

NFPA®

1951

Standard on
Protective Ensembles for
Technical Rescue Incidents

2020



IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

NFPA® codes, standards, recommended practices, and guides (“NFPA Standards”), 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 NFPA 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 NFPA Standards. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making NFPA Standards 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 NFPA Standards. 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.

REVISION SYMBOLS IDENTIFYING CHANGES FROM THE PREVIOUS EDITION

Text revisions are shaded. A  before a section number indicates that words within that section were deleted and a  to the left of a table or figure number indicates a revision to an existing table or figure. When a chapter was heavily revised, the entire chapter is marked throughout with the  symbol. Where one or more sections were deleted, a • is placed between the remaining sections. Chapters, annexes, sections, figures, and tables that are new are indicated with an .

Note that these indicators are a guide. Rearrangement of sections may not be captured in the markup, but users can view complete revision details in the First and Second Draft Reports located in the archived revision information section of each code at www.nfpa.org/docinfo. Any subsequent changes from the NFPA Technical Meeting, Tentative Interim Amendments, and Errata are also located there.



ALERT: THIS STANDARD HAS BEEN MODIFIED BY A TIA OR ERRATA

Users of NFPA codes, standards, recommended practices, and guides (“NFPA Standards”) should be aware that NFPA Standards may be amended from time to time through the issuance of a Tentative Interim Amendment (TIA) or corrected by Errata. An official NFPA Standard at any point in time consists of the current edition of the document together with any TIAs and Errata then in effect.

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, go to www.nfpa.org/docinfo to choose from the list of NFPA Standards or use the search feature to select the NFPA Standard number (e.g., NFPA 13). The document information page provides up-to-date document-specific information as well as postings of all existing TIAs and Errata. It also includes the option to register for an “Alert” feature to receive an automatic email notification when new updates and other information are posted regarding the document.

ADDITIONAL IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

Updating of NFPA Standards

Users of NFPA codes, standards, recommended practices, and guides (“NFPA Standards”) should be aware that these documents may be superseded at any time by the issuance of a new edition, may be amended with the issuance of Tentative Interim Amendments (TIAs), or be corrected by Errata. It is intended that through regular revisions and amendments, participants in the NFPA standards development process consider the then-current and available information on incidents, materials, technologies, innovations, and methods as these develop over time and that NFPA Standards reflect this consideration. Therefore, any previous edition of this document no longer represents the current NFPA Standard on the subject matter addressed. NFPA encourages the use of the most current edition of any NFPA Standard [as it may be amended by TIA(s) or Errata] to take advantage of current experience and understanding. An official NFPA Standard at any point in time consists of the current edition of the document, including any issued TIAs and Errata then in effect.

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, visit the “Codes & Standards” section at www.nfpa.org.

Interpretations of NFPA Standards

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing the Development of NFPA Standards 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.

Patents

The NFPA does not take any position with respect to the validity of any patent rights referenced in, related to, or asserted in connection with an NFPA Standard. The users of NFPA Standards bear the sole responsibility for determining the validity of any such patent rights, as well as the risk of infringement of such rights, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on NFPA Standards.

NFPA adheres to the policy of the American National Standards Institute (ANSI) regarding the inclusion of patents in American National Standards (“the ANSI Patent Policy”), and hereby gives the following notice pursuant to that policy:

NOTICE: The user’s attention is called to the possibility that compliance with an NFPA Standard may require use of an invention covered by patent rights. NFPA takes no position as to the validity of any such patent rights or as to whether such patent rights constitute or include essential patent claims under the ANSI Patent Policy. If, in connection with the ANSI Patent Policy, a patent holder has filed a statement of willingness to grant licenses under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, copies of such filed statements can be obtained, on request, from NFPA. For further information, contact the NFPA at the address listed below.

Law and Regulations

Users of NFPA Standards should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

NFPA Standards are copyrighted. They are made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making these documents available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to these documents.

Use of NFPA Standards for regulatory purposes should be accomplished through adoption by reference. The term “adoption by reference” means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA Standards, contact NFPA at the address below.

For Further Information

All questions or other communications relating to NFPA Standards 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 standards during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101; email: stds_admin@nfpa.org.

For more information about NFPA, visit the NFPA website at www.nfpa.org. All NFPA codes and standards can be viewed at no cost at www.nfpa.org/docinfo.

Copyright © 2019 National Fire Protection Association®. All Rights Reserved.

NFPA® 1951

Standard on

Protective Ensembles for Technical Rescue Incidents

2020 Edition

This edition of NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*, was prepared by the Technical Committee on Special Operations Protective Clothing and Equipment and released by the Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on November 4, 2019, with an effective date of November 24, 2019, and supersedes all previous editions.

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

This edition of NFPA 1951 was approved as an American National Standard on November 24, 2019.

Origin and Development of NFPA 1951

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

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

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

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

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

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

- (1) A utility ensemble, which provides protection from physical hazards, a basic flame resistance for the ensemble and the elements of the ensemble, and a high level of “breathability” of the ensemble to reduce heat stress for the wearers
- (2) A rescue and recovery ensemble, which provides the physical protection of the utility ensemble and a blood-borne pathogen barrier to protect wearers from body fluid infection from injured or deceased victims
- (3) A CBRN ensemble, which in addition to all the protections of the rescue and recovery ensemble, provides limited protection from chemicals, biological agents, and radiological particulates during incidents involving chemical warfare agents or weapons of mass destruction

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

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

For the 2020 edition, several changes have been made to reflect the performance and safety needs of technical rescue responders and the hazards they face. Based on focused input from 589 survey respondents, as well as task group recommendations and technical committee direction, the technical committee developed a single base garment and ensemble elements and removed the utility, rescue and recovery, and CBRN categories. The flammability and thermal stability requirements remain the same. TPP and conductive heat requirements have been removed and blood-borne pathogen (BBP) protection has been added as an optional requirement specified by the end user. In addition, clarifying language has been added to collars and closure systems so as not to be design restrictive. Several test methods have been removed, others have been brought in line with NFPA 1971, and new tests have been added. Annex material has been added in several places to clarify requirements for end users. Definitions for *manufacturer* and *manufacturing facility* have been added to correlate with other standards in the PPE project.

In Memoriam, 11 September 2001

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

Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment

Jason L. Allen, Intertek Testing Services, NY [RT]
James B. Area, Chimera Enterprises International, MD [SE]
Joseph Arrington, San Antonio Fire Department, TX [U]
Roger L. Barker, North Carolina State University, NC [SE]
David T. Bernzweig, Columbus (OH) Division of Fire, OH [L]
 Rep. International Association of Fire Fighters
Cristine Z. Fargo, International Safety Equipment Association, VA [M]
Edmund Farley, Pittsburgh Bureau Of Fire, PA [E]
Patricia A. Gleason, ASTM/Safety Equipment Institute (SEI), VA [RT]
David V. Haston, US Department of Agriculture, ID [E]
Diane B. Hess, PBI Performance Products, Inc., NC [M]
Thomas M. Hosea, US Department of the Navy, FL [RT]
Beth C. Lancaster, US Department of Defense, VA [E]
Jeff Legendre, Northborough Fire Department, MA [U]
Karen E. Lehtonen, LION Group, Inc., OH [M]
David G. Matthews, Fire & Industrial (PPE) Ltd., United Kingdom [SE]
 Rep. International Standards Organization

Benjamin Mauti, Globe Manufacturing/Mine Safety Appliances Company, PA [M]
Michael F. McKenna, Michael McKenna & Associates, LLC, CA [SE]
Douglas Menard, Boston Fire Department, MA [U]
John H. Morris, 3M Company, GA [M]
Jack E. Reall, Columbus (OH) Division of Fire, OH [L]
 Rep. Columbus Firefighters Union
Jeffrey O. Stull, International Personnel Protection, Inc., TX [M]
Robert D. Tutterow, Jr., Fire Industry Education Resource Organization (FIERO), NC [U]
 Rep. NFPA Fire Service Section
William A. Van Lent, Veridian Ltd., Inc., IA [M]
 Rep. Fire & Emergency Manufacturers & Services Association
Bruce H. Varner, BHVarner & Associates, AZ [M]
 Rep. International Fire Service Training Association
Steven H. Weinstein, Honeywell Safety Products, CA [M]
Richard Weise, Los Angeles County Fire Department/Safer, CA [U]
Harry P. Winer, HIP Consulting LLC, MA [SE]

Alternates

Louis Carpentier, Innotech Inc., Canada [M]
 (Alt. to William A. Van Lent)
Robin B. Childs, US Department of Defense, VA [E]
 (Alt. to Beth C. Lancaster)
Patricia A. Freeman, Globe Manufacturing Company, LLC/Mine Safety Appliances Company (MSA), NH [M]
 (Alt. to Benjamin Mauti)
Kenneth Hayes, Boston Fire Department, MA [U]
 (Alt. to Douglas Menard)
Pamela A. Kavalesky, Intertek Testing Services, NY [RT]
 (Alt. to Jason L. Allen)
Judge W. Morgan, 3M Scott Safety, NC [M]
 (Alt. to John H. Morris)
Gary L. Neilson, Sparks, NV [U]
 (Alt. to Robert D. Tutterow, Jr.)
Amanda H. Newsom, UL LLC, NC [RT]
 (Voting Alt.)
Anthony Petrilli, US Department of Agriculture, MT [E]
 (Alt. to David V. Haston)
Kevin M. Roche, Facets Consulting, AZ [M]
 (Alt. to Bruce H. Varner)

Stephen R. Sanders, ASTM/Safety Equipment Institute (SEI), VA [RT]
 (Alt. to Patricia A. Gleason)
Russell Shephard, Australasian Fire & Emergency Service Authorities Council, Australia [SE]
 (Alt. to David G. Matthews)
David P. Stoddard, Michael McKenna & Associates, LLC, CA [SE]
 (Alt. to Michael F. McKenna)
Grace G. Stull, International Personnel Protection, Inc., TX [M]
 (Alt. to Jeffrey O. Stull)
Rick L. Swan, IAFF Local 2881/CDF Fire Fighters, VA [L]
 (Alt. to David T. Bernzweig)
Jonathan V. Szalajda, National Institute for Occupational Safety & Health, PA [E]
 (Voting Alt.)
Donald B. Thompson, North Carolina State University, NC [SE]
 (Alt. to Roger L. Barker)
W. Jason Traynor, MSA Safety, PA [M]
 (Voting Alt.)
Jian Xiang, The DuPont Company, Inc., VA [M]
 (Alt. to Diane B. Hess)

Nonvoting

Robert J. Athanas, FDNY/SAFE-IR, Incorporated, NY [U]
 Rep. TC on Electronic Safety Equipment
Christina M. Baxter, Emergency Response Tips, LLC, VA [U]
 Rep. TC on Hazardous Materials PC&E
George Broyles, US Forest Service, ID []
 Rep. TC on Wildland Fire Fighting PC&E
Tricia L. Hock, ASTM/Safety Equipment Institute (SEI), VA [RT]
 Rep. TC on Emergency Medical Services PC&E
Jeremy Metz, West Metro Fire Rescue, CO [U]
 Rep. TC on Special Operations PC&E

Stephen T. Miles, National Institute for Occupational Safety & Health, WV [E]
 Rep. TC on Respiratory Protection Equipment
Brian Montgomery, US Department of Justice, DC [E]
 Rep. Tactical and Technical Operations Respiratory Protection Equipment
Tim W. Tomlinson, Addison Fire Department, TX [C]

Chris Farrell, NFPA Staff Liaison

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

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

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

Technical Committee on Special Operations Protective Clothing and Equipment

Jeremy Metz, *Chair*
West Metro Fire Rescue, CO [U]

Karen E. Lehtonen, *Secretary*
LION Group, Inc., OH [M]

Jason L. Allen, Intertek Testing Services, NY [RT]
Joseph Arrington, San Antonio Fire Department, TX [U]
Richard J. Broccolo, Orange County Fire Rescue, FL [U]
Paul Dacey, W. L. Gore & Associates, MD [M]
Keith B. Dempsey, City of Dalton Fire Department, GA [C]
Richard Galtieri, Port Of Seattle Fire Department, WA [U]
Stephen J. Geraghty, Fire Department City of New York, NY [U]
Rep. Fire Department City of New York
William E. Haskell, III, National Institute for Occupational Safety & Health, MA [E]
Rep. National Institute for Occupational Safety & Health
Diane B. Hess, PBI Performance Products, Inc., NC [M]
Tricia L. Hock, ASTM/Safety Equipment Institute (SEI), VA [RT]
Gavin P. Horn, University of Illinois Fire Service Institute, IL [SE]

Thomas Howard, New York Division of Homeland Security & Emergency Services, NY [E]
Kim Klaren, Fairfax County Fire & Rescue Department, VA [U]
George R. Krause, II, Globe Manufacturing Company, Inc., NH [M]
Stephen Legros, City of Yuma Fire Department, AZ [U]
Loui McCurley, PMI, CO [M]
H. Dean Paderick, Special Rescue International, VA [SE]
Jack E. Reall, Columbus (OH) Division of Fire, OH [L]
Rep. Columbus Firefighters Union
Mark S. Saner, VF Imagewear/Bulwark Protective Apparel, CA [M]
Cedric Smith, CMC Rescue, Inc., CA [M]
Michael T. Stanhope, TenCate/Southern Mills, Inc., GA [M]
Robert Stinton, Diving Unlimited International, Inc., CA [M]

Alternates

Brian J. Beechner, Orange County Fire Rescue Department, FL [U]
(Alt. to Richard J. Broccolo)
Jeffrey S. Bowles, PMI Denver, CO [M]
(Alt. to Loui McCurley)
Jamey B. Brads, Special Rescue International, VA [SE]
(Alt. to H. Dean Paderick)
Charles S. Dunn, TenGate/Southern Mills, GA [M]
(Alt. to Michael T. Stanhope)
Patricia A. Freeman, Globe Manufacturing Company, LLC/Mine Safety Appliances Company (MSA), NH [M]
(Alt. to George R. Krause, II)
Gregory Gould, New York State Division of Homeland Security & Emergency Services-OFPC, NY [E]
(Alt. to Thomas Howard)
Daniel Hudson, City of Dalton Fire Department, GA [C]
(Alt. to Keith B. Dempsey)
Pamela A. Kavalesky, Intertek Testing Services, NY [RT]
(Alt. to Jason L. Allen)
John McKently, CMC Rescue, Inc., CA [M]
(Alt. to Cedric Smith)
Craig P. Mignogno, Columbus Firefighters Union, IAFF67, OH [L]
(Alt. to Jack E. Reall)

Dean D. Moran, ASTM/Safety Equipment Institute (SEI), VA [RT]
(Alt. to Tricia L. Hock)
James E. Murray, Fire Department City of New York, NY [U]
(Alt. to Stephen J. Geraghty)
Faith Ortins, Diving Unlimited International, Inc., CA [M]
(Alt. to Robert Stinton)
Jeffrey D. Palcic, National Institute for Occupational Safety and Health, PA [E]
(Alt. to William E. Haskell, III)
Jon Saito, West Metro Fire Rescue, CO [U]
(Alt. to Jeremy Metz)
Kimberly Schoppa, Fairfax County Fire And Rescue, VA [U]
(Alt. to Kim Klaren)
Ashley M. Scott, LION Group, Inc., OH [M]
(Alt. to Karen E. Lehtonen)
Brian P. Shiels, PBI Performance Products, Inc., NC [M]
(Alt. to Diane B. Hess)
Beverly Wooten Stutts, UL LLC, NC [RT]
(Voting Alt.)

Chris Farrell, NFPA Staff Liaison

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

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

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

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

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

Contents

Chapter 1 Administration	1951– 8	8.2 Flame Resistance Test 1.	1951– 27
1.1 Scope.	1951– 8	8.3 Heat and Thermal Shrinkage Resistance Test.	1951– 28
1.2 Purpose.	1951– 8	8.4 Total Heat Loss Test.	1951– 31
1.3 Application.	1951– 9	8.5 Tear Resistance Test.	1951– 31
1.4 Units.	1951– 9	8.6 Breaking Strength Test.	1951– 32
Chapter 2 Referenced Publications	1951– 9	8.7 Abrasion Resistance Test 1.	1951– 32
2.1 General.	1951– 9	8.8 Cleaning Shrinkage Resistance Test.	1951– 32
2.2 NFPA Publications.	1951– 9	8.9 Abrasion Resistance Test 2.	1951– 33
2.3 Other Publications.	1951– 9	8.10 Seam Breaking Strength Test.	1951– 34
2.4 References for Extracts in Mandatory Sections. (Reserved)	1951– 10	8.11 Water Absorption Resistance Test.	1951– 34
Chapter 3 Definitions	1951– 10	8.12 Thread Heat Resistance Test.	1951– 35
3.1 General.	1951– 10	8.13 Corrosion Resistance Test.	1951– 35
3.2 NFPA Official Definitions.	1951– 10	8.14 Liquid Penetration Resistance Test.	1951– 35
3.3 General Definitions.	1951– 11	8.15 Viral Penetration Resistance Test.	1951– 36
Chapter 4 Certification	1951– 13	8.16 Force Transmission Test.	1951– 36
4.1 General.	1951– 13	8.17 Physical Penetration Resistance Test.	1951– 37
4.2 Certification Program.	1951– 14	8.18 Electrical Insulation Test.	1951– 37
4.3 Inspection and Testing.	1951– 15	8.19 Suspension System Retention Test.	1951– 38
4.4 Annual Verification of Product Compliance. .	1951– 16	8.20 Retention System Test.	1951– 38
4.5 Manufacturers' Quality Assurance Program. .	1951– 16	8.21 Flame Resistance Test 3.	1951– 39
4.6 Hazards Involving Compliant Product.	1951– 16	8.22 Cut Resistance Test.	1951– 41
4.7 Manufacturers' Investigation of Complaints and Returns.	1951– 17	8.23 Puncture Resistance Test 1.	1951– 42
4.8 Manufacturers' Safety Alert and Product Recall Systems.	1951– 17	8.24 Glove Hand Function Test.	1951– 42
Chapter 5 Labeling and Information	1951– 18	8.25 Grip Test.	1951– 43
5.1 Product Label Requirements.	1951– 18	8.26 Glove Donning Test.	1951– 43
5.2 User Information.	1951– 19	8.27 Flame Resistance Test 4.	1951– 44
Chapter 6 Design Requirements	1951– 19	8.28 Ladder Shank Bend Resistance Test.	1951– 45
6.1 Technical Rescue Protective Ensemble Design Requirements.	1951– 19	8.29 Abrasion Resistance Test 3.	1951– 46
Chapter 7 Performance Requirements	1951– 22	8.30 Slip Resistance Test.	1951– 46
7.1 Technical Rescue Protective Ensemble Performance Requirements.	1951– 22	8.31 Electrical Insulation Test 2.	1951– 46
7.2 Optional Requirements for Blood-Borne Pathogen Protective Technical Rescue Garments.	1951– 24	8.32 Eyelet and Stud Post Attachment Test.	1951– 47
Chapter 8 Test Methods	1951– 25	8.33 Label Durability and Legibility Test.	1951– 47
8.1 Sample Preparation Procedures.	1951– 25	8.34 Burst Strength Test.	1951– 48
		8.35 Torque Test.	1951– 48
		8.36 Fastener Tape Strength Tests.	1951– 49
		8.37 Offset Force Transmission Test.	1951– 49
		Annex A Explanatory Material	1951– 50
		Annex B Informational References	1951– 54
		Index	1951– 56

NFPA 1951

Standard on

Protective Ensembles for Technical Rescue Incidents

2020 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading “Important Notices and Disclaimers Concerning NFPA Standards.” They can also be viewed at www.nfpa.org/disclaimers or obtained on request from NFPA.

