preparation.

8.20.3.1 Specimens shall be conditioned for each environmental condition specified in 8.1.2, 8.1.4, and 8.1.6 prior to each impact.

8.20.3.2 Samples for conditioning shall be complete helmets.

8.20.4 Apparatus.

8.20.4.1 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 8.20.4.1 and Figure 8.20.4.1(a) through Figure 8.20.4.1(c).

8.20.4.2 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 48 mm, ±8 mm (1.9 in., ±0.3 in.) and a chord length of at least 75 mm (3 in.).

8.20.4.3 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 ~~Y~~ $\times 10^9$ N/m (2.5 ~~Y~~ $\times 10^7$ lb/in.)
(5) Minimum mechanical resonant frequency of the headform/load cell system 5000 Hz
(6) Load cell diameter 75 mm (3 in.)

8.20.4.4 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 formula:

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

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

Table 8.20.4.1 Data for Contour Drawing of ISEA Headform (all dimensions in mm)

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

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

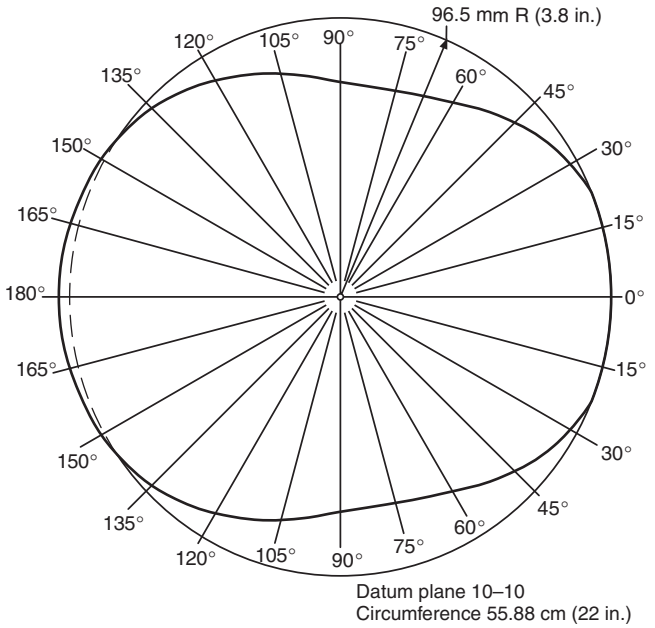

FIGURE 8.20.4.1(a) ISEA size 7 headform, top.

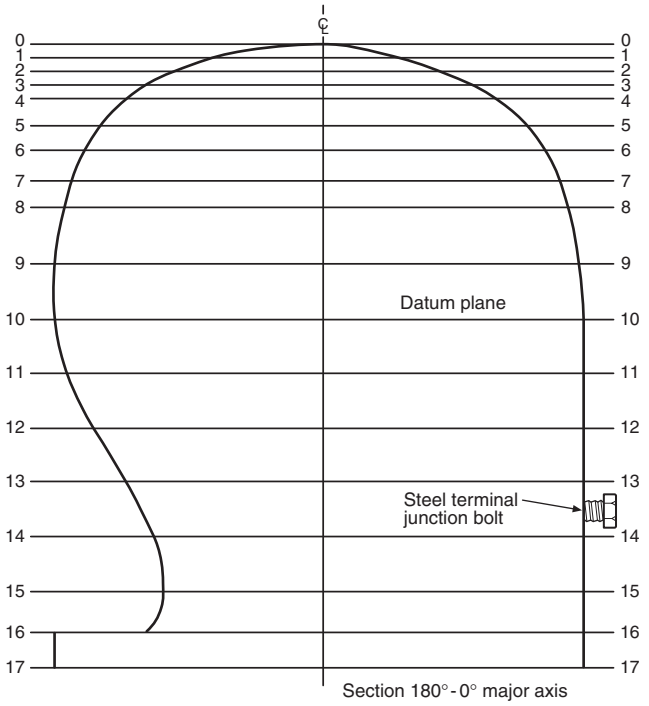

FIGURE 8.20.4.1(b) ISEA size 7 headform, side with modification for steel terminal junction bolt.

8.20.4.5 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.).

8.20.4.6 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.

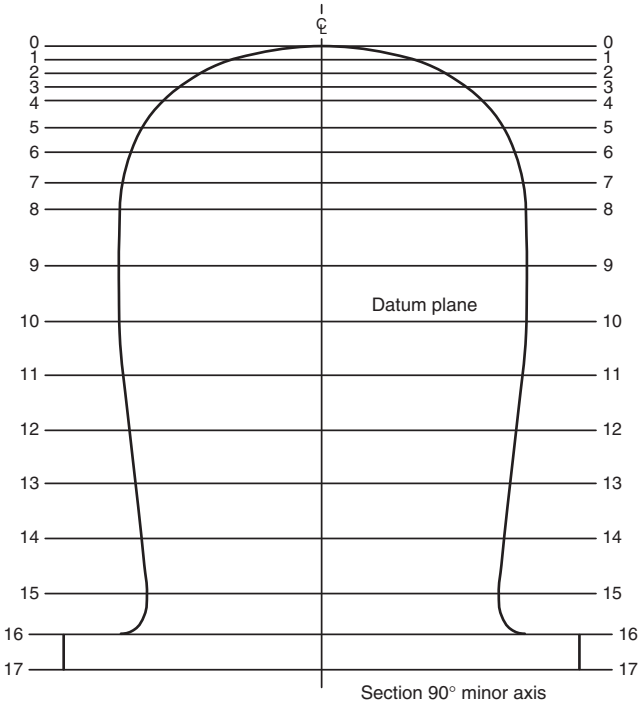

FIGURE 8.20.4.1(c) ISEA size 7 headform, front.

8.20.4.7 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 one degree of level. The steel plate shall be rigidly attached to, and in intimate contact with, the backup mass.

8.20.4.8 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 one 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.

8.20.4.9* The instrumentation calibration shall be verified at least before and after each test series or at the beginning and end of each day of testing, whichever is the shorter length of time.

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

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

8.20.4.12 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.

8.20.5 Procedure.

8.20.5.1 Specimen helmets shall be adjusted to a size sufficiently large to prevent binding. Sample helmets shall be positioned and secured to properly fit on the headform with the horizontal center plane parallel within 5 degrees of the refer-

ence plane. The front to back centerline of the shell shall be within 13 mm (½ in.) of the mid-sagittal plane of the headform. 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.

8.20.5.2 The impactor shall be dropped from a height that yields an impact velocity within 2 percent of 5.47 m/s (17.9 ft/s). A means of verifying the impact velocity to within 2 percent for each impact shall be incorporated.

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

8.20.6 Report.

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

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

8.20.7 Interpretation.

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

8.20.7.2 Pass/fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

8.21 Physical Penetration Resistance Test.

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

8.21.2 Specimens. A minimum of one helmet shall be tested for each environmental condition

8.21.3 Sample Preparation.

8.21.3.1 Specimens 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.

8.21.3.2 Samples for conditioning shall be complete helmets.

8.21.4 Apparatus.

8.21.4.1 The ISO size J headform shall conform to the nominal dimensions in Figure 8.24.4.1. Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

8.21.4.2 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.

