Report of the Committee on

Fire and Emergency Services Protective Clothing and Equipment

Richard M. Duffy, *Chair*

International Association of Fire Fighters, DC [L]

William M. Lambert, *Secretary*

Mine Safety Appliances Company, PA [M] Rep. Compressed Gas Association

Leslie Anderson, USDA Forest Service, MT [E]
Roger L. Barker, North Carolina State University, NC [SE]
Nicholas J. Curtis, Lion Apparel, Inc., OH [M]
Robert A. Freese, Globe Manufacturing Company, NH [M]
Andy Gbur, Intertek, OH [RT]
Bill Grilliot, Morning Pride Manufacturing, LLC, OH [M]
Rep. Fire and Emergency Manufacturers and Services Association Inc.
Kimberly M. Henry, Celanese Advanced Materials Inc., NC [M]
James S. Johnson, Lawrence Livermore National Laboratory, CA [RT]
Cy Long, Texas Commission on Fire Protection, TX [E]
David G. Matthews, Fire & Industrial (P.P.E) Ltd., England [SE]
Richard W. Metzler, US Department of Health & Human Services, PA [RT]
Jim Minx, Oklahoma State Firefighters Association, OK [C]
Rep. Oklahoma State Firefighters Association
Stephen R. Sanders, Safety Equipment Institute (SEI), VA [RT]
Denise N. Statham, Southern Mills, Inc., GA [M]
Jeffrey O. Stull, International Personnel Protection, Inc., TX [SE]
David Trivette, Tyco/Scott Health & Safety, NC [M]
Rep. International Safety Equipment Association
Robert D. Tutterow, Jr., Charlotte Fire Department, NC [U]
Rep. Fire Industry Equipment Research Organization
Harry P. Winer, US Department of the Navy, MA [RT]

Alternates

Jason L. Allen, Intertek, NY [RT]
(Alt. to Andy Gbur)
Eric J. Beck, Mine Safety Appliances Company, PA [M]
(Alt. to William M. Lambert)
Leslie F. Boord, US Department of Health & Human Services, PA [RT]
(Alt. to Richard W. Metzler)
Janice C. Bradley, International Safety Equipment Association, VA [M]
(Alt. to David Trivette)
Steven D. Corrado, Underwriters Laboratories Inc., NC [RT]
(Voting Alt. to UL Rep.)
Patricia A. Freeman, Globe Manufacturing Company, NH [M]
(Alt. to Robert A. Freese)
Patricia A. Gleason, Safety Equipment Institute (SEI), VA [RT]
(Alt. to Stephen R. Sanders)
Mary I. Grilliot, TFG/Morning Pride Manufacturing LLC, OH [M]
(Alt. to Bill Grilliot)
Steven B. Lumry, Oklahoma City Fire Department, OK [C]
(Alt. to Jim Minx)
Andrew P. Perrella, E.I. DuPont Company, DE [M]
(Alt. to Kimberly M. Henry)
Frank P. Taylor, Lion Apparel, Inc., VA [M]
(Alt. to Nicholas J. Curtis)

Nonvoting

Donna P. Brehm, Virginia Beach Fire Department, VA [U]
Rep. TC on Emergency Medical Services PC&E
Don R. Forrest, United Firefighters of Los Angeles City, CA [L]
Rep. TC on Special Operations PC&E
George M. Jackson, USDA Forest Service, MT [E]
Rep. TC on Wildland Fire Fighting PC&E
Glenn P. Jirka, Miami Township Fire & EMS Division, OH [E]
Rep. TC on Hazardous Materials PC&E
Kirk Owen, Plano Fire Department, TX [U]
Rep. TC on Structural and Proximity Fire Fighting PC&E
Ray F. Reed, Dallas Fire Department, TX [U]
Rep. TC on Respiratory Protection Equipment
Bruce H. Varner, Santa Rosa Fire Department, CA [E]
Rep. TC on Electronic Safety Equipment

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.