UPDATES, ALERTS, AND FUTURE EDITIONS: New editions of NFPA codes, standards, recommended practices, and guides (i.e., NFPA Standards) are released on scheduled revision cycles. This edition may be superseded by a later one, or it may be amended outside of its scheduled revision cycle through the issuance of Tentative Interim Amendments (TIAs). An official NFPA Standard at any point in time consists of the current edition of the document, together with all TIAs and Errata in effect. To verify that this document is the current edition or to determine if it has been amended by TIAs or Errata, please consult the National Fire Codes® Subscription Service or the “List of NFPA Codes & Standards” at www.nfpa.org/docinfo. In addition to TIAs and Errata, the document information pages also include the option to sign up for alerts for individual documents and to be involved in the development of the next 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.

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

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

Chapter 1 Administration

1.1* Scope.

1.1.1 This standard shall specify the minimum design, performance, testing, and certification requirements for **technical rescue** protective ensembles for use by emergency services personnel during technical rescue incidents.

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

- Δ 1.1.3 This standard shall not specify requirements for respiratory protection equipment for technical rescue protective ensembles; those requirements are specified by NIOSH in 42 CFR 84 and by OSHA in 29 CFR 1910.134.

1.1.4 This standard shall not establish criteria for water or **wildland** operations.

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

- 1.1.6 This standard shall not establish criteria for protection for any **firefighting** operations or hazardous materials emergencies.

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

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

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

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

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

1.2* Purpose.

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

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

1.2.2.1* This standard shall establish limited protection for operational settings where exposure to physical and **flame** hazards are expected.

1.2.2.2* This standard shall also establish optional requirements for operational settings where exposure to **blood-borne** pathogen hazards are expected.

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

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

1.3 Application.

1.3.1 This standard shall apply to the design, manufacturing, testing, and certification of new **technical rescue** protective ensembles and new ensemble elements.

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

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

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

1.3.5 The requirements of this standard shall not apply to accessories that could be attached to any element of technical rescue ensembles. (See A.1.1.7.)

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

1.3.7 This standard shall not apply to the use of **technical rescue** protective ensembles and ensemble elements.

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

1.4* Units.

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

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

Chapter 2 Referenced Publications

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

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

NFPA 1855, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Technical Rescue Incidents*, 2018 edition.

Δ 2.3 Other Publications.

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

AATCC 42, *Water Resistance: Impact Penetration Test*, 2017.

AATCC 61, *Colorfastness to Laundering: Accelerated*, 2013.

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

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

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

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

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

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, 2016.

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

ASTM D1683/D1683M, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, 2017e1.

ASTM D3787, *Standard Test Method for Bursting Strength of Textiles — Constant-Rate-of-Traverse (CRT) Ball Burst Test*, 2016.

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

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

ASTM D3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*, 1983.

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

ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, 2017.

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

ASTM D5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners*, 2015.

ASTM D5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners*, 2015.

ASTM D5587/D5587M, *Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure*, 2016.

ASTM D6413/D6413M, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, 2015.

ASTM D7138, *Standard Test Method to Determine Melting Temperature of Synthetic Fibers*, 2016.

ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, 2017.

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

ASTM F1671/F1671M, *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*, 2013.

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

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

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

ASTM F2412, *Standard Test Methods for Foot Protection*, 2018a.

ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, 2018.

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

ASTM F2961, *Standard Test Method for Characterizing Gripping Performance of Gloves Using a Torque Meter*, 2015.

2.3.4 CENELEC Publications. CENELEC, European Committee for Electrotechnical Standardization, CEN-CENELEC Management Centre, Avenue Marnix 17, 4th floor, B-1000, Brussels.

CEN EN 16473, *Firefighter Helmets — Helmets for Technical Rescue*, 2014.

EN 13087-8, *Protective helmets — Test methods — Part 8: Electrical properties*, 2005.

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

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

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

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

ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using rotating cylindrical drum device*, 2017.

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

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

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

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

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

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

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

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

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

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

Title 29, Code of Federal Regulations, Part 1910.134, “Respiratory Protection Standard.”

Title 42, Code of Federal Regulations, Part 84.

2.3.9 Other Publications.

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

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

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

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

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational

note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

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

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

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

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

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

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

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

3.3.8 CBRN. An abbreviation for chemicals, biological agents, and radiological particulate hazards.

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

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

3.3.11 Coat. See 3.3.92, Technical Rescue Protective Garments.

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

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 Coverall. See 3.3.92, Technical Rescue Protective Garments.

3.3.18 Decontamination. The act of removing contaminants from protective clothing and equipment by a physical, chemical, or combined process.

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

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

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

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

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

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

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

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

3.3.27 Footwear. See 3.3.91, Technical Rescue Protective Footwear.

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

3.3.29 Garment. See 3.3.92, Technical Rescue Protective Garments.

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

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

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

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

3.3.34 Glove. See 3.3.93, Technical Rescue Protective Gloves.

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

3.3.36 Glove Gauntlet. See 3.3.33, Gauntlet.

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

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

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

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

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

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

▲ **3.3.43 Helmet.** See 3.3.95, Technical Rescue Protective Helmets.

3.3.44 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.

• **3.3.45 Insole.** The inner component of the footwear upon which the foot rests.

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

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

3.3.48 Ladder Shank. See 3.3.82, Shank.

3.3.49 Liquid-Borne Pathogen. See 3.3.4, Body Fluid-Borne Pathogen.

3.3.50 Major A Seam. See 3.3.79.1.

3.3.51 Major B Seam. See 3.3.79.2.

▲ **3.3.52 Manufacturer.** The entity that assumes the liability for the compliant product.

■ **3.3.53 Manufacturing Facility.** A facility that produces, assembles, labels, or performs final inspection of a compliant product.

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

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

3.3.56 Minor Seam. See 3.3.79.3.

3.3.57 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 manufacturer

and quality assurance procedures that are covered by the same certification.

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

3.3.59 Operations.

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

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

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

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

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

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

▲ **3.3.64 Protective Clothing.** See 3.3.90, Technical Rescue Protective Ensembles.

▲ **3.3.65 Protective Coat.** See 3.3.92, Technical Rescue Protective Garments.

▲ **3.3.66 Protective Coverall.** See 3.3.92, Technical Rescue Protective Garments.

▲ **3.3.67 Protective Ensemble.** See 3.3.90, Technical Rescue Protective Ensembles.

▲ **3.3.68 Protective Footwear.** See 3.3.91, Technical Rescue Protective Footwear.

▲ **3.3.69 Protective Garment.** See 3.3.92, Technical Rescue Protective Garments.

▲ **3.3.70 Protective Glove.** See 3.3.93, Technical Rescue Protective Gloves.

▲ **3.3.71 Protective Goggle.** See 3.3.94, Technical Rescue Protective Goggles.

▲ **3.3.72 Protective Helmet.** See 3.3.95, Technical Rescue Protective Helmets.

▲ **3.3.73 Protective Trouser.** See 3.3.92, Technical Rescue Protective Garments.

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

• **3.3.75 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.

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

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

3.3.78 Sample. The ensemble, element, item, component, or composite that is conditioned for testing. (See also 3.3.85, *Specimen*.)

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

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

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

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

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

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

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

3.3.83 Shell. See 3.3.60, Outer Shell.

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

3.3.85 Specimen. The conditioned element, item, component, or composite that is tested; specimens are taken from samples. (See also 3.3.78, *Sample*.)

3.3.86 Strap.

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

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

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

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

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

Δ **3.3.90 Technical Rescue Protective Ensembles.** A protective ensemble that includes but is not limited to garments, helmets, goggles, gloves, and footwear.

Δ **3.3.91 Technical Rescue Protective Footwear.** The certified element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.92 Technical Rescue Protective Garments. The coat, trouser, and coverall certified elements of the protective ensemble that provide protection to the upper and lower torso, arms, and legs.

3.3.93 Technical Rescue Protective Gloves. The certified element of the protective ensemble that provides protection to the hand and wrist.

3.3.94 Technical Rescue Protective Goggles. The certified element of the protective ensemble that provides partial protection to the face and eyes.

Δ **3.3.95 Technical Rescue Protective Helmets.** The certified element of the protective ensemble that provides protection to the head.

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

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

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

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

3.3.100 Torso.

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

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

• **3.3.101 Treatment.** The provision of medical first aid at the incident.

Δ **3.3.102 Trouser.** See 3.3.92, Technical Rescue Protective Garments.

• **3.3.103 Wear Surface.** The bottom of the footwear sole, including the heel.

N **3.3.104 Winter Liner.** An optional component layer that provides added insulation against cold.

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

Chapter 4 Certification

4.1 General.

4.1.1 The process of certification for protective ensembles and ensemble elements as being compliant with NFPA 1951 shall meet the requirements of Section 4.1, General; Section 4.2, Certification Program; Section 4.3, Inspection and Testing; Section 4.4, Annual Verification of Product Compliance; Section 4.5, Manufacturers' Quality Assurance Program; Section 4.6, Hazards Involving Compliant Product; Section 4.7, Manufacturers' Investigation of Complaints and Returns; and

Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

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

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

4.1.4* Manufacturers shall not claim compliance with portions or segments of the requirements of this standard and shall not use the NFPA name or the name or identification of this standard, NFPA 1951, in any statements about their respective product(s) unless the product(s) is certified as compliant to this standard.

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

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

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

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

4.1.9 The certification organization shall not issue any new certifications to the 2013 edition of this standard on or after the NFPA effective date for the 2020 edition.

4.1.10 The certification organization shall not permit any manufacturer to continue to label any protective ensembles or ensemble elements that are certified as compliant with the 2013 edition of this standard on or after the effective date for the 2020 edition plus 12 months.

4.1.11 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2013 edition of this standard from all protective ensembles and ensemble elements that are under the control of the manufacturer on the effective date of the 2020 edition plus 12 months, and the certification organization shall verify that this action is taken.

4.2 Certification Program.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

definition of manufacturing facility. (See 3.3.53, *Manufacturing Facility*.)

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

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

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

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

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

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

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

4.3 Inspection and Testing.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.4 Annual Verification of Product Compliance.

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

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

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

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

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

4.5* Manufacturers' Quality Assurance Program.

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

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

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

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

4.5.3.1 Registration to the requirements of ISO 9001, *Quality management systems — Requirements*, shall be conducted by a registrar that is accredited for personal protective equipment in accordance with ISO/IEC 17021, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*. The registrar shall affix the accreditation mark on the ISO registration certificate.

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

4.6 Hazards Involving Compliant Product.

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

body in the event of misuse of its mark of conformity, and as modified herein.

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

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

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

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

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

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

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

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

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

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

- (1) Notification of parties authorized and responsible for issuing a safety alert when, in the opinion of the certification organization, such a notification is necessary to inform the users

- (2) Notification of parties authorized and responsible for issuing a product recall when, in the opinion of the certification organization, such a recall is necessary to protect the users
- (3) Removal of the mark of certification from the product
- (4) Where a hazardous condition exists and it is not practical to implement 4.6.11(1), 4.6.11(2), or 4.6.11(3), or the responsible parties refuse to take corrective action, the certification organization shall notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard

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

4.6.13* Where a change to an NFPA standard(s) is felt to be necessary, the certification organization shall also provide a copy of the report and corrective actions indicated to the NFPA, and shall also submit either a public proposal for a proposed change to the next revision of the applicable standard, or a proposed temporary interim amendment (TIA) to the current edition of the applicable standard.

4.7 Manufacturers' Investigation of Complaints and Returns.

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

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

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

4.8 Manufacturers' Safety Alert and Product Recall Systems.

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

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

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

- (4) Procedures for removing a product that is recalled and for documenting the effectiveness of the product recall
- (5) A plan for either repairing, replacing, or compensating purchasers for returned product

Chapter 5 Labeling and Information

5.1 Product Label Requirements.

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

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

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

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

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

▲ **5.1.6** The statement specified in 5.1.6.1 for the specific element being certified shall be printed legibly on the product label. The appropriate term for the element (e.g., garment, helmet, glove, footwear, goggles) shall be inserted in the compliance statement text where indicated. All letters shall be at least 2.5 mm ($\frac{3}{32}$ in.) in height.

▲ **5.1.6.1** For technical rescue protective ensemble elements, the following statement shall be printed as specified in 5.1.6:

THIS TECHNICAL RESCUE PROTECTIVE ENSEMBLE
[insert appropriate element term here] **ELEMENT MEETS THE**
REQUIREMENTS OF NFPA 1951, STANDARD ON
PROTECTIVE ENSEMBLES FOR TECHNICAL RESCUE
INCIDENTS, 2020 EDITION.
DO NOT REMOVE THIS LABEL.

5.1.6.2 Where technical rescue garments meet the optional requirements for blood-borne pathogen protective garments, the following statement shall also be printed on the product label as specified in 5.1.6 immediately following the statement in 5.1.6.1:

THIS GARMENT MEETS THE OPTIONAL BLOOD-BORNE
PATHOGEN PROTECTION REQUIREMENTS OF
NFPA 1951-2020.

● **5.1.6.3** Where the technical rescue garments meet the optional requirements for blood-borne pathogen protective garments and are composed of separable layers, at least the following statement and information shall also be printed on the product label as specified in 5.1.6 and placed on the outer shell:

FOR COMPLIANCE WITH THE BLOOD-BORNE PATHOGEN PROTECTION OPTIONAL REQUIREMENTS OF NFPA 1951, THE FOLLOWING PROTECTIVE ITEMS MUST BE WORN IN CONJUNCTION WITH THIS GARMENT:
(list separable layers here).

▲ **5.1.7** The following information shall also be printed legibly on the product label, and all letters shall be at least 1.6 mm ($\frac{1}{16}$ in.) high:

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

5.1.8 Supplementary Product Labels.

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

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

● **5.1.9 Specific Requirements for Technical Rescue Incidents Protective Goggles.**

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

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

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

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

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

MEETS NFPA 1951, 2020 EDITION

5.2 User Information.

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

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

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

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

- (1) Pre-use information, including the following:
 - (a) Safety considerations
 - (b) Limitations of use
 - (c) Marking recommendations and restrictions
 - (d) A statement that most performance properties of the element cannot be tested by the user in the field
 - (e) Warranty information
- (2) Preparation for use, including the following:
 - (a) Sizing/adjustment
 - (b) Recommended storage practices
- (3) Inspection, including inspection frequency and details
- (4) Don/doff, including the following:
 - (a) Donning and doffing procedures
 - (b) Sizing and adjustment procedures
 - (c) Interface issues
- (5) Use, including proper use consistent with 29 CFR 1910.132
- (6) Maintenance and cleaning, including the following:
 - (a) Cleaning instructions and precautions with a statement advising users not to use garments that are not thoroughly cleaned and dried
 - (b) Inspection details
 - (c) Maintenance criteria and methods of repair where applicable
 - (d) Decontamination procedures for both chemical and biological contamination
- (7) Retirement and disposal, including criteria and considerations
- (8) A statement that the liquid barrier layer has not been evaluated for all chemicals that can be encountered during technical rescue operations and information that the effects of chemical exposure on the liquid barrier layer are to be evaluated per the inspection procedures in NFPA 1855.

Chapter 6 Design Requirements

▲ 6.1 Technical Rescue Protective Ensemble Design Requirements.

6.1.1 Technical Rescue Protective Ensemble Garment Elements.

- ▲ 6.1.1.1 Garments shall at least **meet** the design requirements specified in this section.

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

6.1.1.3 All **coats and coveralls** shall have a collar.

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

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

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

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

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

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

6.1.1.10 All coat front closure systems and trouser fly closure systems shall be secured with positive locking fasteners, including, but not limited to, hooks and dees or zippers.

- 6.1.1.10.1 Nonpositive fasteners, such as snaps or hook and pile tape, shall not be used as positive locking fasteners but shall be permitted to be utilized as supplementary garment closure devices.

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

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

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

6.1.1.14* Garment Sizing.

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

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

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

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

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

N 6.1.1.15 Optional Requirements for Blood-Borne Pathogen Protective Technical Rescue Garment Ensemble Elements.

N 6.1.1.15.1* Garments shall have a means of securing the barrier layer to the outer shell.

N 6.1.1.15.2 Garment barrier layers or materials meeting the performance requirements of this component shall extend at least to the neckline seam of coats and to the waistline seam of trousers and shall extend to at least 75 mm (3 in.) of the bottom outer shell hems of both coats and trousers.

N 6.1.1.15.2.1 For coats, the barrier layers or materials meeting the performance requirements of this component shall extend at least to within 25 mm (1 in.) of the sleeve ends of the outer shell and shall be attached at or adjacent to the end of the coat sleeves.