8.21.4.3 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 seconds.

8.21.4.4 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.

8.21.5 Procedure.

8.21.5.1 The environmentally conditioned helmet shall be placed on the rigidly mounted test headform and secured by the helmet retention system or by other means that will not interfere with the test. 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 of the reference plane. The front-to-back centerline of the shell shall be within 13 mm (0.5 in.) of the mid-sagittal plane of the headform.

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

8.21.6 Report. The pass/fail results for each helmet shall be reported.

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

8.22 Electrical Insulation Test One.

8.22.1 Application. This test method shall apply to helmets.

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

8.22.3 Sample Preparation.

8.22.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.22.3.2 Samples for conditioning shall be complete helmets.

8.22.4 Apparatus.

8.22.4.1 The following equipment shall be provided for Procedure A:

(1) A source of 60 Hz alternating current variable from 0 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 milliampmeter 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

8.22.4.2 The following equipment shall be provided for Procedure B:

(1) A source of 60 Hz alternating current variable from 0 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 milliampmeter 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 size 7 ISEA headform modified in accordance with Table 8.20.4.1 and Figure 8.20.4.1(a) through Figure 8.20.4.1(c)

8.22.5 Procedures.

8.22.5.1 Procedure A.

8.22.5.1.1 Where helmets have a vertical adjustment to the suspension system, the vertical adjustment shall be set to raise the helmet to the highest position, with maximum crown clearance between the headform and the inside of the helmet crown, prior to establishing the helmet positioning index. The helmet shall be placed on the ISO size J headform specified in Figure 8.24.4.1 and positioned according to the helmet positioning index for this test. After proper positioning in accordance with the helmet positioning index, the dielectric test plane specified in Figure 8.22.5.1.2 shall be determined.

8.22.5.1.2 The helmet shall be inverted and positioned in accordance with the inverted helmet positioning index while maintaining all vertical adjustments set at their highest position. The inverted helmet shall be filled with tap water equal to the dielectric test plane as shown in Figure 8.22.5.1.2. The helmet shall then be submerged to the same level as the water on the inside of the helmet.

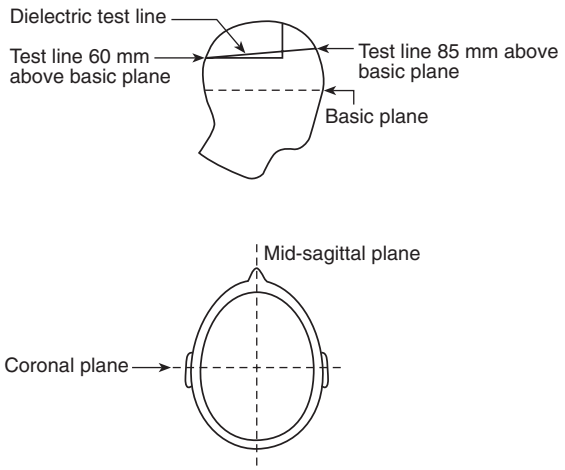

FIGURE 8.22.5.1.2 Test setup.

8.22.5.1.3 A 60 Hz alternating current voltage shall be applied and increased to 2200 volts. The voltage shall be maintained at 2200 volts, ±2 percent for 1 minute.

8.22.5.2 Procedure B.

8.22.5.2.1 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.

8.22.5.2.2 The specimen shall then be mounted on the modified ISEA size 7 aluminum headform, with chin strap firmly secured to the headform by means of the conductive terminal junction bolt.

8.22.5.2.3 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 percent volts. The voltage shall be maintained for 15 seconds.

8.22.6 Report. Any current leakage or evidence of breakdown shall be recorded for each helmet.

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

8.23 Suspension System Retention Test.

8.23.1 Application. This test method shall apply to helmets.

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

8.23.3 Sample Preparation.

8.23.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.23.3.2 Samples for conditioning shall be complete helmets.

8.23.4 Apparatus. The suspension system retention test fixtures shall consist of rigid material of sufficient thickness and optional design to facilitate firm attachment to the helmet suspension and the tensile test machine as shown in Figure 8.23.4.

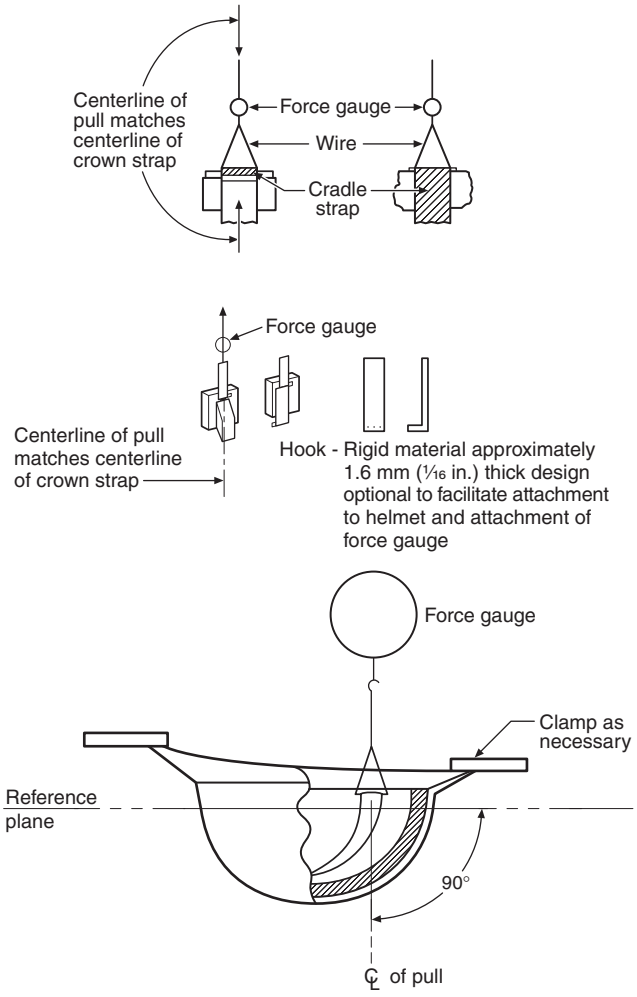

FIGURE 8.23.4 Suspension system test setup.

8.23.5 Procedure.

8.23.5.1 Sample helmets shall be positioned and secured so that the helmet's reference plane is horizontal.

8.23.5.2 Each attachment point of the crown straps shall be tested by applying a pull force perpendicular to the reference plane, to a maximum load of 45 N, ±5 N (10 lb, ±1 lb).

8.23.5.3 The force shall be increased from 0 N (0 lb) to 45 N, ±5 N (10 lb, ±1 lb) at a load rate of 25 mm, ±5 mm (1 in., ±0.2 in.) per minute.