Report of the Committee on

Hazardous Materials Protective Clothing and Equipment

Glenn P. Jirka, *Chair*
Miami Township Fire & EMS Division, OH [E]
Rep. The InterAgency Board

Patricia A. Gleason, *Secretary*
Safety Equipment Institute (SEI), VA [RT]

William Alexander, Onguard Industries, MD [M]
Jeffrey B. Borkowski, Fire Department, City of New York, NY [U]
Steven D. Corrado, Underwriters Laboratories Inc., NC [RT]
Steven M. De Lisi, Virginia Air National Guard, VA [U]
Wade G. DeHate, Hillsborough County Fire Rescue, FL [E]
Jan Dunbar, El Dorado Hills, CA [E]
Rep. International Association of Fire Chiefs
Daniel Gohlke, W. L. Gore & Associates, MD [M]
Kevin W. Klamser, US Navy Coastal Systems Station, FL [RT]
Karen E. Lehtonen, Lion Apparel, Inc., OH [M]
Trudy J. Lewis, Battelle Memorial Institute, OH [RT]
Ulf Nystrom, Trelleborg Protective Products AB, Sweden [M]
Louis V. Ott, Gentex Corporation, PA [M]
Rep. International Safety Equipment Association
Kenneth A. Pever, Guardian Manufacturing Company, OH [M]
Mel Seng, TFG/Norcross Safety Products, IL [M]
Jeffrey O. Stull, International Personnel Protection, Inc., TX [SE]
Jonathan V. Szalajda, US Department of Health & Human Services, PA [E]
Robert West, Texas Instruments, TX [U]
James P. Zeigler, DuPont Personal Protection, VA [M]
Michael Ziskin, Field Safety Corporation, CT [RT]

Alternates

Dale Gregory Beggs, Texas Instruments, TX [U]
(Alt. to Robert West)
Nicholas J. Curtis, Lion Apparel, Inc., OH [M]
(Alt. to Karen E. Lehtonen)
Russell R. Greene, Battelle Memorial Institute, OH [RT]
(Alt. to Trudy J. Lewis)
Andy Gbur, Intertek, OH [RT]
(Voting Alt. to Intertek Rep.)
A. Ira Harkness, US Department of the Navy, FL [RT]
(Alt. to Kevin W. Klamser)
Thomas M. Pease, Gentex Corporation, PA [M]
(Alt. to Louis V. Ott)
John Reilly, Total Fire Group, OH [M]
(Alt. to Mel Seng)
Angie M. Shepherd, Underwriters Laboratories Inc., NC [RT]
(Alt. to Steven D. Corrado)

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

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

Report of the Committee on

Special Operations Protective Clothing and Equipment

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

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

Steven D. Corrado, Underwriters Laboratories Inc., NC [RT]
Dean W. Cox, Fairfax County Fire & Rescue Department, VA [U]
Nicholas J. Curtis, Lion Apparel, Inc., OH [M]
James A. Frank, CMC Rescue, Inc., CA [M]
Hamid M. Ghorashi, E. I. DuPont de Nemours and Co., Inc., VA [M]
Daniel Gohlke, W. L. Gore & Associates, MD [M]
Donald F. Hayde, Fire Department City of New York, NY [U]
Diane B. Hess, Celanese Advanced Materials Inc., NC [M]
Steve Hudson, Pigeon Mountain Industries, Inc., GA [M]
H. Dean Paderick, Special Rescue International, VA [SE]
Jack Reall, Columbus Fire Division, OH [U]
Stephen R. Sanders, Safety Equipment Institute (SEI), VA [RT]
Kelly Sisson, City of La Mesa Fire Department, CA [U]
Michael T. Stanhope, Southern Mills, Inc., GA [M]
Harry P. Winer, US Department of the Navy, MA [RT]

Alternates

Andy Gbur, Intertek, OH [RT]
(Voting Alt. to Intertek Rep.)
Kimberly M. Henry, Celanese Advanced Materials Inc., NC [M]
(Alt. to Diane B. Hess)
Kim Klaren, Fairfax County Fire & Rescue Department, VA [U]
(Alt. to Dean W. Cox)
Karen E. Lehtonen, Lion Apparel, Inc., OH [M]
(Alt. to Nicholas J. Curtis)
Loui (Clem) McCurley, Pigeon Mountain Industries, Inc., CO [M]
(Alt. to Steve Hudson)
Stephen G. Rasweiler, Fire Department City of New York, NY [U]
(Alt. to Donald F. Hayde)
Brennan E. Sigmon, Underwriters Laboratories, Inc., NC [RT]
(Alt. to Steven D. Corrado)
Denise N. Statham, Southern Mills, Inc., GA [M]
(Alt. to Michael T. Stanhope)

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.