N 6.1.1.15.2.2 For trousers, the barrier layers or materials meeting the performance requirements of this component shall be attached to the trouser legs.

N 6.1.1.15.2.3 Any mechanism used to attach the barrier layer to the coat sleeves or trouser legs shall not be greater than 25 mm (1 in.) between the attachment points, and the mechanism and attachment points shall not be expandable.

N 6.1.1.15.3 Garments and their closure systems, including the coat front and the trouser fly, shall be constructed in a manner that provides continuous liquid protection.

N 6.1.1.15.4 All garment barrier layer seams shall be sealed to provide continuous liquid protection.

N 6.1.1.15.5 Pass-through openings of the barrier layer shall not be permitted.

6.1.2 Technical Rescue Protective Ensemble Helmet Elements.

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

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

6.1.2.3 Helmet suspension shall be adjustable in at least 3 mm ($\frac{1}{8}$ in.) hat size increments, and the size range that can be accommodated shall be marked on the product label.

Δ 6.1.2.4 Chin straps shall be provided and shall not be less than 12 mm ($\frac{1}{2}$ in.) in width.

6.1.2.5 Product labels and any other identification labels or markers used on helmet shells shall be affixed without the use of any metal parts or metallic labels.

N 6.1.2.6* Helmets shall be permitted to have ventilation openings.

6.1.3 Technical Rescue Protective Ensemble Glove Elements.

Δ 6.1.3.1 Gloves shall at least meet the design requirements specified in this section.

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

6.1.3.3 The glove shall consist of at least a glove body.

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

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

Δ 6.1.3.3.3 The portion of the glove that extends from the wrist crease up to the end of the entire glove, where present, shall be considered to be the glove interface component and shall meet the glove interface component requirements as specified in 7.1.3.

N 6.1.3.3.3.1 The location of the wrist crease shall be determined by first placing the glove on a measurement board palm down and securing (locking) the fingertips down on the board.

N 6.1.3.3.3.2 A 454 g (1 lb) weight shall be attached to the end of the glove body or gauntlet glove interface component. The weight shall not be attached to a knitted wristlet glove interface component. The weight shall be applied evenly across the glove.

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

6.1.3.3.3.4* Two points shall be marked on the back side of the glove, and the location of the points shall be determined by measuring down the distances shown in Table 6.1.3.3.3.4 from the finger crotch of digit two and from the finger crotch of digit three. The distances are shown according to glove size.

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

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

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

N 6.1.3.4 The glove shall be designed to fit closely around the wearer's wrist or shall be adjustable such that a close fit around the wearer's wrist can be achieved.

Δ Table 6.1.3.3.3.4 Glove Sizes and Corresponding Palm Length

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

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

• **6.1.3.6* Glove Sizing.**

6.1.3.6.1 In order to label or otherwise represent a glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in not fewer than the following sizes:

- (1) Extra Small (XS)
- (2) Small (S)
- (3) Medium (M)
- (4) Large (L)
- (5) Extra Large (XL)
- (6) Extra, Extra Large (XXL)

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

N 6.1.3.6.3 The glove size indicated on the label shall be determined by the hand length and hand circumference ranges provided in Table 6.1.3.6.3.

6.1.4 Technical Rescue Protective Ensemble Footwear Elements.

Δ 6.1.4.1 Footwear shall at least meet the design requirements specified in this section.

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

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

6.1.4.4 Footwear height shall be a minimum of 150 mm (6 in.).

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

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

Δ 6.1.4.4.3 Moisture protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear topline at all locations with the exception of the area inside of and within 13 mm (0.5 in.) around pull-up holes that fully penetrate the

footwear from the outside to the inside. The height of moisture protection at all locations of the boot shall be no less than 150 mm (6 in.) when measured as described in 6.1.4.4.1.

Δ 6.1.4.4.4 Physical protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear topline at all locations with the exception of the tongue, gusset, and the area inside of and within 13 mm (0.5 in.) around pull-up holes that fully penetrate the footwear from the outside to the inside. The height of physical protection at all locations of the boot with the exception of the tongue and gusset shall be no less than 150 mm (6 in.) when measured as described in 6.1.4.4.1.

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

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

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

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

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

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

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

6.1.4.12 Where the footwear incorporates a metatarsal impact guard, it shall be positioned partially over the protective toecap and extended to cover the metatarsal bone area. Where provided, the metatarsal protection shall be an integral and permanent part of the footwear.

Δ 6.1.4.13 Footwear shall meet the performance requirements as specified in ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact-resistant footwear, compression-resistant footwear, and puncture-resistant footwear with the exception that flex resistance to cracking shall not be evaluated.

N 6.1.4.14 Where metatarsal protection is provided, footwear shall also meet the performance requirements as specified in ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, for metatarsal protective footwear.

N **Table 6.1.3.6.3 Hand Length and Hand Circumference Ranges**

	Range for Hand Length	Range for Hand Circumference
	(cm/in.)	(cm/in.)
Sizing for:		
Extra Small (XS) glove	16.25–17.25/6.40–6.79	16.25–20.25/6.40–7.97
Small (S) glove	17.25–18.25/6.79–7.19	17.25–21.25/6.79–8.37
Medium (M) glove	18.25–19.25/7.19–7.58	18.25–22.25/7.19–8.76
Large (L) glove	19.25–20.25/7.58–7.97	19.25–23.25/7.58–9.15
Extra-Large (XL) glove	20.25–21.25/7.97–8.37	20.25–24.25/7.97–9.55
Extra, Extra-Large (XXL) glove	> 21.25/> 8.37	> 24.25/> 9.55

6.1.4.15 Footwear Sizing.

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

- (1) Men's 6–15, including half sizes, and a minimum of three widths
- (2) Women's 5–10, including half sizes, and a minimum of three widths

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

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

6.1.5 Utility Protective Ensemble Goggle Elements.

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

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

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

Chapter 7 Performance Requirements

7.1 Technical Rescue Protective Ensemble Performance Requirements.

7.1.1 Technical Rescue Protective Ensemble Garment Elements.

7.1.1.1 Garment composites shall be tested for total heat loss as specified in Section 8.4, Total Heat Loss Test, and shall have a total heat loss equal to or greater than 650 W/m².

7.1.1.2 Textile fabrics and linings used for garments shall be tested for tear resistance as specified in Section 8.5, Tear Resistance Test, and shall have a tear resistance of not less than 30 N (6.75 lbf).

7.1.1.3 Outer shell fabric shall be tested for breaking strength as specified in Section 8.6, Breaking Strength Test, and shall have a breaking strength of not less than 400 N (90 lbf).

7.1.1.4 Garment outer shell fabrics shall be tested for abrasion resistance as specified in Section 8.7, Abrasion Resistance Test 1, and shall have an ending breaking strength of not less than 230 N (50 lbf).

7.1.1.5 Garment outer shell fabrics and liners shall be individually tested for cleaning shrinkage resistance as specified in Section 8.8, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in either direction.

7.1.1.6 All garment seam assemblies shall be tested for seam strength as specified in Section 8.10, Seam Breaking Strength Test, and shall demonstrate a seam strength equal to or greater than that stipulated for the respective seam type.

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

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

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

7.1.1.7 Textile fabrics, linings, collar linings, lettering, and other materials used in garment construction, including but not limited to padding, reinforcement, interfacing, binding, and hanger loops but excluding emblems, labels, and patches, shall be individually tested for flame resistance as specified in Section 8.2, Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.), shall not have an after-flame of more than 2 seconds, and shall not melt or drip.

▲ **7.1.1.7.1** Zippers shall meet the performance requirements specified in 7.1.1.7 only where located on the exterior of the garment.

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

▲ **7.1.1.7.3** Small specimens that are not large enough to meet the sample size requirements in 8.2.2.1 shall be tested for resistance to flame as specified in 8.2.11 and shall not have an after-flame of more than 2 seconds and shall not melt or drip.

7.1.1.8 Garment materials utilized in garments shall be individually tested for thermal shrinkage resistance as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

7.1.1.9 Garment materials shall be individually tested for heat resistance in their original form as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, ignite, or char.

• **7.1.1.10** Sewing thread utilized in the construction of garments shall be tested for heat resistance as specified in Section 8.12, Thread Heat Resistance Test, and shall not melt.

7.1.1.11 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.13, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

• **7.1.1.12** Garment outer shell fabric shall be tested for water absorption resistance as specified in Section 8.11, Water Absorption Resistance Test, and shall have a percent water absorption of 15 percent or less.

7.1.1.13 Garment product labels shall be tested for legibility as specified in Section 8.33, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

▲ **7.1.1.14** Where used as part of a garment closure, fastener tape shall be tested for breaking strength as specified in Section 8.36, Fastener Tape Strength Tests, and in A-A-55126B,

Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic, and shall meet or exceed the minimum breaking strength requirements as set forth in the specification established in Table 1 of A-A-55126B, Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic.

▲ 7.1.1.15 Where used as part of a garment closure, fastener tape shall be tested for shear strength as specified in Section 8.36, Fastener Tape Strength Tests, and in A-A-55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic, and shall meet or exceed the minimum shear strength requirements as set forth in the specification established in Table 1 of A-A-55126B, Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic.*

▲ 7.1.1.16 Where used as part of a garment closure, fastener tape shall be tested for peel strength as specified in Section 8.36, Fastener Tape Strength Tests, and in A-A-55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic, and shall meet or exceed the minimum peel strength requirements as set forth in the specification established in Table 1 of A-A-55126B, Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic.*

7.1.2 Technical Rescue Protective Ensemble Helmet Elements.

7.1.2.1 Helmets shall be tested for heat resistance as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and shall not have any distortion of the shell extend more than 30 mm (1 $\frac{1}{16}$ in.) below the original position of the helmet, and hardware and retention system shall remain functional.

7.1.2.2 Helmets shall be tested for force transmission as specified by Section 8.16, Force Transmission Test, and shall not transmit an average force of more than 3785 N (850 lbf). No individual specimen shall transmit a force of more than 4450 N (1000 lbf).

■ 7.1.2.3 Helmets shall be tested for force transmission as specified in Section 8.37, Offset Force Transmission Test, and shall not transmit an average force of more than 5 kN (1124 lbf) when subjected to an impact energy of 25 J $\pm$ 1 J.

7.1.2.4 Helmets shall be tested for physical penetration resistance as specified in Section 8.17, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration striker and the headform.

▲ 7.1.2.5 Helmet shell material shall be tested for electrical conductivity as specified in Section 8.18, Electrical Insulation Test, and shall not have electrical leakage current exceeding 1.2 milliamperes.

▲ 7.1.2.6 Helmets with suspension systems shall be tested as specified in Section 8.19, Suspension System Retention Test, and shall not have the minimum force required to separate any individual attachment point of the suspension assembly from the helmet shell be less than 22 N (5 lbf).

7.1.2.7 Helmets shall be tested for retention system and chin strap efficiency as specified in Section 8.20, Retention System Test, and the retention system shall not break or show any slip or stretch greater than 38 mm (1 $\frac{1}{2}$ in.).

7.1.2.8 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.13, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc,

show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

- 7.1.2.9 Helmet product labels shall be tested for legibility as specified in Section 8.33, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.1.3 Technical Rescue Protective Ensemble Glove Elements.

▲ 7.1.3.1 Glove body composites shall be tested for resistance to cut as specified in Section 8.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

▲ 7.1.3.2 Glove body composites shall be tested as specified in Section 8.23, Puncture Resistance Test 1, and shall not puncture under an average applied force of 22 N (5 lbf).

▲ 7.1.3.3 Glove body composites shall be tested as specified in Section 8.9, Abrasion Resistance Test 2, and shall show no wear-through.

7.1.3.4 Gloves shall be tested for hand function as specified in Section 8.24, Glove Hand Function Test, and shall not have an average percent of barehanded control exceeding 170 percent.

7.1.3.5 Gloves shall be tested for grip as specified in Section 8.25, Grip Test, and shall not have a drop of force of more than 30 percent in any 0.2-second interval.

▲ 7.1.3.6 Gloves shall be tested for ease of donning as specified in Section 8.26 and shall have neither a baseline donning time exceed 10 seconds nor a final donning time exceed the baseline donning time plus 20 seconds, shall have no detachment of the inner liner, where present, and shall allow full insertion of all digits.

7.1.3.7 Glove body composites, including but not limited to trim, labels, and external tags, but excluding hardware and hook and pile fasteners that do not directly contact the wearer's body, shall be individually tested for flame resistance as specified in Section 8.21, Flame Resistance Test 3; shall have an average char length of not more than 100 mm (4 in.); shall have an average afterflame of not more than 2 seconds; and shall not melt or drip.

7.1.3.8 Gloves shall be tested for heat resistance as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and shall not separate, melt, ignite, or drip. Hook and pile fasteners on gloves shall be excluded from these requirements because these items are placed such that they will not directly contact the wearer's body.

7.1.3.9 All glove metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.13, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

- 7.1.3.10 Glove knit wristlet material shall be tested for material strength as specified in Section 8.34, Burst Strength Test, and shall have a burst strength of not less than 180 N (40.7 lbf).

7.1.3.11 Sewing thread utilized in the construction of gloves shall be tested for heat resistance as specified in Section 8.12, Thread Heat Resistance Test, and shall not melt.

7.1.3.12 Glove product labels shall be tested for legibility as specified in Section 8.33, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

7.1.3.13 Glove interface component composites shall be individually tested for flame resistance as specified in Section 8.21, Flame Resistance Test 3, and shall have an average char length of not more than 100 mm (4 in.), shall have an average after-flame of not more than 2 seconds, and shall not melt or drip.

7.1.3.14 Gloves shall be tested for grip function as specified in Section 8.35, Torque Test, and shall have an average percent of barehanded control not less than 80 percent.

Δ 7.1.4 Technical Rescue Protective Ensemble Footwear Elements.

7.1.4.1 Footwear uppers shall be tested for abrasion resistance as specified in Section 8.9, Abrasion Resistance Test 2, and shall show no wear-through.

7.1.4.2 Footwear uppers shall be tested for cut resistance as specified in Section 8.22, Cut Resistance Test, and shall have a distance of blade travel not less than 20 mm (0.8 in.).

7.1.4.3 Footwear uppers shall be tested for puncture resistance as specified in Section 8.23, Puncture Resistance Test 1, and shall not puncture under an applied force of 45 N (10 lbf).

7.1.4.4 Footwear ladder shanks shall be tested for resistance to bending as specified in Section 8.28, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (¼ in.).

7.1.4.5 Footwear soles and heels shall be tested for abrasion resistance as specified in Section 8.29, Abrasion Resistance Test 3, and the relative volume loss shall not be greater than 250 mm³ (0.02 in.³).

Δ 7.1.4.6 Footwear shall be tested for slip resistance as specified in Section 8.30, Slip Resistance Test, and shall have a coefficient of friction of 0.45 or greater.

7.1.4.7 Footwear shall be tested for electrical conduction as specified in Section 8.31, Electrical Insulation Test 2, and shall not have any electrical leakage exceed 3 milliamperes.

7.1.4.8 Eyelets and stud hooks shall be tested for detachment strength as specified in Section 8.32, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 300 N (66 lbf).

7.1.4.9 All metal hardware and hardware that includes metal parts shall be tested for corrosion resistance as specified in Section 8.13, Corrosion Resistance Test, and shall have metals that are inherently resistant to corrosion, including but not limited to stainless steel, brass, copper, aluminum, and zinc, show no more than light surface-type corrosion or oxidation; shall have ferrous metals show no corrosion of the base metal; and shall have hardware items remain functional.

7.1.4.10 Footwear shall be individually tested for flame resistance as specified in Section 8.27, Flame Resistance Test 4, shall not have an afterflame of more than 5 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.1.4.11 Footwear shall be tested for heat resistance as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and, other than the laces, shall not have any part of the footwear melt, shall have no delamination or separation of any

part of the footwear, shall have all hardware remain functional, and shall show no water penetration.

- 7.1.4.12** Footwear upper material composite, upper seams, and vamp seams shall be tested for liquid penetration resistance as specified in Section 8.14, Liquid Penetration Resistance Test, and shall show no chemical penetration.

7.1.4.13 Footwear upper material composite, upper seams, and vamp seams shall be tested for biopenetration resistance as specified in Section 8.15, Viral Penetration Resistance Test, and shall show no viral penetration.

7.1.4.14 Sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber, shall be tested for heat resistance as specified in Section 8.12, Thread Heat Resistance Test, and shall not melt.

7.1.4.15 Footwear product labels shall be tested for legibility as specified in Section 8.33, Label Durability and Legibility Test, and shall not be torn, shall remain in place, and shall be legible to the unaided eye.

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

N 7.1.4.17 Where footwear is provided with metatarsal protection, footwear shall meet the performance requirements as specified in ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, for impact-resistant footwear, compression-resistant footwear, metatarsal-protective footwear, and puncture-resistant footwear, with the exception that flex resistance to cracking shall not be evaluated.

7.1.5 Technical Rescue Protective Ensemble Goggle Elements.

7.1.5.1 Goggle elements shall be tested for heat resistance as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, or ignite.

7.2 Optional Requirements for Blood-Borne Pathogen Protective Technical Rescue Garments.

Δ 7.2.1 Where garments are represented as providing blood-borne pathogen protection, they shall also meet the requirements of 7.1.1.2 to 7.1.1.16.

7.2.1.1 Garment composites shall be tested for total heat loss as specified in Section 8.4, Total Heat Loss Test, and shall have a total heat loss equal to or greater than 450 W/m².

- 7.2.1.2** Barrier layer seams shall be individually tested for resistance to heat as specified in Section 8.3, Heat and Thermal Shrinkage Resistance Test, and shall not drip or ignite.

- 7.2.1.3** Barrier layers and barrier layer seams shall be tested for liquid penetration resistance as specified in Section 8.14, Liquid Penetration Resistance Test, and shall show no liquid penetration.

- 7.2.1.4** Barrier layers and barrier layer seams shall be tested for biopenetration resistance as specified in Section 8.15, Viral Penetration Resistance Test, and shall show no viral penetration.