8.23.5.4 The force shall be applied through the centerline of each attachment point.

8.23.6 Report. The individual pass/fail results for each attachment point shall be recorded.

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

8.24 Retention System Test.

8.24.1 Application. This test method shall apply to helmets.

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

8.24.3 Sample Preparation.

8.24.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.24.3.2 Samples for conditioning shall be complete helmets.

8.24.4 Apparatus.

8.24.4.1 An ISO size J headform shall be used and shall be of the nominal dimensions of Figure 8.24.4.1.

8.24.4.2 The mechanical chin structure shall consist of two rollers 13 mm (½ in.) in diameter with centers 75 mm (3 in.) apart. The mechanical chin structure shall conform with Figure 8.24.4.2.

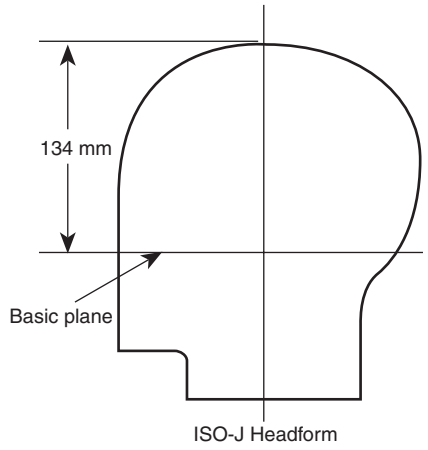

FIGURE 8.24.4.1 ISO size J headform.

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

8.24.4.4 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.

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

8.24.5 Procedure.

8.24.5.1 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

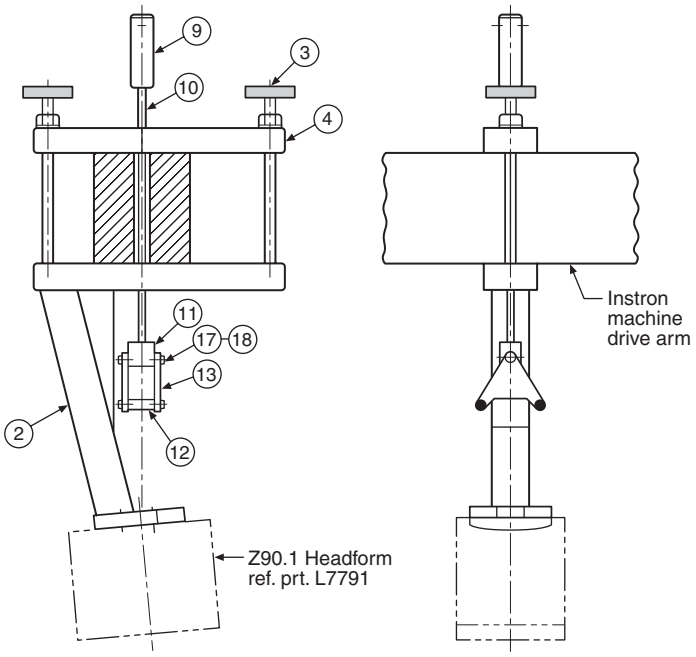

FIGURE 8.24.4.2 Retention system test setup.

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.

rollers, and the helmet shall be secured to the headform. The chin strap shall be adjusted and preloaded to 45 N, ±5 N (10 lb, ±1 lb). The distance between the top of the helmet and the rollers shall be measured and recorded to the nearest 0.5 mm (0.02 in.).

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

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

8.24.5.4 The distance between the top of the helmet and the rollers shall be measured and recorded again after the force has been maintained at 445 N (100 lb) for 60 seconds, +15/−0 seconds. The difference between the second measurement and the first shall be the retention system elongation.

8.24.6 Report. The retention system elongation shall be measured for each helmet specimen.

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

8.25 Flame Resistance Test Three.

8.25.1 Application. This test method shall be applied to glove composite materials.

8.25.2 Specimens.

8.25.2.1 Each specimen to be tested shall be a rectangle at least 50 mm (2 in.) wide by 150 mm (6 in.) long. Specimens shall be the composite used in actual glove construction consisting of each single layer, with all layers arranged in proper order. In each test the specimen's normal outer surface shall be exposed to the flame.

8.25.2.2 Three specimens shall be tested for each material.

8.25.2.3 If a proposed glove 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 (6.0 in.) dimension.

8.25.3 Sample Preparation.

8.25.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.3.

8.25.3.2 All specimens to be tested shall be conditioned as specified in 8.1.2.

8.25.3.3 Samples to be conditioned shall be the composite used in actual glove construction consisting of each single layer, with all layers arranged in proper order and stitched along the edges using the same thread as used in the construction of the glove.

8.25.4 Apparatus.

8.25.4.1 The test apparatus specified in Method 5905.1, "Flame Resistance of Material; High Heat Flux Flame Contact," of Federal Test Method Standard 191A, *Textile Test Methods,* shall be used.

8.25.4.2 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.

8.25.4.3 A specimen support assembly shall be used that consists of a frame and steel rod of 2 mm (1/16 in.) diameter to support the specimen in an L-shaped position as shown in Figure 8.25.4.3.

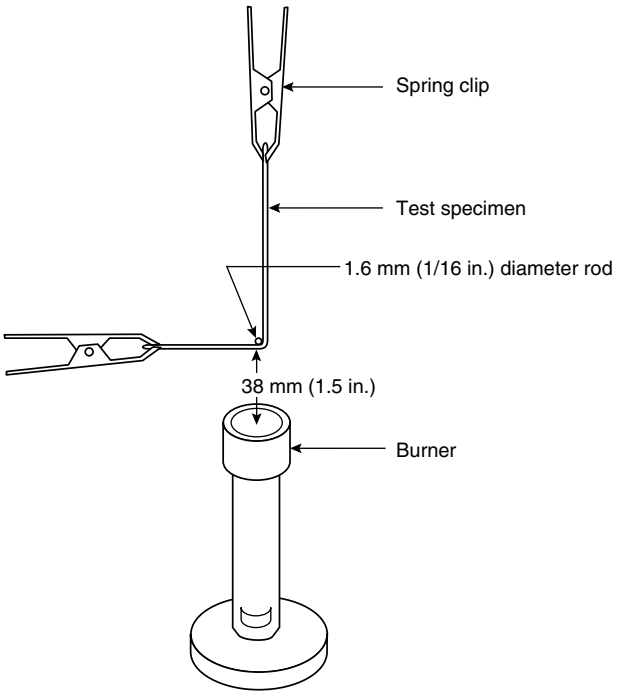

FIGURE 8.25.4.3 Relationship of test material to burner.

8.25.4.4 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 8.25.4.3.

8.25.5 Procedure.

8.25.5.1 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.

8.25.5.2 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 8.25.4.3.

8.25.5.3 The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

8.25.5.4 The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 second, that the specimen continues to flame after the burner is removed from the flame.

8.25.5.5 Each layer of the specimen shall be examined for melting or dripping.

8.25.5.6 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 8.25.5.6.1 through 8.25.5.6.4.