Report of the Committee on
Structural and Proximity Fire Fighting Protective Clothing and Equipment

Kirk Owen, *Chair*
Plano Fire Department, TX [U]
Rep. NFPA Fire Service Section

Patricia A. Freeman, *Secretary*
Globe Manufacturing Company, NH [M]

Donald Aldridge, Lion Apparel, Inc., OH [M]
Jason L. Allen, Intertek, NY [RT]
James M. Baker, National Safety Clean, Inc., PA [IM]
Claude Barbeau, Bacou-Dalloz Protective Apparel Ltd., Canada [M]
Roger L. Barker, North Carolina State University, NC [SE]
Karl J. Beeman, Ensemble Care & Maintenance Services, NV [IM]
Shane Bray, Mine Safety Appliances Company, PA [M]
Donna P. Brehm, Virginia Beach Fire Department, VA [U]
Bill Burke, Fire-Dex, Incorporated, OH [M]
Michael Carlin, La Mesa Fire Department, CA [U]
Steven D. Corrado, Underwriters Laboratories Inc., NC [RT]
Dean W. Cox, Fairfax County Fire & Rescue Department, VA [U]
Don R. Forrest, United Firefighters of Los Angeles City, CA [L]
Greg Gammon, Las Vegas Fire and Rescue, NV [E]
Rep. International Association of Fire Chiefs
Mary I. Grilliot, TFG/Morning Pride Manufacturing LLC, OH [M]
Stephen J. King, Deer Park, NY [SE]
James R. Lawson, US National Institute of Standards & Technology, MD [RT]
Cy Long, Texas Commission on Fire Protection, TX [E]
Michael F. McKenna, Sacramento Metropolitan Fire District, CA [U]
Richard A. Oleson, E. D. Bullard Company, KY [M]
Louis V. Ott, Gentex Corporation, PA [M]
Tom Ragan, Shelby Specialty Gloves, TN [M]
R. Wendell Robison, Fillmore, UT [C]
Rep. National Volunteer Fire Council
Kevin M. Roche, Phoenix Fire Department, AZ [U]
Rep. International Fire Service Training Association
James S. Spahr, US Department of Health & Human Services, WV [RT]
Jeffrey O. Stull, International Personnel Protection, Inc., TX [SE]
William Swope, Lexington Fayette Urban County Government, KY [U]
Jim Tate, Fort Worth Fire Fighters Association, TX [L]
Rep. International Association of Fire Fighters
Robert D. Tutterow, Jr., Charlotte Fire Department, NC [U]
Rep. Fire Industry Equipment Research Organization
Harry P. Winer, US Department of the Navy, MA [RT]

Alternates

Anthony Di Giovanni, Bacou-Dalloz Protective Apparel Ltd., Canada [M]
(Alt. to Claude Barbeau)
Tim Durby, City of Phoenix, AZ [U]
(Alt. to Kevin M. Roche)
Steven Garcia, Fire-Dex, Incorporated, OH [M]
(Alt. to Bill Burke)
Andy Gbur, Intertek, OH [RT]
(Alt. to Jason L. Allen)
Bill Grilliot, Morning Pride Manufacturing, LLC, OH [M]
(Alt. to Mary I. Grilliot)
Allen S. Hay, New York City Fire Department, NY [U]
(Voting Alt. to FDNY Rep.)
F. Joseph Hersick, Mine Safety Appliances Company, PA [M]
(Alt. to Shane Bray)
Kim Klaren, Fairfax County Fire & Rescue Department, VA [U]
(Alt. to Dean W. Cox)
Karen E. Lehtonen, Lion Apparel, Inc., OH [M]
(Alt. to Donald Aldridge)
Robin B. Moore, Underwriters Laboratories Inc., NC [RT]
(Alt. to Steven D. Corrado)
Ted E. Nonini, United Fire Fighters of Los Angeles City, CA [L]
(Alt. to Don R. Forrest)
Kelly Sisson, City of La Mesa Fire Department, CA [U]
(Alt. to Michael Carlin)
Charles C. Soros, Fire Department Safety Officers Association, WA [SE]
(Alt. to Jeffrey O. Stull)
Donald B. Thompson, North Carolina State University, NC [SE]
(Alt. to Roger L. Barker)
Robert Vettori, US National Institute of Standards & Technology, MD [RT]
(Alt. to James R. Lawson)
Donald D. Welch, II, Globe Manufacturing Company, NH [M]
(Alt. to Patricia A. Freeman)

Nonvoting

Matthew I. Chibbaro, US Department of Labor, DC [E]
Rep. Occupational Safety & Health Administration
(Alt. to NV Principal)
Robert B. Bell, US Department of Labor, DC [E]
Rep. Occupational Safety & Health Administration

Committee Scope: This Committee shall have primary responsibility for documents on protective ensembles, except respiratory protection, that provides head, limb, hand, foot, torso, and interface protection for fire fighters and other emergency services responders during incidents involving structural fire fighting operations or proximity fire fighting operations.