Chapter 8 Test Methods

8.1 Sample Preparation Procedures.

8.1.1 Application.

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

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

▲ 8.1.2 Room Temperature Conditioning Procedure for Garments, Helmets, Gloves, Footwear, and Goggles.

■ 8.1.2.1 Garment, gloves, and footwear samples shall be conditioned at a temperature of $21^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($70^{\circ}\text{F} \pm 5^{\circ}\text{F}$) and a relative humidity of 65 percent $\pm$ 5 percent for at least 24 hours. Specimens shall be tested within 5 minutes after removal from conditioning.

■ 8.1.2.2 Helmets and goggle component samples shall be conditioned at a temperature of $21^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($70^{\circ}\text{F} \pm 5^{\circ}\text{F}$) and a relative humidity of 25 to 50 percent for at least 4 hours. Specimens shall be tested within 5 minutes after removal from conditioning.

8.1.3 Washing and Drying Procedure for Garment Materials.

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

8.1.4 Low Temperature Environmental Conditioning Procedure for Helmets.

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

8.1.4.2 If during testing, as specified in Section 8.16, Force Transmission Test, and Section 8.17, Physical Penetration Resistance Test, a helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet.

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

8.1.5 Wet Conditioning Procedure for Helmets. Sample helmets shall be conditioned by immersing them in water at a temperature of 20°C to 28°C (68°F to 82°F) for at least 4 hours but not more than 24 hours. The helmet shall be allowed to drain and tested within 10 minutes after removal from water. If during testing, as specified in Section 8.16, Force Transmission

Test, and Section 8.17, Physical Penetration Resistance Test, a helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet. If the time out of the environment exceeds 4 minutes, the helmet shall be returned to the environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or for a maximum of 12 hours, whichever is less, before the resumption of testing with that helmet.

▲ 8.1.6 Convective Heat Conditioning Procedure for Helmets.

▲ 8.1.6.1 Samples shall be conditioned by exposing them as follows:

- (1) The oven temperature shall be stabilized at 50°C , $\pm 2^{\circ}\text{C}$ (122°F , $\pm 4^{\circ}\text{F}$), and the exposure time shall be between 4 hours and 24 hours.
- (2) The exposure time shall begin when the test thermocouple reading has stabilized at the required exposure temperature.
- (3) Helmet specimens shall be placed on a room temperature nonconductive headform conforming to the dimensions in Figure 8.3.9.4 before being placed in the oven.

● 8.1.6.2 After oven exposure, the required testing shall be performed within 15 seconds $\pm$ 5 seconds, or the specimen shall be discarded and a new specimen shall be conditioned and tested as specified in 8.1.6.

■ 8.1.6.3 Only one helmet shall be conditioned at a time.

8.1.7 Wet Conditioning Procedure for Whole Gloves.

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

8.1.7.2 The wrist crease location shall be marked as described in 6.1.3.3.3.3 through 6.1.3.3.3.7 on each specimen around the entire glove $+0/-3 \text{ mm}$ ($+0/-0.25 \text{ in.}$). In the same manner, the water height line shall then be marked on each specimen 25 mm, $+0/-3 \text{ mm}$ (1 in., $+0/-0.25 \text{ in.}$) below (toward the fingers) the location of the wrist crease around the entire glove.

8.1.7.3 The test subject shall don the test specimen gloves.

8.1.7.4 The test subject shall immerse the donned specimens into two containers of water at a temperature of $21^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($70^{\circ}\text{F} \pm 5^{\circ}\text{F}$) to the water height line for 15 seconds, $+1.5/-0$ seconds.

8.1.7.5 The glove specimens shall be tested within 1 minute after removal from the conditioning tank.

▲ 8.1.8 Convective Heat Conditioning for Labels and Visibility Markings. Samples shall be conditioned by exposing them to the procedures specified in 8.3.4 and in 8.3.5.2 through 8.3.5.4, with the following modifications:

- (1) The oven temperature shall be stabilized at 140°C , $+6^{\circ}\text{C}/-0^{\circ}\text{C}$ (285°F , $+10^{\circ}/0^{\circ}\text{F}$), 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 8.3.5.5 and 8.3.5.6 shall be disregarded.
- (4) The required post-oven exposure testing shall be performed within 4 hours.

8.1.9 Washing and Drying Procedures for Gloves and Glove Pouches.

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

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

8.1.9.3 A front-loading washer/extractor shall be used for washing the samples. The capacity shall be between 16 kg (35 lb) and 24.9 kg (55 lb).

8.1.9.4 For gloves and glove pouches, the wash load shall be at two-thirds of the rated capacity of the washer. If ballast is needed to reach two-thirds capacity, 212.6 g/m² (7.5 oz/yd²) woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent anti-stat fiber ballast shall be used. Two-thirds of the rated capacity of the washer shall not be exceeded.

8.1.9.5 The wash cycle procedure in Table 8.1.9.5(a) and Table 8.1.9.5(b) shall be followed. In addition, the g force shall not exceed 100 g throughout the wash cycle.

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

▲ Table 8.1.9.5(a) Wash Cycle Procedure for Gloves and Glove Pouches

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

N Table 8.1.9.5(b) Water Level for Gloves and Glove Pouches Operation Wash Cycle Procedure

Low Water Level		High Water Level	
± 1 cm (3/8 in.)		± 1 cm (3/8 in.)	
cm	in.	cm	in.
12.7	5	25.4	10

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

• 8.1.9.8 Gloves and glove pouches shall be dried using a tumble dryer with a stack temperature of 38°C to 49°C (100°F to 120°F) when measured on an empty load 20 minutes into the drying cycle.

8.1.9.9 Gloves and glove pouches shall be tumbled for 60 minutes and shall be removed immediately at the end of the drying cycle. At the conclusion of the final drying cycle, the gloves or glove pouches shall be permitted to be dried on a forced air nontumble drying mechanism operated at 10°C ± 5°C (50°F ± 9°F) above current room temperature until completely dry.

8.1.10 Helmet Positioning.

8.1.10.1 The helmet shall be seated firmly on the applicable test headform in accordance with the helmet positioning index (HPI).

8.1.10.2 The HPI shall be the vertical distance as specified by the helmet manufacturer from the lowest point of the front lateral midpoint of the helmet shell aligned with the midsagittal plane, to the basic plane of an ISO size J headform conforming to the nominal dimensions in Figure 8.20.4.1, with the helmet firmly positioned on the headform.

8.1.10.3 When positioning the helmet for testing on headforms other than the ISO size J, the basic plane used for the HPI positioning shall be located 134 mm (5 1/4 in.) below and parallel to the crown of the headform and shall be marked on the headform.

8.1.11* Glove Test Areas. Glove test areas shall be as described in this paragraph and as shown in Figure 8.1.11. Glove test area abbreviations shall be as follows:

- (1) P = Palm; B = Back; S = Side.
- (2) A-P: Palm side of hand from finger crotch line to 1/3 of the way down (grasp area)
- (3) B-P: Palm side of hand from 1/3 of the way down (grasp area) to the wrist crease
- (4) C-P: Palm side of hand from the wrist crease to the end of the glove
- (5) D-P: Palm side of thumb
- (6) E-P: Palm side of tip of thumb
- (7) F-P: Palm side of index finger
- (8) G-P: Palm side of fingertip of index finger
- (9) H-P: Palm side of non-index fingers
- (10) I-P: Palm side of fingertip of non-index fingers
- (11) A-PS: Sides of hand adjacent to area A-P
- (12) B-PS: Outside of hand adjacent to area B-P
- (13) C-PS: Sides of hand adjacent to area C-P
- (14) D-PS: Outside of thumb adjacent to area D-P
- (15) E-PS: Inside of thumb adjacent to area D-P
- (16) F-PS: Outside of index finger adjacent to area F-P
- (17) H-PS: Between fingers adjacent to areas F-P and H-P
- (18) I-PS: Outside of and adjacent to the smallest finger
- (19) A-B: Back side of hand from finger crotch line to 1/3 of the way down (knuckle area)
- (20) B-B: Back side of hand from 1/3 of the way down (knuckle area) to the wrist crease
- (21) C-B: Back side of hand from the wrist crease to the end of the glove

- (22) D-B: Back side of thumb
- (23) E-B: Back side of tip of thumb
- (24) F-B: Back side of index finger
- (25) G-B: Back side of fingertip of index finger
- (26) H-B: Back side of non-index fingers
- (27) I-B: Back side of fingertip of non-index fingers
- (28) A-BS: Sides of hand adjacent to area A-B
- (29) B-BS: Outside of hand adjacent to area B-B
- (30) C-BS: Sides of hand adjacent to area C-B
- (31) D-BS: Outside of thumb adjacent to area D-B
- (32) E-BS: Inside of thumb adjacent to area D-B
- (33) F-BS: Outside of index finger adjacent to area F-B
- (34) H-BS: Between fingers adjacent to areas F-B and H-B
- (35) I-BS: Outside of and adjacent to the smallest finger

8.1.12 Pouch Construction for Glove Composite Sample One.

8.1.12.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test. However, for the test specified in Section 8.2, the pouch size shall not be reduced.

8.1.12.2 The pouch shall be made of two glove composite swatches.

8.1.12.3 The two glove composite swatches shall be of the same materials and construction.

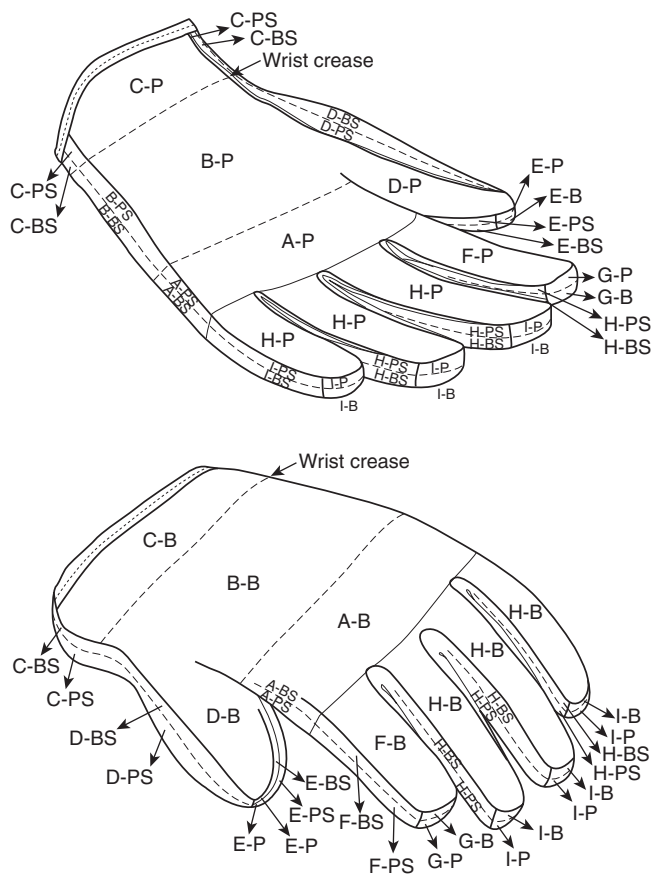


FIGURE 8.1.11 Glove Test Areas.

8.1.12.4 The two glove composite swatches shall be constructed to simulate the actual layers of the glove body or glove interface component as appropriate, arranged in proper order.

8.1.12.5 Each of the two glove composite swatches shall be stitched on all four sides using the same thread as used in the glove construction.

8.1.12.6 The two glove composite swatches shall then be sewn together, inner liner to inner liner, or inside to inside for single layer composites, on three sides using the same thread as used in the glove construction.

8.1.12.7 The two glove composite swatches and resulting pouch shall be permitted to not be stitched or have reduced stitching if a laundering preconditioning is not required to be performed on the composite sample.

8.2 Flame Resistance Test 1.

8.2.1 Application.

8.2.1.1 This test method shall apply to protective garment textiles and visibility markings.

8.2.1.2 Modifications to this test method for testing woven textile materials shall be as specified in 8.2.8.

8.2.1.3 Modifications to this test method for testing knit textile materials shall be as specified in 8.2.9.

8.2.1.4 Modifications to this test method for testing nonwoven textile materials shall be as specified in 8.2.10.

8.2.1.5 Modifications to this test method for testing small specimens not meeting the specimen size requirements of 8.2.2.1 shall be as specified in 8.2.11.

8.2.2 Sample Preparation.

8.2.2.1 Samples shall be as specified in 8.2.8, 8.2.9, 8.2.10, or 8.2.11.

8.2.2.2 Samples shall be conditioned as specified in 8.1.2. Other samples shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

8.2.3 Specimens.

8.2.3.1 Specimens shall consist of a 75 mm × 305 mm (3 in. × 12 in.) rectangle with the long dimension parallel to either the warp direction (machine or course), the filling direction (cross-machine), or wales of the material.

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

8.2.3.3 All specimens to be tested shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

8.2.4 Apparatus. The test apparatus specified in ASTM D6413/D6413M, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, shall be used.

8.2.5 Procedure.

8.2.5.1 Flame resistance testing shall be performed in accordance with ASTM D6413/D6413M, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*.

8.2.5.2 Each specimen shall be examined for evidence of melting or dripping.

8.2.6 Report.

8.2.6.1 Afterflame time and char length shall be reported for each specimen.

8.2.6.2 The average afterflame time and char length for each material shall be calculated, recorded, and reported.

8.2.6.3 The afterflame time shall be reported to the nearest 0.1 second and the char length to the nearest 3 mm ($\frac{1}{8}$ in.).

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

8.2.7 Interpretation.

8.2.7.1 Pass or fail performance shall be based on any observed melting or dripping, the average afterflame time, and the average char length.

8.2.7.2 Failure in either direction shall constitute failure of the material.

8.2.8 Specific Requirements for Testing Woven Textile Materials.

8.2.8.1 Five specimens from each of the warp and filling directions shall be tested.

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 Knit Textile Materials.

8.2.9.1 Five specimens from each of the warp and filling directions shall be tested.

8.2.9.2 Samples for conditioning shall include material that is a minimum of 75 mm $\times$ 305 mm (3 in. $\times$ 12 in.).

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 Nonwoven Textile Materials.

8.2.10.1 Five specimens from each of the machine and cross-machine directions shall be tested.

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

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

8.2.11 Specific Requirements for Testing Small Materials.

8.2.11.1 Five specimens attached to the textile layer as used in the protective garments shall be tested. The specimens shall be attached to the textile layer such that the bottom (exposure) edge of the item coincides with the bottom (exposure) edge of the textile support layer.

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

8.2.11.3 Testing shall be performed as described in 8.2.2 through 8.2.7, other than char length, which shall not be measured.

8.3 Heat and Thermal Shrinkage Resistance Test.

8.3.1 Application.

8.3.1.1 This test method shall apply to protective garment textiles and optional barrier layer seams, protective helmets, protective gloves, protective footwear, and goggles.

8.3.1.2 Modifications to this test method for testing garment textiles and optional barrier layer seams shall be as specified in 8.3.8.

- **8.3.1.3** Modifications to this test method for testing helmets shall be as specified in 8.3.9.

8.3.1.4 Modifications to this test method for testing gloves shall be as specified in 8.3.10.

8.3.1.5 Modifications to this test method for testing footwear shall be as specified in 8.3.11.

8.3.1.6 Modifications to this test method for testing goggles shall be as specified in 8.3.12.

8.3.2 Sample Preparation.

Δ **8.3.2.1** Samples shall be as specified in 8.3.8, 8.3.9, 8.3.10, 8.3.11, or 8.3.12.

8.3.2.2 Samples shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2, except glove samples shall be conditioned as specified in 8.1.9 followed by conditioning as specified in 8.1.2.

- **8.3.3 Specimens.**

Δ **8.3.3.1** Specimens shall be as specified in 8.3.8, 8.3.9, 8.3.10, 8.3.11, or 8.3.12.

Δ **8.3.3.2** Heat resistance testing shall be conducted on a minimum of three specimens for each helmet, footwear, goggle, and other protective garment materials not listed in 8.3.3.3.

8.3.3.3 Both heat and thermal shrinkage resistance testing shall be conducted on a minimum of three specimens for each garment textile and on whole gloves.

8.3.3.4 Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

Δ **8.3.3.5** Testing shall be conducted on specimens taken from samples conditioned according to 8.3.2.2, except as modified by 8.3.8 through 8.3.12.

8.3.4 Apparatus.

8.3.4.1 The test oven shall be a horizontal-flow circulating oven with minimum interior dimensions of 610 mm $\times$ 610 mm $\times$ 610 mm (24 in. $\times$ 24 in. $\times$ 24 in.) such that a specimen can be suspended and be at least 50 mm (2 in.) from any interior oven surface or other specimen.

8.3.4.2 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.

8.3.4.3 A test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted sample specimen. The thermocouple shall be equidistant between the vertical centerline of a mounted specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber. The thermocouple shall be an exposed bead, Type J

or Type K, No. 30 AWG thermocouple. The test oven shall be heated and the test thermocouple stabilized at 260°C, +6/−0°C (500°F, +10/−0°F) for a period of not less than 30 minutes.

8.3.5 Procedure.

8.3.5.1 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*.

8.3.5.2 The specimen shall be suspended by metal hooks at the top and centered in the oven so that the entire specimen is not less than 50 mm (2 in.) from any oven surface or other specimen, and airflow is parallel to the plane of the material.

8.3.5.3 The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and shall be turned on when the door is closed. The total oven recovery time after the door is closed shall not exceed 30 seconds.

8.3.5.4 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).

8.3.5.5 Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition, melting, dripping, or separation.

8.3.5.6 After the specified exposure, the specimen shall also be measured to determine pass or fail performance. Knit fabric shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement to determine pass or fail performance.

8.3.6 Report.

8.3.6.1 Observations of ignition, melting, dripping, or separation shall be recorded and reported for each specimen.

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

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

8.3.7 Interpretation.

8.3.7.1 Any evidence of ignition, melting, dripping, or separation on any specimen shall constitute failing performance.

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

8.3.7.3 Failure in any one direction shall constitute failure for the entire sample.

8.3.8 Specific Requirements for Testing Garment Textiles.

8.3.8.1 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.