8.25.5.6.1 The specimen shall be folded lengthwise and creased, by hand, along a line through the highest peak of the charred area.

8.25.5.6.2 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.

8.25.5.6.3 A weight of sufficient size such that the weight and hook together shall equal the total tearing load required in Table 8.25.5.6.3 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 8.25.5.6.3.

Table 8.25.5.6.3 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
over 203–508	over 6.0–15.0	0.2	0.5
over 508–780	over 15.0–23.0	0.3	0.75
over 780	over 23.0	0.45	1.0

8.25.5.6.4 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 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.

8.25.6 Report.

8.25.6.1 The afterflame time and char length shall be reported for each specimen. The average afterflame time and char length shall also be calculated and reported. The afterflame time shall be reported to the nearest 0.2 second and the char length to the nearest 2.5 mm (1/10 in.).

8.25.6.2 Observations of melting or dripping for each specimen shall be reported.

8.25.7 Interpretation. Pass/fail performance shall be based on any observed hole formation, melting or dripping, the average afterflame time, and the average char length.

8.26 Conductive Heat Resistance Test.

8.26.1 Application.

8.26.1.1 This test methods shall apply to glove and upper footwear materials.

8.26.1.2 Modifications to this method for glove materials shall be as specified in 8.26.7.

8.26.1.3 Modifications to this method for footwear upper materials shall be as specified in 8.26.8.

8.26.2 Specimens. A total of three specimens shall be tested.

8.26.3 Sample Preparation. Specimens shall be conditioned as specified in 8.1.2.

8.26.4 Procedure.

8.26.4.1 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.*

8.26.4.2 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).

8.26.4.3 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.

8.26.5 Report. The time to pain and time to second-degree burn for each specimen shall be reported. The average time to pain and time to second-degree burn shall be calculated and reported. 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 reported as ">30 s."

8.26.6 Interpretation.

8.26.6.1 Pass/fail determinations shall be based on the average time to pain and average time to second-degree burn of all specimens tested.

8.26.6.2 If an individual result from any test set varies more than ±8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

8.26.7 Specific Requirement for Testing Gloves.

8.26.7.1 Specimens shall be representative of glove body composite construction at the palm of the hand and at the palm side of the fingers.

8.26.7.2 Specimens shall be stitched around the perimeter using the same thread used in glove construction.

8.26.7.3 Glove specimens shall be tested before and after being subjected to the procedure specified in 8.1.3.

8.26.8 Specific Requirements for Testing Footwear Upper Materials. Footwear specimens shall include the thinnest portions of the footwear upper.

8.27 Cut Resistance Test.

8.27.1 Application.

8.27.1.1 This test method shall apply to glove and footwear upper materials.

8.27.1.2 Modifications to this test method for evaluation of glove body, gauntlet, and wristlet materials shall be as specified in 8.27.7.

8.27.1.3 Modifications to this test method for evaluation of footwear upper materials shall be as specified in 8.27.8.

8.27.2 Specimens. A minimum of three specimens, consisting of all layers, shall be tested.

8.27.3 Sample Preparation.

8.27.3.1 Samples for conditioning shall be whole gloves or footwear uppers.

8.27.3.2 Glove specimens shall be preconditioned to five wash/dry cycles in accordance with the method specified in 8.1.3. All specimens shall be conditioned as specified in 8.1.2.

8.27.4 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 cut distance.

8.27.5 Report.

8.27.5.1 The cut distance shall be reported to the nearest 1 mm (1/32 in.) for each sample specimen.

8.27.5.2 The average cut distance in mm shall be reported for all specimens tested.

8.27.6 Interpretation. The average cut force shall be used to determine pass/fail performance.

8.27.7 Specific Requirements for Testing Glove Body, Gauntlet, and Wristlet Materials.

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

8.27.7.2 Cut resistance testing shall be performed under a load of 200 g.

8.27.8 Specific Requirements for Testing Footwear Upper Materials.

8.27.8.1 Specimens shall be taken from the parts of the footwear upper that provide uniform thickness and shall not include seams.

8.27.8.2 Cut resistance testing shall be performed under a load of 800 g.

8.28 Puncture Resistance Test One.

8.28.1 Application.

8.28.1.1 This test shall be applied to glove and footwear upper materials.

8.28.1.2 Modifications to this test method for testing glove materials shall be as specified in 8.28.7.

8.28.1.3 Modifications to this test method for testing footwear upper material shall be as specified in 8.28.8.

8.28.2 Specimens. A minimum of three specimens measuring at least 150 mm (6 in.) square shall be tested.

8.28.3 Sample Preparation.

8.28.3.1 Samples for conditioning shall be complete gloves or footwear upper sections.

8.28.3.2 Specimens shall be tested after conditioning as specified in 8.1.2.

8.28.4 Procedure. Specimens shall be tested in accordance with ASTM F 1342, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture.*

8.28.5 Report. The puncture force shall be reported for each specimen to the nearest 0.05 kg (0.1 lb) of force. The average puncture force shall be reported for all specimens tested.

8.28.6 Interpretation. The average puncture force shall be used to determine pass/fail performance.

8.28.7 Specific Requirements for Testing Glove Materials. Specimens shall consist of each composite of the palm and palm side of the fingers with layers arranged in the proper order. Where the specimen composites of the palm and palm side of the fingers are identical, only one representative composite shall be required to be tested.

8.28.8 Specific Requirements for Testing Footwear Upper Materials. Specimens shall consist of each composite of the footwear item used in the actual suit footwear configuration, with layers arrange in proper order. Specimens shall be taken from the thinnest portion of the footwear upper.

8.29 Glove Hand Function Test.

8.29.1 Application. This test shall apply to gloves.

8.29.2 Specimens.

8.29.2.1 A minimum of three glove pairs each for small and large sizes shall be used for testing.

8.29.2.2 Each glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

8.29.2.3 Glove pair specimens shall not receive special softening treatments prior to tests.

8.29.3 Sample Preparation.

8.29.3.1 Glove pair specimens shall be preconditioned as specified in 8.1.3.

8.29.3.2 Samples for conditioning shall be whole glove pairs.

8.29.4 Apparatus. A pegboard apparatus shall be used that consists of 25 stainless steel pins and a pegboard. Each stainless steel pin shall have a diameter of 9.5 mm (0.375 in.) and a length of 38 mm (1½ in.). The pegboard shall have 25 holes with each hole having a diameter of 10 mm (0.39 in.) and a depth of 13 mm (½ in.). The holes shall be in a 5 by 5 pattern and each hole shall have a separation of 25 mm (1 in.) from other holes.

8.29.5 Procedures.

8.29.5.1 Each available size of gloves shall be evaluated with at least one separate test subject with the same pair of gloves.

8.29.5.2 A minimum of three different glove pairs shall be evaluated.

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

8.29.5.4 Each test subject used to perform this testing shall practice the hand functions a minimum of three times before conducting actual testing.