Structural fire fighting operations include the activities of rescue, fire suppression, and property conservation during incidents involving fires in buildings, enclosed structures, vehicles, marine vessels, or like properties.

Proximity fire fighting operations include the activities of rescue, fire suppression, and property conservation during incidents involving commercial and military aircraft fires, bulk flammable gas fires, bulk flammable and combustible liquids fires, combustible metal fires, exotic fuel fires, and other such fires that produce very high levels of radiant heat as well as convective and conductive heat.

Additionally, this Committee shall have primary responsibility for documents on the selection, care, and maintenance of structural and proximity fire fighting protective ensembles by fire and emergency services organizations and personnel.

These lists represent the membership at the time each Committee was balloted on the text of this report. Since that time, changes in the membership may have occurred. A key to classifications is found at the front of the document.

Staff Liaison: **Bruce W. Teele**

The Committee on **Fire and Emergency Services Protective Clothing and Equipment** is presenting four Reports for adoption, as follows:

The Reports were prepared by the:

- Technical Correlating Committee on **Fire and Emergency Services Protective Clothing and Equipment** (FAE-AAC)
- Technical Committee on Hazardous Materials Protective Clothing and Equipment (FAE-HAZ)
- Technical Committee on Special Operations Protective Clothing and Equipment (FAE-SCE)
- Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment (FAE-SPF)

Report I: The Technical Committee proposes for adoption, a complete revision to NFPA 1971, **Standard on Protective Ensemble for Structural Fire Fighting,** 2000 edition. NFPA 1971-2000 is published in Volume 11 of the 2004/2005 National Fire Codes and in separate pamphlet form.

NFPA 1971 has been submitted to letter ballot of the **Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment** which consists of 33 voting members; of whom 30 voted affirmatively, 1 negatively after circulation of any negative votes (Bray), and 2 ballots were not returned (Robison, Swope).

Mr. Bray voted negatively stating:

- Protective Hood Interface Component CBR Design Requirements for Both Ensembles, section 6.20.16.2 should include a requirement for a chemical/biological/particulate barrier layer to be included in the protective hood. The hood is in contact with the firefighter's neck, face and head and best suited to provide dermal protection. It also interfaces with a SCBA facepiece that the firefighter would wear in response to a WMD incident. An added benefit to making the hood a required design element of a CBR protective garment is that it provides the firefighter with a continuous level of CBR protection.
- In 8.A.2.1 samples for inward leakage testing, the helmet should not be required to undergo testing when the helmet does not form part of the CBR protective ensemble. The CBR protective ensemble should be tested and approved less the helmet.

Mr Barbeau voted affirmatively with this comment:

I am concerned about that the labeling information can be misinterpreted, Eg: 5.2.1 "THIS XXXX MEETS THE STRUCTURAL FIRE FIGHTING XXXX REQUIREMENTS OF NFPA 1971 ON PROTECTIVE ENSEMBLES FOR STRUCTURAL FIRE FIGHTING AND PROXIMITY FIRE FIGHTING 2006 EDITION. DO NOT REMOVE THIS LABEL." It is possible that anyone reading this on the inside of a structural coat may be led to believe that they are also adequately protected to fight a high-radiant heat fire. I understand that we are referring to the title of the standard, but it may not be so obvious when read on a label for the first time.

Section 6.20: "Chemical" and "Biological" are accurate terms, but I am unsure about leaving the word "Radiological" are we testing for this? Should we be more precise with "Particulate Barrier".

We are concerned about this test, prior to the ROP no test results were shared at the meeting and no indicator of pass or fail was described. Additionally the TPP machine would have to be modified to include compression capability to Jan 2006. Additionally, this process should involve a round-robin test of fabric combinations. We are concerned about meeting the timeline.