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

8.3.8.3 Testing shall be performed as described in 8.3.2 through 8.3.7.

8.3.9 Specific Testing Requirements for Helmets.

8.3.9.1 Helmet specimens shall include complete helmets. Only one helmet shall be tested at a time.

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

8.3.9.3 The test oven shall be heated and stabilized to a temperature of 90°C, +5°C/−0°C (194°F, +10°/−0°F).

8.3.9.4 Sample helmets shall be positioned according to the HPI as described in 8.1.11 on the thermal headform conforming to the dimensions in Figure 8.3.9.4.

8.3.9.5 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.

8.3.9.6 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.

8.3.9.7 Testing shall be performed as described in 8.3.2 through 8.3.7. Thermal shrinkage shall not be measured.

8.3.9.8 After 20 minutes, +15/−0 seconds, the sample helmet mounted on the headform shall be removed from the test oven. The helmet shall be allowed to cool for a minimum of 5 minutes. The vertical distance from the marked points to the base plane shall be measured, recorded, and compared with the measurements recorded in 8.3.9.5 to determine pass or fail performance.

8.3.9.9 Hardware shall be evaluated to determine functionality.

8.3.10 Specific Requirements for Testing Gloves.

8.3.10.1 Specimens shall include complete gloves with labels. Only three glove specimens shall be tested at a time.

8.3.10.2 The glove body shall be filled with 4 mm (0.15 in.) perforated soda-lime glass beads, with care taken to tightly pack the glass beads into the fingers of the glove and the glove body. The opening of the glove shall be clamped closed, and 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.

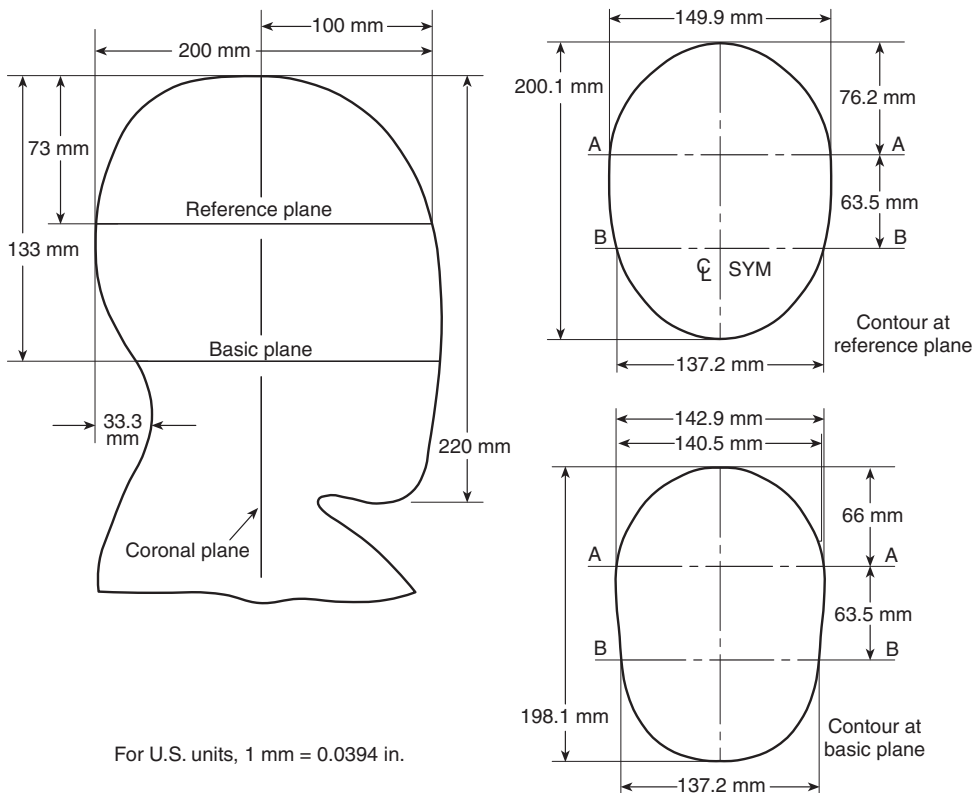
8.3.10.3 Testing shall be performed as described in 8.3.2 through 8.3.7. Thermal shrinkage shall not be measured.

8.3.11 Specific Testing Requirements for Footwear.

8.3.11.1 Only the conditioning specified in 8.1.2 shall be required prior to testing. One footwear specimen shall be tested at a time.

8.3.11.2 Samples for conditioning shall be whole boots.

8.3.11.3 The footwear specimen for testing shall be men's size 9.



▲ FIGURE 8.3.9.4 Thermal Headform.

8.3.11.4 A minimum of three specimens shall be tested. One footwear specimen shall be tested at a time.

8.3.11.5 Footwear specimens shall be filled to capacity with nominal 4 mm (0.15 in.) perforated soda-lime glass beads or borosilicate glass beads. Any closures shall be fastened.

8.3.11.6 The test thermocouple shall be positioned so that it is level with the horizontal centerline of a footwear test specimen. The thermocouple shall be equidistant between the vertical centerline of a footwear test specimen placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

8.3.11.7 The specimen shall be placed in the center of the test oven with the centerline of the front of the specimen facing the airflow.

8.3.11.8 Testing shall be performed as specified in 8.3.2 through 8.3.7. Thermal shrinkage shall not be measured.

8.3.11.9 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 5 minutes, +15/-0 seconds. The test specimen shall be examined inside and outside for evidence of melting, separation, or ignition within 10 minutes, +15/-0 seconds after removal from the oven. Separation occurring in this test shall be recorded and reported if it is at least 1.4 mm × 18 mm (0.05 in. × 0.7 in.) in any orientation.

8.3.11.10 Each test specimen shall then be reconditioned as specified in 8.1.2 and then reexamined inside and outside for evidence of melting, separation, or ignition.

▲ **8.3.11.11** Footwear functionality shall be determined by flexing the specimen for 100,000 cycles performed in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:

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

8.3.11.12 Specimens shall then be examined for evidence of sole separation, seam separation, or component breakage.

▲ **8.3.11.13** After flexing, the footwear specimen shall be marked with a water height line on the exterior at a height of 75 mm (3 in.) below the height of the boot as defined in 6.1.4.4 but no lower than 125 mm (5 in.) where measured up from the center of the insole at the heel. The measurement shall be made on the interior and transferred to the exterior.

• **8.3.11.14** Plain white paper toweling shall be placed inside the footwear specimen such that the paper toweling intimately contacts all areas inside the footwear specimen to at least the water height line.

8.3.11.15 The footwear specimen shall then be placed in a container that allows its immersion in tap water, treated with a dye and surfactant that achieves a surface tension of 35 dynes/cm $\pm$ 5 dynes/cm, to within 0.5 in. of the water height line.

8.3.11.16 After 2 hours $\pm$ 10 minutes, the paper toweling shall be removed and examined for evidence of liquid leakage. The test specimen shall also be reexamined for evidence of sole separation or seam separation.

8.3.11.17 Footwear not remaining functional after flexing shall be recorded and reported as a failure for the tested specimen. The appearance of any liquid on the removed paper toweling shall be recorded and reported as a failure for the tested specimen. One or more footwear specimens failing this test shall constitute failing performance.

8.3.12 Specific Testing Requirements for Goggles.

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

8.3.12.2 Where provided, goggle specimens shall include straps or headbands and attachment devices.

8.3.12.3 Goggles shall be mounted on a thermal headform conforming to the dimensions in Figure 8.3.9.4. The headform with goggles attached shall be placed in the center of the test oven with the centerline of the front of the goggles facing the airflow.

8.3.12.4 The test thermocouple shall be positioned so that it is level with the horizontal centerline of the mounted goggles. The thermocouple shall be equidistant between the vertical centerline of the mounted test goggles placed in the middle of the oven and the oven wall where the airflow enters the test chamber.

8.3.12.5 Testing shall be performed as described in 8.3.2 through 8.3.7. Thermal shrinkage shall not be measured.

8.3.12.6 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 2 minutes. The specimen shall be examined to ascertain any effects of the heat exposure.

8.4 Total Heat Loss Test.

8.4.1 Application. This test method shall apply to the protective garment base composites, excluding winter liners.

8.4.2 Sample Preparation.

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

8.4.2.2 Samples to be tested shall be conditioned as specified at a temperature of 25°C $\pm$ 7°C (75°F $\pm$ 12°F) and a relative humidity of 65 percent $\pm$ 5 percent for at least 4 hours.

8.4.3 Specimens.

8.4.3.1 Specimen size shall be the size required to cover the sweating guarded hot plate.

8.4.3.2 At least three specimens shall be tested.

8.4.3.3 Specimens shall consist of all layers in the protective garment base composite arranged in the order and orientation as worn and shall not include any reinforcement materials.

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

8.4.5* Procedure. Testing shall be conducted in accordance with ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials using a Sweating Hot Plate*, using Part C, with the following modifications:

- (1) The specimen shall be placed on the test plate with the side normally facing the human body toward the test plate.
- (2) For multiple layers, the layers shall be arranged in the order and orientation as worn.
- (3) Each layer shall be smoothed by hand to eliminate wrinkles or bubbles in each layer and, if necessary, the edges shall be secured.
- (4) Once the test is started, no further adjustments to the specimen shall be made.

8.4.6 Report.

8.4.6.1 The average intrinsic thermal resistance (R_{it}) of the sample shall be recorded and reported.

8.4.6.2 The average apparent intrinsic evaporative resistance (AR_{et}) of the sample shall be recorded and reported.

8.4.6.3 The average total heat loss (Q) of the sample shall be calculated and reported.

8.4.7 Interpretation.

8.4.7.1 Pass or fail determination shall be based on the average reported total heat loss measurement of all specimens tested.

8.4.7.2 Where an individual result from any test set varies more than $\pm$ 10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

8.5 Tear Resistance Test.

8.5.1 Application. This test shall apply to garment materials. If the garment is constructed of several separable layers, then all layers shall be individually tested.

8.5.2 Sample Preparation.

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

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

8.5.3 Specimens.

8.5.3.1 Specimens shall be the size specified in ASTM D5587, *Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure*.

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

8.5.3.3 If the material is isotropic, then 10 specimens shall be tested.

8.5.3.4 Testing shall be conducted on 10 specimens taken from both samples conditioned according to 8.5.2.2 and 8.5.2.3.

8.5.4 Procedure. Specimens shall be tested in accordance with ASTM D5587, *Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure*, using Option 1 for the calculation of tear resistance.

8.5.5 Report.

8.5.5.1 The tear resistance of each specimen shall be recorded and reported to the nearest 0.5 N (0.1 lbf).

8.5.5.2 An average tear resistance shall be individually calculated for the warp and filling directions.

8.5.5.3 For isotropic materials, a single average tear resistance shall be calculated.

8.5.6 Interpretation.

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

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

8.6 Breaking Strength Test.

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

8.6.2 Sample Preparation.

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

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

8.6.3 Specimens.

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

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

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

Δ **8.6.3.4** Testing shall be conducted on 10 specimens taken from both samples conditioned according to 8.6.2.2.

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

8.6.5 Report.

8.6.5.1 The breaking strength of each specimen shall be recorded and reported to the nearest 0.5 N (0.1 lbf) of force.

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

8.6.5.3 For isotropic materials, a single average breaking strength shall be calculated.

8.6.6 Interpretation.

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

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

8.7 Abrasion Resistance Test 1.

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

8.7.2 Sample Preparation.

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

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

8.7.3 Specimens.

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

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

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

8.7.4 Procedure.

8.7.4.1 Specimens shall be subjected to abrasion in accordance with ASTM D3885, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)*, under the following conditions:

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

8.7.4.2 After being abraded as specified in 8.7.4.1, specimens shall be tested in accordance with ASTM D5035, *Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*.

8.7.5 Report.

8.7.5.1 The breaking strength of each specimen shall be recorded and reported to the nearest 0.5 N (0.1 lbf).

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

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

8.7.6 Interpretation.

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

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

8.8 Cleaning Shrinkage Resistance Test.

8.8.1 Application.

8.8.1.1 This test method shall apply to garment materials.

8.8.1.2 Modifications to this test method for woven material shall be as specified in 8.8.7.

8.8.1.3 Modifications to this test method for knit and stretch woven materials shall be as specified in 8.8.8.

8.8.2 Sample Preparation.

8.8.2.1 Samples shall be as specified in 8.8.7 or 8.8.8.

8.8.2.2 Samples shall be conditioned as specified in 8.1.2.

8.8.3 Specimens.

8.8.3.1 Samples shall be as specified in 8.8.7 or 8.8.8.

8.8.3.2 At least three specimens shall be tested.

8.8.3.3 Each material shall be tested separately.

8.8.4 Procedure.

8.8.4.1 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*.

8.8.4.2 A 1.8 kg $\pm$ 0.1 kg (4.0 lb $\pm$ 0.2 lb) load shall be used. A laundry bag shall not be used.

8.8.4.3 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*.

8.8.5 Report.

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

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

8.8.6 Interpretation.

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

8.8.6.2 Failure in any one direction shall constitute failure for the entire sample.

8.8.7 Specific Requirements for Testing Woven Textile Materials.

8.8.7.1 Each specimen shall be 380 mm $\times$ 380 mm $\pm$ 13 mm (15 in. $\times$ 15 in. $\pm$ ½ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

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

8.8.7.3 Testing shall be performed as described in 8.8.2 through 8.8.6.

8.8.8 Specific Requirements for Testing Knit and Stretch Woven Textile Materials.

8.8.8.1 Each specimen shall be 380 mm $\times$ 380 mm $\pm$ 13 mm (15 in. $\times$ 15 in. $\pm$ ½ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.8.8.2 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.

8.8.8.3 Testing shall be performed as described in 8.8.2 through 8.8.6.

8.8.8.4 Knit fabric specimens, instead of being restored to 7.4.2 of AATCC 135, *Dimensional Changes in Automatic Home*

Laundering of Woven and Knit Fabrics, shall be pulled to their original dimensions and shall be allowed to relax for 1 minute prior to measurement.

8.9 Abrasion Resistance Test 2.

8.9.1 Application.

8.9.1.1 This test shall apply to glove palm composites and footwear upper materials.

8.9.1.2 Modifications to this test method for testing glove composites shall be as specified in 8.9.7.

8.9.1.3 Modifications to this test method for testing footwear upper materials shall be as specified in 8.9.8.

8.9.2 Sample Preparation.

8.9.2.1 Samples shall be as specified in 8.9.7 or 8.9.8.

8.9.2.2 Samples shall be conditioned as specified in 8.1.2.

8.9.3 Specimens.

8.9.3.1 Samples shall be as specified in 8.9.7 or 8.9.8.

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

8.9.3.3 At least five samples shall be tested.

8.9.4 Procedure. Specimens shall be tested in accordance with ASTM D3884, *Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, using a Calibrade H-18 wheel for a total of 2500 cycles. At the end of each abrasion exposure, the specimen shall be examined for wear-through of the outermost separable layer.

8.9.5 Report. The wear-through determination shall be reported for each specimen tested.

8.9.6 Interpretation. Any specimen of the outermost separable layer showing wear-through shall constitute failure of this test.

8.9.7 Requirements for Testing Glove Composites.

8.9.7.1 Specimens shall be representative of the glove body composite construction at the glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B as described in 8.1.11 and shall not include seams. Samples and specimens shall be permitted to be materials representative of those used in the construction of the glove.

8.9.7.2 Specimens shall consist of the outer separable layer of the glove composite.

8.9.7.3 A load of 500 g (17.67 oz) on each wheel shall be used in abrasion testing of gloves.

8.9.8 Requirements for Testing Footwear Upper Materials.

8.9.8.1 Specimens shall be taken from the footwear upper area, excluding the tongue and gusset, and shall not include seams. Samples and specimens shall be permitted to be materials representative of those used in the construction of the footwear. Specimens shall consist of the outer separable layer of the boot composite and the outer separable layer of the boot that is at least 50 percent of the total surface area.

8.9.8.2 Samples for conditioning shall be complete footwear items.

8.9.8.3 A load of 1000 g (35.27 oz) on each wheel shall be used in abrasion testing of footwear.

8.10 Seam Breaking Strength Test.

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

8.10.2 Sample Preparation.

8.10.2.1 Samples for conditioning shall be full clothing items or 305 mm (12 in.) or greater lengths of seam with at least 150 mm (6 in.) of material on either side of the seam centerline.

8.10.2.2 Samples shall be conditioned as specified in 8.1.2.

8.10.3 Specimens.

8.10.3.1 Specimens shall be cut from the finished garment or shall be permitted to be prepared by the joining of two pieces of the garment fabric as specified in 8.2.1.2 of ASTM D1683/D1683M, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, for woven fabrics or 7.2.2 of ASTM D3940, *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.

8.10.3.2 Specimens shall be the size specified in ASTM D1683/D1683M, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, for woven fabrics or ASTM D3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*, for knit or stretch woven fabrics.

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

8.10.4 Procedure.

8.10.4.1 All woven seam assemblies shall be tested in accordance with ASTM D1683/D1683M, *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).

8.10.4.2 All knit seam assemblies shall be tested in accordance with ASTM D3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*.

8.10.5 Report.

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

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

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

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

8.11 Water Absorption Resistance Test.

Δ 8.11.1 Application. This test method shall apply to the protective garment outer shell materials.

8.11.2 Sample Preparation.

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

Δ 8.11.2.2 Specimens shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

8.11.3 Specimens.

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

8.11.3.2 At least 3 specimens shall be tested.

8.11.4 Apparatus. The test apparatus shall be as specified in AATCC 42, *Water Resistance: Impact Penetration Test*, with the following modifications:

- (1) A metal roller 113 mm ± 6 mm (4½ in. ± ¼ in.) long and weighing 1 kg (2¼ lb) shall be used.
- (2) Embroidery hoops, measuring 150 mm to 180 mm (6 in. to 7 in.) in diameter shall be used for mounting the specimens.

8.11.5 Procedure.

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

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

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

8.11.5.4 A 500 mL volume of distilled water at a temperature of 27°C ± 1°C (80°F ± 2°F) shall be poured quickly into the funnel and allowed to spray onto the specimen.