8.29.5.5 Before each test, the pegs shall be placed on a hard, smooth surface adjacent to the pegboard. The pegs shall be randomly scattered in the working area most comfortable to the test subject (i.e., the right side for right-handed test subjects, left side for left-handed test subjects, directly in front, etc.).

8.29.5.6 In starting the test, each peg shall be picked up using a pincer grasp near the center of the barrel of the peg and shall be placed in the pegboard beginning at the upper left corner, left-to-right and top-to-bottom.

8.29.5.7 The time to place all pegs in the pegboard shall be measured for each test subject and shall be known as the dexterity test time.

8.29.5.8 Each test subject shall perform the test following the steps in 8.29.5.5 through 8.29.5.7 until variance of the dexterity times of that person's last three repetitions does not exceed 8 percent. Variance shall be calculated by dividing the standard

deviation by the average of the three repetitions and multiplying by 100. The average of the three repetitions shall be used as the baseline dexterity test time (DTT_b) and shall be between 25 and 45 seconds. The test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

8.29.5.9 Each test subject shall then perform the test with one pair of gloves following the steps in 8.29.5.5 through 8.29.5.7 with the pair of test gloves until the variance of the dexterity times of that person's fastest three repetitions does not exceed 8 percent. Variance shall be calculated as in 8.29.5.8. The average of the fastest three repetitions shall be used as the dexterity test time with gloves (DTT_g). Each test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

8.29.5.10 The dexterity test times with gloves (DTT_g) shall be compared with the baseline dexterity test time (DTT_b) for each test subject. The percentage of barehand control shall be calculated as follows:

$$\text{Percent of barehand control} = \frac{DTT_g}{DTT_b} \times 100$$

8.29.6 Report. The average percent of barehand control shall be reported for each test subject. The average percent of barehand control for all test subjects shall be calculated.

8.29.7 Interpretation. The average percent of barehand control shall be used to determine pass/fail performance.

8.30 Grip Test.

8.30.1 Application. This test method shall apply to protective gloves.

8.30.2 Specimens.

8.30.2.1 A minimum of three gloves pairs each for small and large sizes shall be used for testing.

8.30.2.2 Each glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

8.30.2.3 Glove pair specimens shall not receive special softening treatments prior to tests.

8.30.2.4 Glove pair specimens shall be tested for each material and construction combination.

8.30.3 Sample Preparation.

8.30.3.1 Glove pair specimens shall be preconditioned as specified in 8.1.3.

8.30.3.2 Glove pair specimens shall be tested after being conditioned for dry conditions as specified in 8.1.2.

8.30.3.3 Glove pair specimens shall be tested after being conditioned for wet conditions as specified in 8.1.7.

8.30.3.4 Samples for conditioning shall be whole gloves.

8.30.4 Apparatus. Grip testing shall be evaluated with the use of a 9.5 mm (⅜ in.) diameter, 3-strand prestretched polyester rope attached to a calibrated force measuring device.

8.30.5 Procedure.

8.30.5.1 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.

8.30.5.2 Each test subject shall make three successive attempts to lift as much weight using the halyard as possible, using both hands and keeping both feet firmly planted on the ground. The average weight hoisted over the three trials shall be the barehand weight lift capability.

8.30.5.3 Dry-conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

8.30.5.4 Wet-conditioned sample gloves shall be tested on a dry rope and then on a wet rope.

8.30.5.5 Each test subject shall be tested with a minimum of three pairs of gloves. Test subjects shall attempt one trial with each pair of gloves for a minimum of six grip tests for each set of conditions, with at least three grip tests with small sized gloves and three grip test with large sized gloves.

8.30.5.6 Weight pulling capacity with gloves shall be compared with barehand weight lift capability. The percentage of weight pulling capacity with gloves to barehand weight lift capability shall be calculated as follows:

$$\text{Percent of barehand control} = \frac{WPC_g}{WLC_b} \times 100$$

where:
WPC_g = weight-pulling capacity with gloves
WLC_b = barehand weight lifting capability

8.30.6 Report. The percent of barehand control shall be reported for each glove pair specimen, condition, and test subject tested.

8.30.7 Interpretation. One or more glove pair specimens failing this test shall constitute failing performance.

8.31 Liner Retention Test.

8.31.1 Application. This test shall apply to protective gloves.

8.31.2 Specimens. A minimum of three glove pairs each for small and large sizes shall be used for testing.

8.31.3 Sample Preparation.

8.31.3.1 Specimens to be tested shall be conditioned as specified in 8.1.3.

8.31.3.2 Samples for conditioning shall be whole gloves.

8.31.4 Procedure.

8.31.4.1 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.

8.31.4.2 The time to don one glove of the glove pair specimen shall be determined by measuring the time it takes for the test subject to don the single glove on three consecutive trials without altering the sample glove linings between donnings.

8.31.4.3 Each donning trial shall start with the glove lying in front of the test subject and shall end when the test subject's fingers are seated in the glove sample.

8.31.4.4 The baseline donning time shall be the average of the first three donning times as determined in 8.31.4.2. The baseline donning time shall not exceed 10 seconds. The doffing time between donning shall not exceed 10 seconds.

8.31.4.5 Glove pair specimens shall then be conditioned as specified in 8.1.3.

8.31.4.6 The final donning time shall be the average of the times for the first three donnings after removal from the final drying cycle as specified in 8.31.4.4. No preparation of the gloves shall be done.

8.31.5 Report. The final donning time and the baseline donning time shall be reported to the nearest 0.1 second for each trial. The average final and average baseline donning times shall be calculated and reported.

8.31.6 Interpretation. Pass/fail determinations shall be made using the average final and average baseline donning times.

8.32 Overall Liquid Integrity Test Two.

8.32.1 Application. This test method shall apply to protective gloves.

8.32.2 Specimens. A minimum of three glove pairs each for small and large sizes shall be used for testing.

8.32.3 Sample Preparation.

8.32.3.1 Specimens shall be tested after being subjected to the procedure specified in 8.1.3.

8.32.3.2 Specimens to be tested shall be conditioned as specified in 8.1.2.

8.32.4 Apparatus.

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

8.32.4.2 Water used for integrity testing shall be treated with a nonfoaming surfactant to lower its surface tension to less than 34 dynes/cm, ±5 dynes/cm.

8.32.5 Procedure.

8.32.5.1 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.

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

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

8.32.5.4 The glove specimen shall be removed from the testing person's hand and the inner glove shall be inspected for water marks.

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

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

8.33 Flame Resistance Test Four.

8.33.1 Application. This test method shall apply to protective footwear.

8.33.2 Specimens. Three complete footwear items shall be tested.

8.33.3 Sample Preparation.

8.33.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.33.3.2 Samples for conditioning shall be whole boots.

8.33.4 Apparatus.

8.33.4.1 The test apparatus specified in Method 5905.1, "Flame Resistance of Material; High Heat Flux Flame Contact," of Federal Test Method Standard 191A, *Textile Test Methods*, shall be used.

8.33.4.2 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.