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

- (1) The specimen shall be removed from the hoops and placed between sheets of blotting paper on a flat horizontal surface.
- (2) The metal roller shall be rolled quickly forward and back one time over the paper without application of any pressure other than the weight of the roller.
- (3) A square 100 mm × 100 mm (4 in. × 4 in.) shall be cut out of the center of the wet portion of the specimen and weighed to the nearest 0.05 g. This weight shall be designated the "wet weight." Not more than 30 seconds shall elapse between the time the water has ceased flowing through the spray nozzle and the start of the weighing.
- (4) The same 100 mm (4 in.) square shall be conditioned as specified in 8.1.2 until it has dried and reached moisture equilibrium with the surrounding standard atmosphere for textiles.
- (5) Following this conditioning it shall be reweighed.
- (6) This weight shall be designated the "dry weight."

8.11.5.6 The percent water absorption shall be calculated using the following equation: *Percent water absorption* = $[(wet\ weight - dry\ weight) / (dry\ weight)] \times 100$.

8.11.6 Report.

8.11.6.1 The percent water absorption for each specimen shall be recorded and reported.

8.11.6.2 The average percent water absorption for all tested specimens shall be calculated and reported.

8.11.7 Interpretation. The average percent water absorption shall be used to determine pass or fail performance.

8.12 Thread Heat Resistance Test.

Δ 8.12.1 Application. This test method shall apply to each type of thread used in the construction of garments, gloves, and footwear.

8.12.2 Sample Preparation.

8.12.2.1 Samples shall be 150 mm (6 in.) or greater in length.

8.12.2.2 Samples shall be conditioned as specified in 8.1.2.

8.12.3 Specimens.

8.12.3.1 Samples shall be 150 mm (6 in.) or greater in length.

8.12.3.2 At least three samples of each thread type shall be tested.

• 8.12.4 Procedure. The melting temperature of specimens shall be determined in accordance with ASTM D7138, *Standard Test Method to Determine Melting Temperature of Synthetic Fibers*, using Procedure 1.

Δ 8.12.5 Report.

N 8.12.5.1 The melting point of the sample unit shall be the average of the results obtained from the specimens tested and shall be recorded and reported to the nearest degree C.

N 8.12.5.2 The pass/fail results for each specimen tested shall be recorded and reported.

8.12.6 Interpretation. One or more thread specimens failing this test shall constitute failing performance of the thread type.

8.13 Corrosion Resistance Test.

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

8.13.1.1 Modifications to this test method for testing garment and glove hardware shall be as specified in 8.13.7.

8.13.1.2 Modifications to this test method for testing helmet hardware shall be as specified in 8.13.8.

8.13.1.3 Modifications to this test method for testing footwear hardware shall be as specified in 8.13.9.

8.13.2 Sample Preparation.

8.13.2.1 Samples shall be as specified in 8.13.7, 8.13.8, or 8.13.9.

8.13.2.2 Samples shall be conditioned as specified in 8.1.2.

8.13.3 Specimens.

8.13.3.1 Specimens shall be the same as the samples.

8.13.3.2 At least five specimens shall be tested for each hardware type.

8.13.4 Procedure.

8.13.4.1 Specimens shall be tested in accordance with ASTM B117, *Standard Practice for Using Salt Spray (Fog) Apparatus*. Salt spray shall be 5 percent saline solution, and test exposure shall be for 20 hours.

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

8.13.4.3 Specimens shall then be examined visually with the unaided eye to determine pass or fail.

8.13.4.4 The functionality of each specimen shall be evaluated.

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

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

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

8.13.8 Specific Requirements for Testing Helmets. Samples for conditioning shall be whole helmets.

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

8.14 Liquid Penetration Resistance Test.

8.14.1 Application.

8.14.1.1 This test shall apply to footwear materials, optional barrier layers, and optional barrier layer seams.

8.14.1.2 Modifications to this test method for testing optional barrier layers and optional barrier layer seams shall be as specified in 8.14.7.

• 8.14.1.3 Modifications to this test method for testing footwear materials shall be as specified in 8.14.8.

8.14.2 Sample Preparation.

Δ 8.14.2.1 Samples shall be 1 m (1 yd) square of material for garments and garment seams and whole elements for footwear.

Δ 8.14.2.2 Garment material samples shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

8.14.2.3 Footwear samples shall be conditioned as specified in 8.1.2 only.

• 8.14.3 Specimens.

Δ 8.14.3.1 Specimens shall be as specified in 8.14.7 or 8.14.8.

8.14.3.2 Specimens shall be 75 mm (3 in.) squares of each composite type.

8.14.3.3 At least three specimens per liquid shall be tested for each material type.

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

8.14.4 Procedure.

8.14.4.1 Liquid penetration resistance testing shall be conducted in accordance with ASTM F903, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids*, exposure procedure C.

8.14.4.2 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 by weight sulfuric acid to water)
- (3)* Fire-resistant hydraulic fluid, phosphate ester base, containing 50-80 percent tributyl phosphate [CAS No. 126-73-8]
- (4) Surrogate gasoline fuel H as defined in ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*, consisting of 42.5 percent toluene, 42.5 percent isooctane, and 15 percent ethanol, by volume, respectively
- (5) Swimming pool chlorinating chemical containing at least 65 percent free chlorine (saturated solution)
- (6) Automotive antifreeze fluid (ethylene glycol, 90 percent by weight or higher concentration)

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

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

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

8.14.7 Specific Requirements for Testing Optional Barrier Layer and Optional Barrier Layer Seams. Specimens shall consist of the barrier layer and barrier layer seams, which are intended to prevent the penetration of liquids.

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

8.15 Viral Penetration Resistance Test.

8.15.1 Application.

8.15.1.1 This test shall apply to optional barrier layers, optional barrier layer seams, and footwear materials.

8.15.1.2 Modifications to this test method for testing optional barrier layers and optional barrier layer seams shall be as specified in 8.15.7.

8.15.1.3 Modifications to this test method for testing footwear materials shall be as specified in 8.15.8.

8.15.2 Sample Preparation.

Δ **8.15.2.1** Samples shall be 1 m (1 yd) square of material for garments and garment seams and whole elements for footwear.

Δ **8.15.2.2** Garment material samples shall be conditioned as specified in 8.1.3 followed by conditioning as specified in 8.1.2.

8.15.2.3 Footwear samples shall be conditioned as specified in 8.1.2 only.

8.15.3 Specimens.

Δ **8.15.3.1** Specimens shall be as specified in 8.15.7 or 8.15.8.

8.15.3.2 Specimens shall be 75 mm (3 in.) squares of each composite type. A minimum of three specimens per liquid shall be tested for each material type.

8.15.3.3 At least three specimens per liquid shall be tested for each material type.

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

8.15.4 Procedure.

8.15.4.1 Biopenetration resistance testing shall be conducted in accordance with ASTM F1671/F1671M, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage as a Test System*.

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

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

8.15.6 Interpretation. One or more failures of any specimen shall constitute failure of the material.

8.15.7 Specific Requirements for Testing Optional Barrier Layer and Optional Barrier Layer Seams. Specimens shall consist of the barrier layer and barrier layer seams, which are intended to prevent the penetration of liquids.

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

8.16 Force Transmission Test.

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

8.16.2 Samples.

Δ **8.16.2.1** Samples shall be complete helmets. Externally mounted goggle components shall be removed. Internally mounted faceshield components shall be removed except where the internal faceshield is an integral part of the helmet.

8.16.2.2 Samples shall be conditioned for each environmental condition specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each impact.

8.16.3 Specimens.

8.16.3.1 Specimens shall be complete helmets.

8.16.3.2 At least three specimens shall be tested as specified for each environmental condition.

• **8.16.3.3** If during testing for the conditions specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 the helmet is returned to the condition-

ing environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet. If the time out exceeds 4 minutes, the helmet shall be returned to the environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or for a maximum of 24 hours, whichever is less, before resumption of testing with that helmet.

▲ 8.16.4 Procedure.

▲ 8.16.4.1 Specimen helmets shall be tested in accordance with Section 10.2 of ANSI/ISEA Z89.1 *American National Standard for Industrial Head Protection*.

8.16.4.2 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.

■ 8.16.4.3 Where an internal faceshield is an integral part of the helmet, it shall be deployed as far as possible without interfering with the test equipment.

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

8.16.6 Interpretation.

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

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

8.17 Physical Penetration Resistance Test.

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

8.17.2 Sample Preparation.

▲ 8.17.2.1 Samples shall be complete helmets. Externally mounted goggle components shall be removed. Internally mounted faceshield components shall be removed except where the internal faceshield is an integral part of the helmet.

8.17.2.2 Separate samples shall be conditioned for each environmental condition specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each physical penetration.

8.17.3 Specimens.

8.17.3.1 Specimens shall be complete helmets.

8.17.3.2 At least three specimens shall be tested as specified for each environmental condition.

8.17.4 Apparatus.

8.17.4.1 The ISO size J headform shall conform to the nominal dimensions in Figure 8.20.4.1. Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

8.17.4.2 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 $\pm$ 1/2 degree, a height of 38 mm (1 1/2 in.), and a tip radius of 0.5 mm

$\pm$ 0.1 mm (0.020 in. $\pm$ 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.

8.17.4.3 The contact indicator shall indicate when electrical contact has been made between the penetration striker and the conductive surface of the test headform. The contact indicator shall have a response time of less than 0.5 second.

8.17.4.4 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.

8.17.5 Procedure.

▲ 8.17.5.1 The environmentally conditioned helmet shall be positioned according to the HPI as described in 8.1.11 on the test headform and secured by the helmet retention system or by other means that will not interfere with the test.

■ 8.17.5.1.1 Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

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

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

■ 8.17.5.1.4 The front-to-back centerline of the shell shall be within 13 mm (0.5 in.) of the midsagittal plane of the headform.

■ 8.17.5.1.5 Where an internal faceshield is an integral part of the helmet, it shall be deployed as far as possible without interfering with the test equipment.

8.17.5.2 The drop height of the penetration striker shall be adjusted so that the velocity at impact is 7 m/sec $\pm$ 0.1 m/sec (23 ft/sec $\pm$ 0.5 ft/sec). The penetration striker shall be dropped to strike the sample helmet shell within a circle whose diameter is 75 mm (3 in.) and whose center shall be the geometric center of the shell. The penetration striker shall not fall on any portion of the ridges or make contact with the headform.

8.17.6 Report. The pass or fail result for each helmet shall be recorded and reported.

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

▲ 8.18 Electrical Insulation Test.

▲ 8.18.1 Application. This test method shall apply to helmets.

8.18.2 Sample Preparation.

8.18.2.1 Samples shall be complete helmets.

8.18.2.2 Samples shall be conditioned as specified in 8.1.2.

8.18.3 Specimens. At least three specimens shall be tested.

• 8.18.4 Procedures. Specimens shall be subjected to electrical insulation testing in accordance with EN 13087-8, *Protective helmets — Test methods — Part 8: Electrical properties*, section 5.4.

• 8.18.5 Report. Any current leakage or evidence of breakdown shall be recorded and reported for each helmet.

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

8.19 Suspension System Retention Test.

8.19.1 Application. This test method shall apply to helmets.

8.19.2 Sample Preparation.

8.19.2.1 Samples shall be complete helmets.

8.19.2.2 Samples shall be conditioned as specified in 8.1.2.

8.19.3 Specimens.

8.19.3.1 Specimens shall be complete helmets.

8.19.3.2 At least three specimens shall be tested.

8.19.4 Apparatus.

8.19.4.1 The suspension system retention test fixtures shall consist of rigid material of sufficient thickness to facilitate firm attachment of the inverted helmet to the tensile test machine as shown in Figure 8.19.4.1.

8.19.4.2 The calibrated tensile testing machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified forces.

8.19.5 Procedure.

8.19.5.1 Each helmet suspension strap shall be cut such that sufficient length of strap remains to be gripped by the movable jaw of the testing machine.

8.19.5.2 Specimens shall be positioned and secured in the tensile testing machine so that the helmet's reference plane is horizontal.

8.19.5.3 Each attachment point of the crown strap shall be tested by applying a pull force along the centerline of the suspension strap, perpendicular to the reference plane, to a maximum load of $22\text{ N} \pm 2\text{ N}$ ($5\text{ lb} \pm 0.5\text{ lb}$). The force shall be increased from 0 N to $22\text{ N} \pm 2\text{ N}$ (0 lbf to $5\text{ lbf} \pm 0.5\text{ lbf}$) at a load rate of $25\text{ mm/min} \pm 5\text{ mm/min}$ ($1\text{ in./min} \pm \frac{3}{16}\text{ in./min}$).

8.19.5.4 After application of the force is complete, the load shall be released and the suspension system shall be inspected for any separation from the helmet shell.

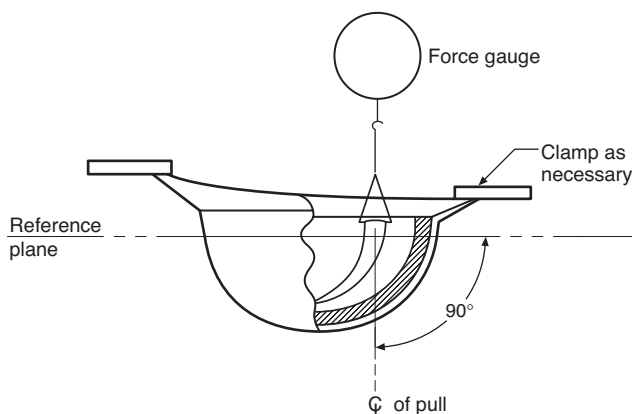


FIGURE 8.19.4.1 Suspension System Test Setup.

8.19.6 Report. The pass or fail result for each attachment point shall be recorded and reported.

8.19.7 Interpretation.

8.19.7.1 Separation of the helmet suspension from the helmet shall constitute failing performance.

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

8.20 Retention System Test.

8.20.1 Application. This test method shall apply to helmets.

8.20.2 Sample Preparation.

8.20.2.1 Samples shall be complete helmets.

8.20.2.2 Samples shall be conditioned as specified in 8.1.2.

8.20.3 Specimens.

8.20.3.1 Specimens shall be complete helmets.

8.20.3.2 At least three specimens shall be tested.

8.20.4 Apparatus.

8.20.4.1 An ISO size J headform shall be used and shall be of the nominal dimensions given in Figure 8.20.4.1.

8.20.4.2 A mechanical chin structure shall be designed for use with a calibrated tensile test machine. The mechanical chin structure shall consist of two rollers 13 mm ($\frac{1}{2}\text{ in.}$) in diameter with centers 75 mm (3 in.) apart. The mechanical chin structure shall conform with Figure 8.20.4.2.

8.20.4.3 The calibrated tensile test machine that shall be capable of measuring the force applied to the retention system within 2 percent at the specified force.

8.20.5 Procedure.

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

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

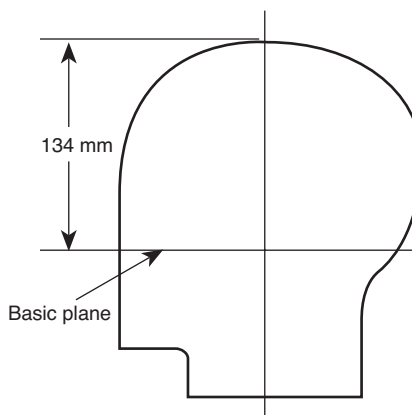


FIGURE 8.20.4.1 ISO Size J Headform.

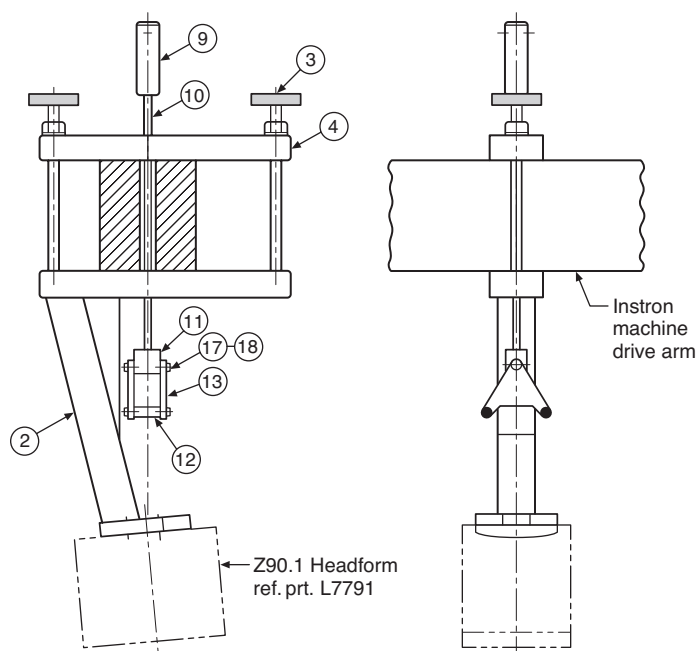


FIGURE 8.20.4.2 Retention System Test Setup.

ITEM NO.	PART NO.	SHT. NO.	DESCRIPTION	MAT'L.	VEND. OR STR. SIZE	QTY.
1	L8539	1	Retention Test Fxt. 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.

8.20.5.3 The headform and mechanical chin structure shall be positioned such that the distance between the bottom of the rollers and the top of the headform is 210 mm $\pm$ 10 mm (8.3 in. $\pm$ 0.4 in.). The chin strap shall be passed around the rollers, and the helmet shall be secured to the headform. The chin strap shall be adjusted and preloaded to 45 N $\pm$ 5 N (10 lbf $\pm$ 1 lbf). The distance between the top of the helmet and the rollers shall be measured and recorded to the nearest 0.5 mm ($\frac{1}{64}$ in.).

8.20.5.4* The force applied to the retention system shall be increased smoothly from 45 N (10 lbf) to 500 N (110 lbf) at a rate between 9.0 N/sec (2 lbf/sec) and 45 N/sec (10 lbf/sec).

8.20.5.5 The load rate of the tensile testing machine shall be 25 mm (1 in.) per minute to a limit of 500 N (110 lbf).

8.20.5.6 The distance between the top of the helmet and the rollers shall be measured and recorded again after the force has been maintained at 500 N (110 lbf) for 60 seconds, $\pm$ 15/–0 seconds. The difference between the second measurement and the first shall be the retention system elongation.

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

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

8.21 Flame Resistance Test 3.

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

8.21.1.1 This test method shall be applied to glove body composites and glove interface component composites.

8.21.1.2 Modifications to this test method for evaluation of glove body composites shall be as specified in 8.21.8.

8.21.1.3 Modifications to this test method for evaluation of glove interface component composites other than wristlet composites shall be as specified in 8.21.9.

8.21.1.4 Modifications to this test method for evaluation of wristlet glove interface component composites shall be as specified in 8.21.10.

8.21.2 Sample Preparation.

8.21.2.1 Samples shall be prepared for each glove body composite and glove interface component composite. Samples shall be the composite used in actual glove construction, consisting of each single layer, with all layers arranged in proper order.

8.21.2.2 Samples shall be conditioned as specified in 8.1.9, followed by conditioning as specified in 8.1.2.

8.21.2.3 Other samples shall be conditioned as specified in 8.1.2 only.

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

8.21.3 Specimens.

8.21.3.1 Specimens shall be cut from the samples.

8.21.3.2 At least three specimens shall be tested for each material.

8.21.3.3 Testing shall be conducted on specimens taken from samples conditioned according to 8.21.2.2 and 8.21.2.3.

8.21.3.4 In each test, the specimen's normal outer surface shall be exposed to the flame.

8.21.4 Apparatus.

8.21.4.1 The test apparatus shall consist of a burner, crucible tongs, support stand, utility clamp, stopwatch, butane gas, gas

regulator valve system, and measuring scale, and the following criteria shall be met:

- (1) The burner shall be a high temperature, liquefied petroleum gas-type Fisher burner.
- (2) The stopwatch or other timing device shall measure the burning time to the nearest 0.1 second.
- (3) The butane shall be of commercial grade, 99.0 percent pure or better.
- (4) The gas regulator system shall consist of a control valve system with a delivery rate designed to furnish gas to the burner under a pressure of $17.3 \text{ kPa} \pm 1.7 \text{ kPa}$ ($2.5 \text{ psi} \pm 0.25 \text{ psi}$) at the reducing valve.
- (5) The flame height shall be adjusted at the reducing valve producing a pressure of $0.7 \text{ kPa} \pm 0.07 \text{ kPa}$ ($0.1 \text{ psi} \pm 0.01 \text{ psi}$).

8.21.4.2 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.

8.21.4.3 A specimen support assembly shall be used that consists of a frame and steel rod of 1.6 mm ($\frac{1}{16}$ in.) diameter to support the specimen in an L-shaped position as shown in Figure 8.21.4.3.

8.21.4.4 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 8.21.4.3.

8.21.5 Procedure.

8.21.5.1 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

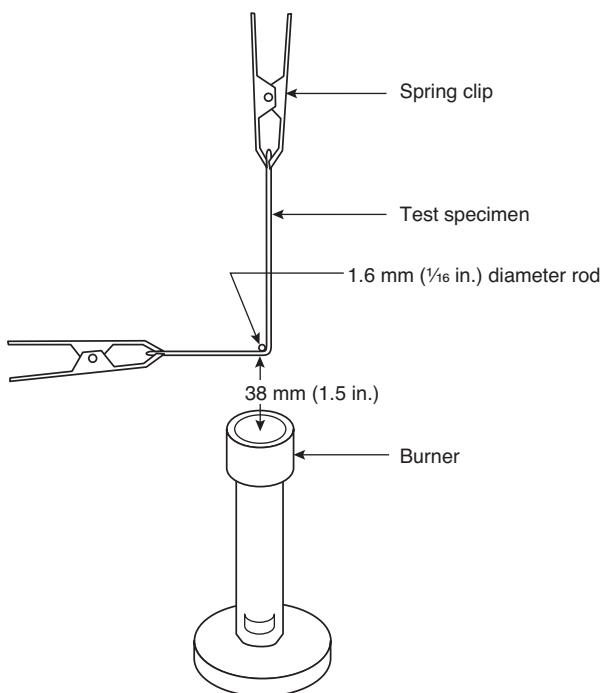


FIGURE 8.21.4.3 Relationship of Test Material to Burner.

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.

8.21.5.2 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 8.21.4.3.

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

8.21.5.4 The afterflame time shall be measured as the time, in seconds, to the nearest 0.1 second, that the specimen continues to flame after the burner is removed from the flame.

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

8.21.5.6 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 8.21.5.6.1 through 8.21.5.6.4.

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

8.21.5.6.2 The hook shall be inserted in the specimen or a hole that is 6 mm ($\frac{1}{4}$ in.) in diameter or less that is punched out for the hook, at one side of the charred area 6 mm ($\frac{1}{4}$ in.) from the adjacent outside edge at the point where the specimen contacted the steel rod, and 6 mm ($\frac{1}{4}$ in.) in from the lower end.

8.21.5.6.3 A weight of sufficient size such that the weight and hook together shall equal the total tearing load required in Table 8.21.5.6.3 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 8.21.5.6.3.

8.21.5.6.4 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.

8.21.6 Report.

8.21.6.1 The afterflame time and char length shall be reported for each specimen.

8.21.6.2 The average afterflame time and char length shall also be calculated and reported.

Table 8.21.5.6.3 Determining Tearing Weight

Specified Weight of Material Before Any Fire-Retardant Treatment or Coating		Total Tearing Weight for Determining Charred Length	
g/m ²	oz/yd ²	kg	lb
68–203	2.0–6.0	0.1	0.25
>203–508	>6.0–15.0	0.2	0.5
>508–780	>15.0–23.0	0.3	0.75
>780	>23.0	0.45	1.0

8.21.6.3 The afterflame time shall be reported to the nearest 0.1 second and the char length to the nearest 2.5 mm ($\frac{1}{10}$ in.).

8.21.6.4 Observations of melting or dripping for each specimen shall be reported. Dripping or hole formation in any layer, other than the outer layer, shall be reported for each specimen.

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

8.21.8 Specific Requirements for Testing Glove Body Components.

8.21.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.12.

8.21.8.2 Specimens shall be representative of each glove body composite construction.

8.21.8.3 After conditioning, the pouch and necessary stitching shall be cut to form 50 mm $\times$ 150 mm (2 in. $\times$ 6 in.) specimens for testing.

8.21.8.4 If a proposed glove body construction has stitched-through seams, three additional specimens containing these seams shall be tested. The seam shall be in the direction of the 150 mm (6 in.) dimension.

8.21.9 Specific Requirements for Testing Protective Glove Interface Components Other than Wristlet Composites.

8.21.9.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.12.

8.21.9.2 Specimens shall be representative of the glove interface component composite construction.

8.21.9.3 After conditioning, the necessary stitching shall be cut to form 50 mm $\times$ 150 mm (2 in. $\times$ 6 in.) specimens for testing.

8.21.10 Specific Requirements for Testing Protective Wristlet Glove Interface Components.

8.21.10.1 Samples for conditioning shall include wristlet material.

8.21.10.2 Specimens shall be representative of the wristlet glove interface component composite construction.

8.21.10.3 Three specimens shall be tested after the conditioning specified in 8.1.2. Three additional specimens shall be tested after the conditioning specified in 8.1.3 followed by the conditioning specified in 8.1.2.

8.21.10.4 After conditioning, the material shall be cut to form 50 mm $\times$ 150 mm (2 in. $\times$ 6 in.) specimens for testing.

8.22 Cut Resistance Test.

8.22.1 Application.

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

8.22.1.2 Modifications to this test method for evaluation of glove materials shall be as specified in 8.22.7.

8.22.1.3 Modifications to this test method for evaluation of footwear upper materials shall be as specified in 8.22.8.

8.22.2 Sample Preparation.

8.22.2.1 Samples shall be as specified in 8.22.7 or 8.22.8.

8.22.2.2 Samples shall be conditioned as specified in 8.1.2.

8.22.3 Specimens.

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

8.22.3.2 At least three specimens shall be tested.

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

8.22.5 Report.

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

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

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

8.22.7 Specific Requirements for Testing Glove Materials.

8.22.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.12.

8.22.7.2 Specimens shall be representative of glove body composite construction at glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B as described in 8.1.11.

8.22.7.2.1 All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately.

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

8.22.7.2.3 Specimens shall not include seams except in the following cases:

- (1) Ridged areas or similar areas where stitching is used to create specific performance characteristics rather than for glove assembly.
- (2) Where there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

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

8.22.7.4 Cut resistance testing shall be performed under a load of 150 g ($\frac{5}{16}$ oz.).

8.22.8 Specific Requirements for Testing Footwear Upper Materials.

8.22.8.1 Samples shall be footwear uppers or representative materials.

8.22.8.2 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, excluding the tongue and gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested. Specimens shall not include seams.

8.22.8.3 Cut resistance testing shall be performed under a load of 800 g (28.22 oz).

8.23 Puncture Resistance Test 1.

8.23.1 Application.

△ **8.23.1.1** This test shall be applied to glove and footwear upper materials.

8.23.1.2 Modifications to this test method for testing glove materials shall be as specified in 8.23.7.

8.23.1.3 Modifications to this test method for testing footwear upper material shall be as specified in 8.23.8.

8.23.2 Sample Preparation.

△ **8.23.2.1** Samples shall be as specified in 8.23.7 or 8.23.8.

8.23.2.2 Samples shall be conditioned as specified in 8.1.2.

8.23.3 Specimens.

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

8.23.3.2 At least three specimens shall be tested.

8.23.4 Procedure. Specimens shall be tested in accordance with ASTM F1342/F1342M, *Standard Test Method for Protective Clothing Material Resistance to Puncture*, using Test Method A.

8.23.5 Report.

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

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

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

8.23.7 Specific Requirements for Testing Glove Materials.

8.23.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.12.

8.23.7.2 Specimens shall be representative of glove body composite construction at glove areas A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P as described in 8.1.11. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately.

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

8.23.7.2.2 Specimens shall not include seams except in the following cases:

- (1) Ridged areas or similar areas where stitching is used to create specific performance characteristics rather than for glove assembly.

- (2) Where there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

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

8.23.8 Specific Requirements for Testing Footwear Upper Materials.

8.23.8.1 Samples shall be footwear uppers or representative materials.

8.23.8.2 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, excluding the tongue and gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested. Specimens shall not include seams.

8.24 Glove Hand Function Test.

8.24.1 Application. This test shall apply to gloves.

8.24.2 Sample Preparation.

8.24.2.1 Samples shall be whole glove pairs, sizes small and large.

8.24.2.2 Samples shall be conditioned as specified in 8.1.2.

8.24.3 Specimens.

8.24.3.1 A minimum of three glove pair specimens each for size small and large shall be used for testing.

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

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

8.24.4 Apparatus. The apparatus shall be as specified in ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Finger Dexterity Using a Modified Pegboard Test*, with the following modification: The stainless steel pins shall have a medium knurled 30 degree (25 teeth per in.) surface.

△ **8.24.5 Procedures.** Testing shall be as specified in ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Finger Dexterity Using a Modified Pegboard Test*.

8.24.6 Report.

8.24.6.1 The average percent of barehanded control shall be recorded and reported for each test subject.

△ **8.24.6.2** The average percent of barehanded control for all test subjects shall be recorded and reported for each size.

△ 8.24.7 Interpretation.

N **8.24.7.1** The average percent of barehanded control for size small and size large shall be used to determine pass or fail performance.

N **8.24.7.2** Failure of either size shall constitute failure of the test.

8.25 Grip Test.

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

8.25.2 Sample Preparation.

8.25.2.1 Samples shall be whole glove pairs, sizes small and large, in new, as-distributed condition.

8.25.2.2 Samples shall be conditioned as specified in 8.1.2.

8.25.3 Specimens.

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

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

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

8.25.3.4 Specimens shall be tested for each material and construction combination.

8.25.3.5 Specimen glove pairs shall be tested after being conditioned for wet conditions as specified in 8.1.7.

8.25.4 Apparatus. The apparatus shall consist of a pulling device that is a 31.7 mm (1¼ in.) diameter fiberglass pole attached to an overhead calibrated force measuring device in such a fashion that pulls on the pole will be perpendicular to the ground and downward in direction. This pole shall be used until surface degradation occurs. The force measuring system shall provide a graphical plot of force versus time.

8.25.5 Procedure.

8.25.5.1 Test subjects shall be selected such that their hand dimensions are as close as possible to those specified in accordance with manufacturing glove-sizing guidelines. At least three test subjects shall be selected for both size small and size large.

8.25.5.2 The gloves shall be conditioned by the wetting procedure specified in 8.1.7 before each set of three pulls by the test subject as described in 8.25.5.4.1 through 8.25.5.4.6.

8.25.5.3 The pulling device shall be wet conditioned before each individual pull by wiping with a damp rag.

8.25.5.4 Pulls shall be performed as described in 8.25.5.4.1 through 8.25.5.4.6.

8.25.5.4.1 The test subject shall stand facing the pole with feet shoulder width apart.

8.25.5.4.2 While wearing specimen gloves, the test subject shall grasp the pole with the bottom of the bottom hand at a height equal to the height of the test subject as shown in Figure 8.25.5.4.2.

8.25.5.4.3 The test subject's hands shall be stacked on each other and the thumbs shall not overlap the fingers as shown in Figure 8.25.5.4.3.

8.25.5.4.4 The test subject's body shall be distanced from the pole so that the forearms are approaching vertical and are not in plane with the pole.

8.25.5.4.5 The test subject's elbows shall be shoulder width apart, rotated neither fully in (arms parallel to the pole) nor fully out (arms perpendicular to the pole).



FIGURE 8.25.5.4.2 Position of Test Subject's Body, Arms, and Hands. (Photo courtesy of Intertek Testing Services. Used by permission.)

8.25.5.4.6 The test subject shall pull the pole with as much pulling force as possible in a smooth, steady, swift, and nonjerking action for 5 seconds, +1/-0 seconds. The test subject shall minimize forward or backward movement during the pull as much as possible. The test subject shall not bend their knees or pull down with body weight during the pull. The test subject shall continue to pull until the test facilitator instructs the test subject to end the pull at 5 seconds, +1/-0 seconds.

8.25.5.5 Test subjects shall repeat the pull described in 8.25.5.4.1 through 8.25.5.4.6 for a total of three pulls.

8.25.6 Report. Any drop in force greater than 30 percent in any 0.2-second interval, as measured in the graphical plot of force versus time, shall be recorded and reported.

8.25.7 Interpretation. Any drop in force greater than 30 percent in any 0.2-second interval shall constitute failing performance.

8.26 Glove Donning Test.

8.26.1 Application. This test shall apply to protective gloves.

8.26.2 Sample Preparation.

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

8.26.2.2 Samples for conditioning shall be whole gloves.



N **FIGURE 8.25.5.4.3** Close-Up of Position of Test Subject's Hands on Pole. (Photo courtesy of Intertek Testing Services. Used by permission.)

8.26.2.3 All glove opening configurations shall be considered for testing.

8.26.3 Specimens.

8.26.3.1 Specimens shall be conditioned as specified in 8.1.9 prior to testing.

8.26.3.2 Specimens shall be donned once after removal from the conditioning specified in 8.26.3.1 before beginning testing.

8.26.4 Procedure.

8.26.4.1 Test subjects shall be selected such that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference for size small and large.

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

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

test subject shall be permitted to don either the right-hand glove or left-hand glove according to individual preference.

Δ 8.26.4.4 The glove shall be donned in accordance with the manufacturer's donning procedure.

8.26.4.5 The glove shall be removed by grasping the fingertip of the middle finger and pulling the hand out of the glove.

8.26.4.6 The test subject shall wear the glove of the opposite handing during the test.

8.26.4.7 Where the glove cannot be donned because of detachment of the inner liner or moisture barrier, the trial for that glove shall be stopped. If any fingers cannot be fully inserted into the glove, the trial for that glove shall be stopped.

•
N 8.26.4.8 The dry hand donning time shall be the average of the first three dry hand donning times as determined in 8.26.4.3.

N 8.26.4.9 The test subject's hand shall then be completely submerged in room temperature water [$21^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($70^{\circ}\text{F} \pm 5^{\circ}\text{F}$)] for 10 seconds before donning the glove each time.

N 8.26.4.10 Immediately after the hand-wetting procedure specified in 8.26.4.10 the times shall be recorded.

N 8.26.4.11 The wet hand donning time shall be the average of the first three wet hand donning times as determined in 8.26.4.11.

N 8.26.4.12 Each test subject shall preform the test with one pair of gloves.

8.26.5 Report.

8.26.5.1 The dry hand donning time shall be recorded and reported to the nearest 0.1 second for each trial.

8.26.5.2 The wet hand donning time shall be recorded and reported to the nearest 0.1 second for each trial.

N 8.26.5.3 The average dry hand and wet hand donning times shall be calculated, recorded, and reported for each size.

8.26.5.4 Any inner liner or barrier layer separations shall be recorded and reported.

8.26.5.5 Any glove digits that do not allow full insertion shall be recorded and reported.

8.26.6 Interpretation.

8.26.6.1 Pass or fail determinations shall be made using the average final and average baseline donning times for each specimen glove size.

8.26.6.2 Failure of either size shall constitute failure of the test.

•
N 8.26.6.3 Any detachment of the inner liner and/or moisture barrier shall constitute failing performance.

N 8.26.6.4 Any glove digits that do not allow full insertion shall constitute failing performance.

8.27 Flame Resistance Test 4.

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

8.27.2 Sample Preparation.

8.27.2.1 Samples shall be whole footwear.

8.27.2.2 Samples shall be conditioned as specified in 8.1.2.

8.27.3 Specimens.

8.27.3.1 Specimens shall be whole footwear.

8.27.3.2 At least three specimens shall be tested.

8.27.4 Apparatus. The test apparatus shall consist of a fuel pan, movable shutter(s), specimen holder, n-heptane, ignition source, and timing device.