8.33.4.3 A specimen support assembly shall be used to support the footwear specimen above the burner flame.

8.33.5 Procedure.

8.33.5.1 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.

8.33.5.2 With the specimen mounted in the support assembly, the burner shall be moved such that the flame contacts the specimen at a 90 degree angle to the flame, in the areas shown in Figure 8.33.5.2.

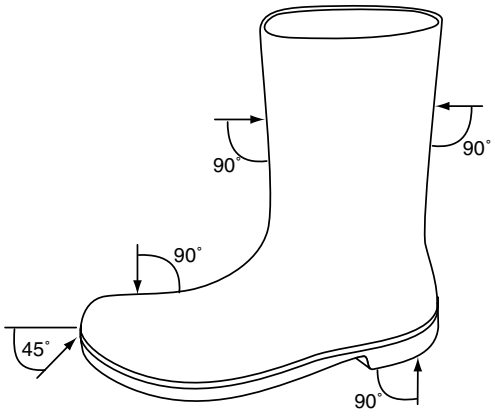

FIGURE 8.33.5.2 Test areas.

8.33.5.3 The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

8.33.5.4 The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 second that the specimen continues to flame after the specimen is removed from the flame.

8.33.5.5 Following the flame exposure, the specimen shall be removed and examined for burn-through. Each layer of the specimen shall be examined for melting or dripping.

8.33.6 Report.

8.33.6.1 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 0.2 second.

8.33.6.2 Observations of burn through, melting, or dripping for each specimen shall be reported.

8.33.7 Interpretation. Pass/fail performance shall be based on any observed hole formation, melting or dripping, and the average afterflame time.

8.34 Impact and Compression Resistance Test.

8.34.1 Application. This test method shall apply to the toe section of the footwear.

8.34.2 Specimens. A minimum of three footwear items shall be tested for both impact and compression.

8.34.3 Sample Preparation.

8.34.3.1 Samples for conditioning shall be complete footwear toes.

8.34.3.2 Specimens shall be conditioned as specified in 8.1.2.

8.34.4 Procedure. Footwear specimens shall be tested in accordance with Section 1.4 of ANSI Z41, *Standard for Safety-Toe Footwear*.

8.34.5 Report. The impact and compression forces for each specimen shall be reported.

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

8.35 Ladder Shank Bend Resistance Test.

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

8.35.2 Specimens. A minimum of three footwear ladder shanks shall be tested.

8.35.3 Sample Preparation.

8.35.3.1 Samples for conditioning shall be footwear ladder shanks.

8.35.3.2 Specimens shall be conditioned as specified in 8.1.2.

8.35.4 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 8.35.4.

8.35.5 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).

8.35.6 Report. Deflection at 182 kg (400 lb) 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.).

8.35.7 Interpretation. Pass/fail performance shall be determined using the average deflection for all specimens tested.

8.36 Abrasion Resistance Test Three.

8.36.1 Application. This test method shall apply to footwear soles.

8.36.2 Specimens. A minimum of three footwear soles shall be tested.

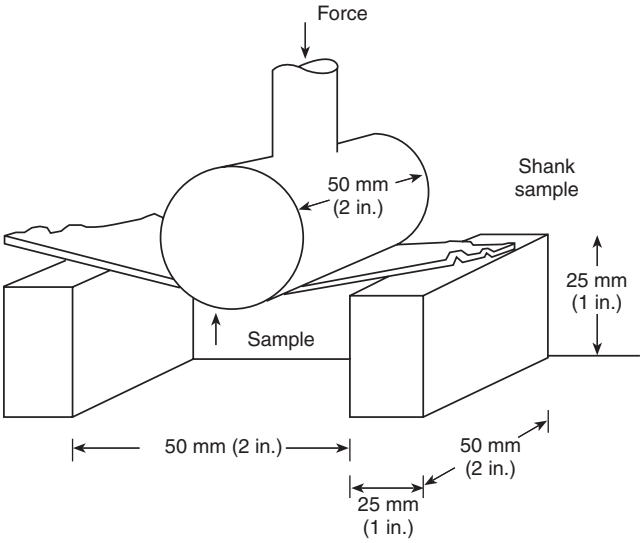

FIGURE 8.35.4 Shank bend test setup.

8.36.3 Sample Preparation.

8.36.3.1 Samples for conditioning shall be footwear soles.

8.36.3.2 Specimens shall be conditioned as specified in 8.1.2.

8.36.4 Procedure. Abrasion resistance shall be performed in accordance with ASTM D 1630, *Standard Test Method for Rubber Property — Abrasion Resistance (Footwear Abrader)*.

8.36.5 Report. The abrasion resistance rating of each specimen shall be reported.

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

8.37 Puncture Resistance Test Two.

8.37.1 Application. This test method shall apply to footwear soles.

8.37.2 Specimens. A minimum of three footwear soles shall be tested.

8.37.3 Sample Preparation.

8.37.3.1 Samples for conditioning shall be footwear sole sections.

8.37.3.2 Specimens shall be conditioned as specified in 8.1.2.

8.37.4 Procedure. Puncture resistance shall be performed in accordance with Section 3 of CSA Z195 M-92, *Standard for Protective Footwear, Occupational Health and Safety*.

8.37.5 Report. The force required to puncture the sole reinforcement device of each specimen shall be reported.

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

8.38 Flex Fatigue Test.

8.38.1 Application. This test shall apply to protective footwear.

8.38.2 Specimens. A minimum of three footwear items shall be tested.

8.38.3 Sample Preparation.

8.38.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.38.3.2 Samples for conditioning shall be whole footwear.

8.38.4 Procedure.

8.38.4.1 Protective footwear shall be tested in accordance with FIA Standard 1209, *Whole Shoe Flex*. No water shall be used in this testing.

8.38.4.2 The test shall consist of 100,000 flexes.

8.38.4.3 Following the testing, the specimen shall be examined for sole separation.

8.38.5 Report. The separation of soles from any specimen shall be reported as failure for the tested specimen.

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

8.39 Slip Resistance Test.

8.39.1 Application. This test method shall apply to footwear soles.

8.39.2 Specimens. A minimum of three complete footwear items shall be tested.

8.39.3 Sample Preparation.

8.39.3.1 Samples for conditioning shall be footwear.

8.39.3.2 Specimens shall be conditioned as specified in 8.1.2.

8.39.4 Procedure. Slip resistance shall be performed in accordance with ASTM F 489, *Standard Test Method for Static Coefficient of Friction of Shoe Sole and Heel Materials as Measured by the James Machine,* in a dry condition.

8.39.5 Report. The static coefficient of friction under a dry condition of each specimen shall be reported.

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

8.40 Electrical Insulation Test Two.

8.40.1 Application. This test shall apply to protective footwear.

8.40.2 Specimens. A minimum of three footwear items shall be tested.

8.40.3 Sample Preparation.

8.40.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.40.3.2 Samples for conditioning shall be whole footwear.