8.27.4.1 The fuel pan shall be 305 mm × 457 mm × 63.5 mm (12 in. × 18 in. × 2.5 in.).

8.27.4.2 The movable shutter(s) shall be located at a height of 255 mm (10 in.) ± 13 mm (½ in.) above the surface of the water and n-heptane fluid as measured before ignition. The shutter(s) shall be of a size sufficient to cover the surface area of the fuel pan and shall be capable of being fully retracted or fully extended within 1 second.

8.27.4.3 The specimen holder shall be capable of suspending the specimen over the flame in a manner such that the holder does not impede the flames.

8.27.4.4 The stopwatch or other device shall measure the burning time to the nearest 0.1 second.

8.27.5 Procedure.

8.27.5.1 The test shall be conducted in a draft-free area.

8.27.5.2 The fuel pan shall be level.

8.27.5.3 Water shall be placed in the fuel pan to a height of 13 mm (½ in.).

8.27.5.4 Then, 400 mL to 500 mL of n-heptane shall be added to the fuel pan such that it will burn freely for 1.5 minutes to 2.0 minutes.

8.27.5.5 The specimen shall be mounted in the specimen holder as follows:

- (1) The toe shall be at a 7.5 degree ± 2.5 degree angle above the heel.
- (2) The height of the lowest edge of the specimen shall be 305 mm (12 in.), ± 25 mm (+0/-1 in.) from the surface of the water and n-heptane fluid as measured before ignition.
- (3) The heel-toe axis of the specimen shall be parallel with the 457 mm (17.9 in.) side of the fuel pan.

8.27.5.6 With the shutter retracted, the n-heptane shall be ignited using a suitable ignition source.

8.27.5.6.1 Where paper or other material is used to ignite the n-heptane, it shall not be left in the fuel pan where it can disturb the flame pattern.

8.27.5.7 The n-heptane shall burn freely for 1 minute ± 5 seconds.

8.27.5.8 The shutter shall be positioned above the flame.

8.27.5.9 The specimen shall be positioned above the shutter(s) over the approximate center of the flame area.

8.27.5.10 The shutter(s) shall be retracted and specimen flame exposure shall commence not longer than 1 minute + 15 seconds from ignition.

8.27.5.11 The specimen shall be exposed to the flame for 12 seconds, +/0.2 second.

8.27.5.12 Following flame exposure, the shutter(s) shall be repositioned above the flame.

8.27.5.13 The afterflame time shall be measured as the time, in seconds, to the nearest 0.1 second that the specimen continues to flame after the shutter is repositioned over the flame.

8.27.5.14 Following the flame exposure, the specimen shall be visually examined for melting, dripping, and burn-through.

8.27.6 Report.

8.27.6.1 The afterflame time shall be reported for each specimen. The average afterflame time shall also be calculated and reported. The afterflame time shall be reported to the nearest 0.1 second.

8.27.6.2 Observations of melting, dripping, and burn-through for each specimen shall be reported.

8.27.7 Interpretation. Pass or fail performance shall be based on the average afterflame time and any observed melting, dripping, or burn-through.

8.28 Ladder Shank Bend Resistance Test.

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

8.28.2 Sample Preparation.

8.28.2.1 Samples shall be complete footwear ladder shanks.

8.28.2.2 Samples shall be conditioned as specified in 8.1.2.

8.28.3 Specimens.

8.28.3.1 Specimens shall be complete footwear ladder shanks.

8.28.3.2 At least three specimens shall be tested.

8.28.4 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 8.28.4.

8.28.5 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).

8.28.6 Report. Deflection at 1780 N (400 lbf) shall be reported to the nearest 1 mm (⅜ in.). The average deflection shall be calculated and reported to the nearest 1 mm (⅜ in.).

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

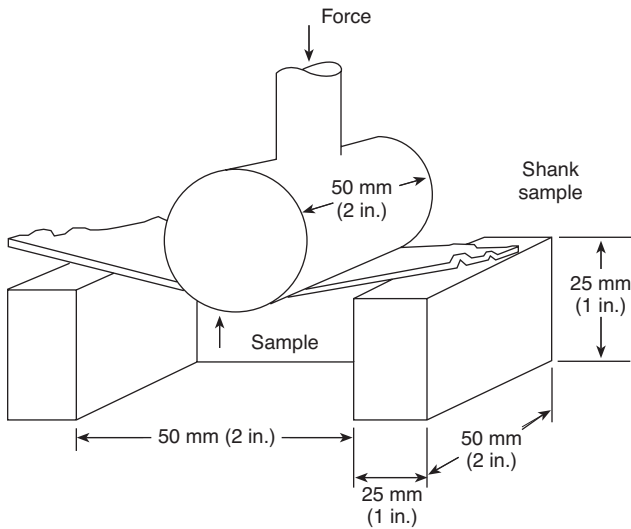


FIGURE 8.28.4 Shank Bend Test Setup.

8.29 Abrasion Resistance Test 3.

8.29.1 Application. This test method shall apply to footwear soles and heels.

8.29.2 Sample Preparation.

8.29.2.1 Samples shall be uniform cylinders of footwear sole and heel material as specified in ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*.

8.29.2.2 Samples shall be conditioned as specified in 8.1.2.

8.29.3 Specimens.

8.29.3.1 Specimens shall be uniform cylinders of footwear sole and heel material as specified in ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*.

8.29.3.2 At least three specimens shall be tested.

8.29.4 Procedure. Abrasion resistance shall be performed in accordance with ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using rotating cylindrical drum device*, Method A, with a vertical force of 10 N (2.25 lbf) over an abrasion distance of 40 m (44 yd).

8.29.5 Report. The relative volume loss of each specimen shall be reported.

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

8.30 Slip Resistance Test.

8.30.1 Application. This test method shall apply to footwear.

8.30.2 Sample Preparation.

8.30.2.1 Samples shall be the whole footwear in men's size 9D, medium width.

8.30.2.2 Samples shall be conditioned as specified in ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction*

for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester.

8.30.3 Specimens.

8.30.3.1 Specimens shall be the whole footwear in men's size 9D, medium width.

8.30.3.2 At least three specimens shall be tested.

8.30.4 Procedure. Slip resistance shall be performed in accordance with ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester*, in the configurations in 8.30.4.1 through 8.30.4.3. References to any other flooring and/or contaminant within ASTM F2913 shall not apply.

8.30.4.1 Footwear shall be tested both in the forepart and heel positions.

8.30.4.2 Footwear shall be tested in the wet condition.

8.30.4.3 Footwear shall be tested on a quarry tile surface that meets the following specifications:

- (1) Is a flat and unglazed clay tile that is wider than the test specimen and long enough to allow a sliding distance of at least 75 mm (2.9 in.) without crossing a joint
- (2) Is sufficiently flat to allow the tile to be secured on the mounting table such that no movement occurs between the tile and mounting table during the test
- (3) Has a ribbed profile or directional marking on the underside to identify the direction in which the tile should be aligned (with the ribs parallel to the sliding direction)
- (4) Conforms to the coefficient of friction values specified in Table 8.30.4.3 when calibrated by the Slider 96 method

8.30.4.3.1* Calibration of the tiles shall be checked after every 10 tests or prior to each day of testing, whichever is the less frequent, to ensure that they are not being worn smooth or otherwise damaged.

8.30.5 Report.

8.30.5.1 The coefficient of friction of each specimen shall be reported.

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

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

8.31 Electrical Insulation Test 2.

8.31.1 Application. This test shall apply to protective footwear.

8.31.2 Sample Preparation.

8.31.2.1 Samples shall be whole footwear.

Table 8.30.4.3 Calibration Values for Quarry Tile

	Dry CF	Wet CF
Minimum	0.57	0.43
Maximum	0.63	0.49

8.31.2.2 Samples shall be conditioned as specified in 8.1.2.

8.31.3 Specimens.

8.31.3.1 Specimens shall be whole footwear.

8.31.3.2 At least three specimens in men's size 9 shall be tested.

Δ 8.31.4 Procedure. Protective footwear shall be tested in accordance with Section 9 of ASTM F2412, *Standard Test Methods for Foot Protection*, with the following modification: specimens shall be tested to 14,000 V (rms).

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

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

8.32 Eyelet and Stud Post Attachment Test.

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

8.32.2 Sample Preparation.

8.32.2.1 Samples shall be whole footwear.

8.32.2.2 Samples shall be conditioned as specified in 8.1.2.

8.32.3 Specimens.

8.32.3.1 Specimens shall be 25 mm × 50 mm (1 in. × 2 in.) containing two eyelets and two stud posts.

8.32.3.2 At least three specimens from separate footwear items shall be tested.

8.32.4 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.

8.32.5 Procedure.

8.32.5.1 The stud post or eyelet puller shall be inserted or attached to the upper position of the tensile machine.

8.32.5.2 The traverse rate shall be set at 50 mm/min (2 in./min).

8.32.5.3 The test eyelet or stud post shall be attached using the appropriate puller fixture.

8.32.5.4 The eyelet stay shall be clamped, but clamping the metal portion of the eyelets or stud hook in the lower clamps shall not be permitted.

8.32.5.5 The distance between the clamps and the stud hooks or eyelets shall be 1.6 mm to 3.2 mm (0.063 in. to 0.125 in.).

8.32.5.6 The test shall then be started.

8.32.6 Report.

8.32.6.1 The force shall reach a peak, decline slightly, and then increase to complete failure; however, the value at which the force first declines shall be recorded and reported as the initial failure point, as this is the separation point of the material around the eyelet or stud post.

8.32.6.2 The average force shall be calculated, recorded, and reported.

8.32.7 Interpretation. The average force shall be used to determine pass or fail.

8.33 Label Durability and Legibility Test.

8.33.1 Application.

8.33.1.1 This test method shall apply to labels on protective garments, helmets, gloves, and footwear.

8.33.1.2 Modifications to this test method for testing garment labels shall be as specified in 8.33.7.

8.33.1.3 Modifications to this test method for testing helmet labels shall be as specified in 8.33.8.

8.33.1.4 Modifications to this test method for testing glove labels shall be as specified in 8.33.9.

8.33.1.5 Modifications to this test method for testing footwear labels shall be as specified in 8.33.10.

8.33.2 Sample Preparation.

8.33.2.1 Samples shall be as specified in 8.33.7, 8.33.8, 8.33.9, and 8.33.10.

8.33.2.2 Samples shall be conditioned as specified for the respective tests.

8.33.3 Specimens.

8.33.3.1 At least three specimens of each type of label shall be tested in each test.

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

8.33.4 Procedures.

8.33.4.1 Laundering Durability Test.

8.33.4.1.1 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*.

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

8.33.4.1.3 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.

8.33.4.2 Abrasion Durability Test.

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

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

8.33.4.2.2 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.

8.33.4.3 Heat Durability Test.

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

8.33.4.3.2 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.

8.33.5 Report. The legibility for each specimen shall be recorded and reported as acceptable or unacceptable.

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

8.33.7 Specific Requirements for Testing Garment Labels.

8.33.7.1 For testing label legibility after laundering, specimens shall include individual labels sewn onto a 1 m (1 yd) square of ballast material no closer than 50 mm (2 in.) apart in parallel strips. The ballast material shall be as specified in AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*.

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

8.33.7.3 For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 380 mm $\pm$ 13 mm (15 in. $\pm$ ½ in.) square of material that meets the outer shell requirements of this standard.

8.33.7.4 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability as specified in 8.33.4.1, 8.33.4.2, and 8.33.4.3, respectively.

8.33.8 Specific Requirements for Testing Helmet Labels.

8.33.8.1 Samples for conditioning shall be whole helmets with labels attached.

8.33.8.2 Specimens shall be conditioned as specified in 8.1.4, 8.1.5, and 8.1.6 with the label examined legibility to the unaided eye by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 305 mm (12 in.) in a well-illuminated area.

8.33.8.3 Specimens shall also be tested separately for legibility after heat durability as specified in 8.33.4.3.

8.33.9 Specific Requirements for Testing Glove Labels.

8.33.9.1 For testing label legibility after laundering and heat durability, specimens shall include gloves with labels attached.

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

8.33.9.3 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability as specified in 8.33.4.1, 8.33.4.2, and 8.33.4.3, respectively.

N 8.33.9.4 For the drying cycles of the laundering durability test specified in 8.33.4.1.1, gloves shall be tumbled for 60 minutes and shall be removed immediately at the end of the drying cycle. At the conclusion of the final drying cycle, the gloves shall be permitted to be dried on a forced air nontumble

drying mechanism operated at 10°C $\pm$ 5°C (50°F $\pm$ 9°F) above current room temperature until completely dry.

8.33.10 Specific Requirements for Testing Footwear Labels.

8.33.10.1 For testing label legibility after heat durability, specimens shall include footwear with labels attached.

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

8.33.10.3 Specimens shall be tested separately for legibility after abrasion and heat durability as specified in 8.33.4.2 and 8.33.4.3, respectively.

Δ 8.34 Burst Strength Test.

8.34.1 Application. This test shall apply to knit materials used in gloves.

8.34.2 Sample Preparation.

8.34.2.1 Samples shall be a 0.5 m (20 in.) long section of knit material.

8.34.2.2 Samples shall be conditioned as specified in 8.1.2.

8.34.3 Specimens.

Δ **8.34.3.1** Specimens shall be the size specified in ASTM D3787, *Standard Test Method for Bursting Strength of Textiles — Constant-Rate-of-Traverse (CRT) Ball Burst Test*.

8.34.3.2 At least 10 specimens shall be tested.

8.34.3.3 Specimens shall include all layers of the wristlet used in glove construction.

Δ **8.34.4 Procedure.** Specimens shall be tested as specified in ASTM D3787, *Standard Test Method for Bursting Strength of Textiles — Constant-Rate-of-Traverse (CRT) Ball Burst Test*.

8.34.5 Report.

8.34.5.1 The burst strength of each specimen shall be reported.

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

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

• 8.35 Torque Test.

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

8.35.2 Samples.

8.35.2.1 Samples for conditioning shall be whole gloves.

8.35.2.2 Sample glove pairs shall be conditioned as specified in 8.1.2.

8.35.3 Specimens.

8.35.3.1 A minimum of three glove specimens each for size small and size large shall be used for testing.

• **8.35.3.2** Each specimen glove shall be tested in new, as distributed, condition.

8.35.3.3 Specimen gloves shall be tested for each material and construction combination.

8.35.4 Apparatus. The apparatus shall be as specified in ASTM F2961, *Standard Test Method for Characterizing Gripping Performance of Gloves Using a Torque Meter*.

8.35.5 Procedure. The testing procedures shall be as specified in ASTM F2961, *Standard Test Method for Characterizing Gripping Performance of Gloves Using a Torque Meter*.

8.35.6 Report. The percentage of barehanded control value shall be recorded and reported for each specimen glove size.

8.35.7 Interpretation.

8.35.7.1 The percentage of barehanded control value for size small and size large shall be used to determine pass or fail performance.

8.35.7.2 Failure of either size shall constitute failure of the test.

8.36 Fastener Tape Strength Tests.

8.36.1 Application. This test shall apply to fastener tape used in the construction of garments.

8.36.2 Samples.

8.36.2.1 Sample size shall be defined as defined in A-A 55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic*.

8.36.2.2 Samples shall be washed for three washings per AATCC 61, *Colorfastness to Laundering: Accelerated*, using the laundering conditions established for Test 3A.

8.36.3 Specimens. A minimum of five specimens shall be evaluated.

8.36.4 Procedures.

8.36.4.1 Fastener tape breaking strength shall be measured in accordance with ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, with the following modifications:

- (1) Specimens shall be tested in the provided width only in lieu of the specified 100 mm (4 in.) width.
- (2) Only specimens parallel to the length of the tape shall be tested.

8.36.4.2 Fastener tape shear strength shall be measured in accordance with ASTM D5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners*.

8.36.4.3 Fastener tape shear strength shall be measured in accordance with ASTM D5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners*.

8.36.5 Report. The average breaking strength, shear strength, and peel strength shall be calculated and recorded.

8.36.6 Interpretation. Pass or fail determinations shall be based on the average breaking strength, shear strength, and peel strength specified for Type 2, Class 1 and 4 fastener tapes as established in Table 1 of A-A 55126B, *Commercial Item Description: Fastener Tapes, Hook and Loop, Synthetic*.

N 8.37 Offset Force Transmission Test.

N 8.37.1 Application. This test method shall apply to protective helmets.

N 8.37.2 Samples.

N 8.37.2.1 Samples shall be complete helmets. Externally mounted goggle components shall be removed. Internally mounted faceshield components shall be removed except where the internal faceshield is an integral part of the helmet.

N 8.37.2.2 Samples shall be conditioned for each environmental condition specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each impact.

N 8.37.3 Specimens.

N 8.37.3.1 Specimens shall be complete helmets.

N 8.37.3.2 At least three specimens shall be tested as specified for each environmental condition.

N 8.37.3.3 If during testing for the conditions specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 the helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet. If the time out exceeds 4 minutes, the helmet shall be returned to the environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or for a maximum of 24 hours, whichever is less, before resumption of testing with that helmet.

N 8.37.4 Procedure.

N 8.37.4.1 Specimen helmets shall be tested in accordance with Section 6.5.3, Lateral Impacts (front, side, rear) of EN 16473, *Firefighters Helmets — Helmets for Technical Rescue*. All three impacts (locations 2, 3, and 4 as shown in Figure 1 of EN 16473) shall be performed on the same helmet.

N 8.37.4.2 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.

N 8.37.4.3 Where an internal faceshield is an integral part of the helmet, it shall be deployed as far as possible without interfering with the test equipment.

N 8.37.5 Report.

N 8.37.5.1 The peak force transmitted shall be recorded and reported for each test to the nearest 10 N.

N 8.37.5.2 The average peak force for each impact location and condition combination shall be calculated and reported.

N 8.37.6 Interpretation.

N 8.37.6.1 Disengagement of, deformation of, or damage to the helmet shell or component parts shall not of itself constitute failure.

N 8.37.6.2 The average peak force for each impact location and condition combination shall be used to determine pass or fail performance. Failure of any impact location and condition combination shall constitute failing performance.