8.40.4 Procedure. Protective footwear shall be tested to 14,000 V (rms) in accordance with Section 5.1.1 of ASTM F 1116, *Standard Test Method for Determining Dielectric Strength of Overshoe Footwear*. The electrode inside the boot shall be conductive metal shot.

8.40.5 Report. Any current leakage or evidence of breakdown shall be recorded for each footwear item.

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

8.41 Eyelet and Stud Post Attachment Test.

8.41.1 Application. This test method shall apply to protective footwear eyelets and stud posts.

8.41.2 Specimens.

8.41.2.1 Specimens shall total two eyelets and two stud posts on three separate footwear items.

8.41.2.2 Specimens shall be removed from the footwear and shall be 25 mm × 50 mm (1 in. × 2 in.).

8.41.3 Sample Preparation.

8.41.3.1 Samples for conditioning shall be whole footwear.

8.41.3.2 The eyelets or stud post specimens shall be conditioned as specified in 8.1.2.

8.41.4 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.

8.41.5 Procedure. The stud post or eyelet puller shall be inserted or attached to the upper position of the tensile machine. The traverse rate shall be set at 50 mm/min (2 in./min). The test eyelet or stud post shall be attached using the appropriate puller fixture. 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. The distance between the clamps and stud hooks or eyelets shall be 1.6 mm to 3.2 mm (0.063 in. to 0.125 in.). The test shall then be started.

8.41.6 Report. The force will 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. The average force shall be calculated and reported.

8.41.7 Interpretation. The average force shall be used to determine pass/fail.

8.42 Overall Liquid Integrity Test Three.

8.42.1 Application. This test shall apply to protective footwear.

8.42.2 Specimens. A minimum of three footwear items shall be tested.

8.42.3 Sample Preparation.

8.42.3.1 Specimens shall be conditioned as specified in 8.1.2.

8.42.3.2 Samples for conditioning shall be whole footwear.

8.42.4 Procedure.

8.42.4.1 Protective footwear shall be tested in accordance with FIA Standard 1209, *Whole Shoe Flex*. The level of water shall be no less than 25 mm (1 in.) from the lowest point of the throat.

8.42.4.2 The test shall consist of 100,000 flexes.

8.42.4.3 After flexing, the specimen shall be placed in a container that allows its immersion in tap water, treated with a dye and a surfactant that achieves a surface tension of 34 dynes/cm, ±4 dynes/cm, to a height of not less than 25 mm (1 in.) from the lowest point of the throat. The paper toweling required in FIA Standard 1209, *Whole Shoe Flex*, shall be placed inside the footwear specimen such that the toweling intimately contacts all areas inside the footwear specimen to a height of not less than 25 mm (1 in.) from the lowest point of the throat.

8.42.4.4 After 2 hours, ±10 minutes, the paper toweling shall be removed and examined for evidence liquid leakage.

8.42.5 Report. The appearance of water leakage on the removed paper toweling shall be reported as failure for the tested specimen.

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

8.43 Label Durability and Legibility Test.

8.43.1 Application. This test method shall apply to labels on protective garments.

8.43.2 Samples. A minimum of three of each type of garment label shall be tested in each test. Where labels have areas of "write-in" information, two additional specimens shall be tested that include those areas with sample information written in.

8.43.3 Sample Preparation.

8.43.3.1 Specimens shall be conditioned as specified in 8.1.6.

8.43.3.2 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*.

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

8.43.3.4 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.

8.43.3.5 Specimen conditioning shall be as specified for the respective tests.

8.43.3.6 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.43.4.1, 8.43.4.2, and 8.43.4.3, respectively.

8.43.4 Procedures.

8.43.4.1 Laundering Durability Test.

8.43.4.1.1 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*.

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

8.43.4.1.3 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.

8.43.4.2 Abrasion Durability Test.

8.43.4.2.1 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 by applying 20 ml (0.68 oz) of distilled water from a squeeze bottle by squirting on the center of the abrasive composite pad.
(3) Specimens shall be subjected to 200 cycles, 3200 revolutions, of the test apparatus.

8.43.4.2.2 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.

8.43.4.3 Heat Durability Test.

8.43.4.3.1 Specimens shall be subjected to convective heat as specified in 8.1.8.

8.43.4.3.2 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.

8.43.5 Report. The legibility for each specimen shall be reported as acceptable or unacceptable.

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

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 The majority of performance criteria in this standard were based on the 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, U.S. Fire Administration, September 1993. This report documents 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.1.1.1 Emergency response personnel can encounter many common liquids during the normal performance of their duties. The reference to limited protection from chemical splash in 1.1.1 and Chapter 7 should not be interpreted to mean that the protective garments are suitable or are permitted to be used for protection to the wearer during any hazardous materials situation.

A.1.1.4 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 Ensemble for Structural 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 Ensemble for Structural Fire Fighting*
(2) NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*
(3) 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*
(2) NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*

Organizations responsible for emergency medical operations should use protective clothing and equipment specifically designed for those activities. The applicable standard is NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations.*

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 trim patterns. Tests specified in this standard should not be deemed as defining or establishing performance levels for protection from all technical rescue environments.

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 ensemble 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 USAR 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 USAR protective ensembles versus structural firefighting protective ensembles can be dependent on the level of fire risk at the incident.

A.1.2.2 The testing requirements in Chapter 8 of this standard are not intended to establish the limitations of the working environment for technical rescue but are intended to establish material performance.

Users should be advised that if unusual conditions prevail, or if there are signs of abuse or mutilation of the protective ensemble or any element or component thereof, or if modifications or replacements are made or accessories are added without authorization of the protective ensemble element manufacturer, the margin of protection 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 Metric units are used throughout with U.S. equivalents provided in parentheses.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.67 Product Label. The product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark can be attached to it or be part of the product label.

A.4.1.4 The NFPA, from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment could be carrying labels falsely identifying them as compliant with an NFPA standard. The requirement for placing the certification organization's mark on or next to the product label is to help ensure that the purchaser can readily determine compliance of the respective product through independent third-party certification.

A.4.2.1 The certification organization should have sufficient breadth of interest and activity so that the loss or award of a specific business contract would not be a determining factor in the financial well being of the agency.

A.4.2.3 The contractual provisions covering a certification program should contain clauses advising the manufacturer that if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently listed products.

Without the clauses, certifiers would not be able to move quickly to protect their name, marks, or reputation. A product safety certification program would be deficient without these contractual provisions and the administrative means to back them up.

A.4.2.4 Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the agency before any major testing is undertaken.

A.4.2.7 Such inspections should include, in most instances, witnessing of production tests. With certain products the certification organization inspectors should select samples from the production line and submit them to the main laboratory

for countercheck testing. With other products, it can be desirable to purchase samples in the open market for test purposes.

A.4.2.9 For further information and guidance on recall programs, see 21 CFR 7, Subpart C.

A.4.6 ISO 9000, *Quality Management Systems — Fundamentals and Vocabulary*, defines quality terms and concepts. It gives an overview of the content and use of the ISO 9000 series. ISO 9001, *Quality Management Systems — Requirements*, is used to register the manufacturer's quality system processes. It prescribes quality system requirements for design, development, production, installation, and servicing.

A.5.1.1 Purchasers could wish to include a requirement in the purchase specifications for an additional label that includes certain information such as the date of manufacture, manufacturer's name, and garment identification number to be located in a protected location on the garment in order to reduce the chance of label degradation and as a backup source of information to aid in garment tracking or during an investigation.

A.5.1.3 See A.4.1.4.

A.5.2.4 A statement should be included in the user information specifying that, upon the purchaser's request, the manufacturer is to furnish all documentation required by this standard and the test data showing compliance with this standard. A statement also should be included in the user information specifying that, upon the purchaser's request, the manufacturer is to furnish a complete specification of all materials and components comprising each certified helmet.

A.6.1.19 The selection of protective clothing size is related directly to the garment's ability to function properly. In occupations such as fire and rescue services, proper fit and function are related directly to the individual's ability to perform jobs that are often hazardous. Issues of proper fit are directly associated with the risk of injury. Protective clothing that restricts movement or exposes the skin to hazardous environments will result in lost efficiency and can promote injury and illness, respectively. Proper sizing is a factor in the ability of a person to perform tasks that often involve life or death situations. Protective clothing should fit well to function properly when additional safety equipment or other garments are worn. In addition, the selection of protective garment size has a direct impact on maintaining appropriate protection in areas where the protective garment has an interface with safety equipment or other protective garments. ASTM F 1731, *Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing*, can be useful when selecting protective clothing for technical operations. ASTM F 1731 primarily addresses processes for sizing station/work uniforms referenced in NFPA 1975, *Standard on Station/Work Uniforms for Fire and Emergency Services*; however, the techniques described in the standard will be useful in the selection of protective clothing addressed in this standard as well.

A.6.3.5 The purchaser should consider the following sizing performance recommendations and evaluation methods:

(1) Glove Fit/Performance Requirements.
   (a) Glove fit is defined in terms of finger length, finger circumference, glove circumference, and crotch offset.
   (b) The thumb and index finger of the hand should reach the ends of the thumb and index finger of the glove.
   (c) The middle and ring fingers of the glove can be permitted to extend beyond the finger of the hand no more than 10 mm (25⁄64 in.).
   (d) The little finger of the glove can be permitted to extend beyond the little finger of the hand no more than 13 mm (½ in.).
   (e) The finger crotches of the glove can be offset from the finger crotches of the hand no more than 13 mm (½ in.).
   (f) The glove should not be permitted to constrict the fingers of the hand in circumference.
   (g) Excess circumference of the glove over the fingers and hand can be permitted but should not exceed 10 mm (25⁄64) for any finger, or 13 mm (½ in.) for the hand as a whole.

(2) Glove Fit Test Method.
   (a) The subject's hand should be measured for hand circumference and hand length to determine the correct size of test glove. The method described in 6.3.4 should be used.
   (b) Samples should be conditioned to be new, after 10 washes *(see 8.1.3)*, and after heat resistance testing *(see Section 8.5)*.
   (c) The subjects should don the test gloves as they would their own gloves.
   (d) The subject should determine if the thumb and index finger are at the ends of the thumb and index finger of the glove. The tips of the thumb and index finger should be felt from the outside to verify the subject's answer.
   (e) An inside diameter caliper should be used to measure the excess of glove finger over the test subject's finger for the middle, ring, and little fingers.
   (f) The subject should determine if the glove constricts either the fingers or the hand in terms of circumference. Each finger, and the sides of the gloved hand, should be felt to verify the subject's answer.
   (g) An inside diameter caliper should be used to measure any excess circumference in each finger and in the hand. When recording the values, it should be noted that the measured excess should be doubled to convert the flat dimension into a circumferential dimension (to account for the fact that there are two thicknesses of the glove material).
   (h) The subject's hand dimensions, glove size, and all test results should be recorded.

A.8.1.6.7 A radiant heat exposure condition for helmets is specified in 8.1.6.7. Under controlled conditions, a radiant heat load of 1.0 W/cm^2 is applied until a temperature of 260°C (500°F) is reached on a transducer. This temperature alone does not simulate actual field conditions but is a test devised to put extreme heat loads on helmets in an accurate and reproducible manner by testing laboratories. However, the radiant heat load of 1.0 W/cm^2 was selected as an average value based on studies of fire conditions that relate to field use.

A.8.20.4.9 The following multiple-step calibration procedure is recommended:

(1) *Procedure 1: Medium and System Calibration.* This calibration step should be carried out with an accelerometer mounted in the impactor. The accelerometer should be mounted with its sensitive axis within 5 degrees of vertical. A calibrating medium should be mounted over the load cell, as specified in Section 6.20. The centers of the load cell, medium, impactor, and accelerometer should be colinear within 3 mm (⅛ in.), T.I.R. The impactor should be dropped from a height that yields a peak force of

9000 N, +500 N (2000 lbf, + 110 lbf). A means of verifying the impact velocity within 2 percent should be utilized. The measured peak force should equal (within 2.5 percent) the measured peak acceleration (in g's) times the weight of the impactor. This accuracy should be repeatable through at least five impacts.

(2) *Procedure 2: System Calibration Only.* A calibrating medium that has been tested in accordance with Procedure 1 can be used without an accelerometer or guided mass. The force value obtained when testing in accordance with Procedure 1 should be recorded and provided with the calibrating medium. The calibrating medium should be mounted over the load cell. The centers of the load cell, medium, impactor, and accelerometer should be collinear within 3 mm (⅛ in.), T.I.R. The impactor should be dropped onto the medium, and the peak force measured by the load cell should be recorded. The peak force should be within 2.5 percent of that recorded while testing in accordance with Procedure 1. The calibrating medium should be retested in accordance with Procedure 1 at not more than 4-month intervals.

(3) *Procedure 3: Electronic Calibration.* When in use, electronic calibration of the normally used instrumentation scales should be undertaken at least every 6 months. This should be accomplished by following the procedures recommended by the manufacturer of the instrumentation.

A.8.32.4.1 An example of an inner glove fabric is a lightweight, tightly woven, medium- or dark-colored, 100-percent polyester fabric without surface treatment.

Annex B Informational References

B.1 Referenced Publications. The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

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

NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting,* 2000 edition.

NFPA 1975, *Standard on Station/Work Uniforms for Fire and Emergency Services,* 1999 edition.

NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting,* 2000 edition.

NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting,* 1998 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* 2000 edition.

NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies,* 2000 edition.

NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations,* 1997 edition.

B.1.2 Other Publications.

B.1.2.1 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428–2959.

ASTM F 1731, *Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing*, 1996.

B.1.2.2 ISO Publications. International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Geneve 20, Switzerland.

ISO 9000, *Quality Management Systems — Fundamentals and Vocabulary*, 2000.

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

B.1.2.3 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 21, *Code of Federal Regulations*, Part 7, Subpart C, 1997.

B.2 Informational References. (Reserved)

Index