Ms. Grillot voted affirmatively with this comment:

I am voting yes with a comment to be circulated to the committee in hopes that corrections can be made before the ROC vote:

1. The committee Action taken on Proposals – Log 127 page 24 of 1971 and its counter part Log 10 of 1976 needs to be re-addressed. For a component to be subjected to a simple oven test and pass if it totally vaporizes but does not melt, separate, or ignite cannot be the desire of the committee. Garments labeled to the 2000 edition of the 1971 standard contained unidentified moisture barrier materials in the front area of the garment (which in my opinion were definitely needed to pass the shower test) and had the barrier portion of the material totally disappear sometime during the oven test leaving only what the bare woven substright material remaining – this material did pass the Standard as currently written and were used in NFPA 1971/2000 certified garment construction.
2. The Committee Statement rational on Log 7 of 1976 rejecting the allowance of the OPTION of the Authority Having Jurisdiction (AHJ) conducting a risk assessment and modifying a proximity garment to allow for the stress relief found in the breathability of a 1971 composite in the rear area of the garment (not facing the radiant challenge) is contrary to fire services desire to provide a less stressful ensemble. This is an important option for many applications but certainly would not be appropriate for all applications – the AHJ should be given the opportunity of evaluating such an option if their risk assessment finds the option acceptable.

Mr. Spahr voted affirmatively with this comment:

1. Tables 6.7.6(a) through Table 6.7.6(e) all have the same typographical error – there should be a hyphen between the range numbers for all dimensions. See last two columns; example "16.2517.25" should read "16.25 – 17.25."
2. Table 6.7.6(b) Small Glove Sizing (page 44)

Digit 4 length has a math error. (compare with NFPA 1977 and 1976 for fourth digit length where the tolerance are all 600 mm or .25 in. or .635 cm). The correct range should be "6.55 – 7.82" (not 6.55 – 7.03).

3. Table 6.7.6(c) Medium Glove Sizes is missing entire column for "inches" (range to be accommodated). (page 44)

Mr. Stull voted affirmatively with this comment:

I believe the committee has done a great job in assembling the ROP document that included consolidation of two standards, a formatting change, and several comprehensive issues. While I am voting in favor of the document, I would like to express my opinions on several different actions since I was unable to attend the last two committee meetings due to health reasons.

Proposal 1971-8 Log #106, Proposal 1971-9 Log #109, and Proposal 1971-10 Log #108: While I understand the committee's position to move the decision on definitions to the TCC, I firmly believe that the current definitions for the moisture barrier (Log #106), outer shell (Log #109), and thermal barrier (Log #108) are clearly out of date and are inaccurate. These definitions have remained unchanged since earlier editions and have failed to capture the increased multifunctional performance aspects of these layers as addressed in the addition of new requirements implemented in the past couple of revisions. I further feel that the committee is negligent is specifically addressing facings, which often can be an entirely different material than the moisture barrier and that should be evaluated for the same properties as the moisture barrier.

Proposal 1971-24 Log #115 and Proposal 1971-25 Log #116: It is inappropriate for a performance requirement and test method to establish a design requirement. Current test requirements for CCHR establish a requirement for reinforcements on the shoulders and knees. Whereas in the current edition, this may have meant no reinforcement at all for the shoulder areas, the newly proposed requirement for a CCHR requirement of 25 as applied to both areas will necessitate the use of additional layers in the construction of this clothing for reinforcement. The committee must specify some minimum area and position of the reinforcements, which of course can be exceeded by the manufacturer in their respective designs. The proposed requirements are consistent with the sample requirements specified in the test method.

Proposal 1971-28 Log #104: While I think this proposal is an outstanding idea, I do not believe that it should mandatory to have a drag rescue device in all clothing. Certainly, similar devices could be created on the SCBA to achieve the same purpose with less effect on the clothing.

Proposal 1971-31 Log #99: I find it incredulous as much as the committee deliberated on establishing a minimum weight requirement for footwear that it should then accept a proposal to increase the minimum height of footwear and therefore essentially mandate a higher burden to the fire fighter. The committee judiciously decided to forego a minimum weight requirement in anticipation of a detailed ergonomic study that addressed footwear and other elements. The incorporation of improved design requirements for ensuring that the moisture barrier extends higher in the footwear will partly address concerns for liquids leaking through footwear. Fire fighters should be extended the same choices for footwear height as afforded by the current edition of the standard.

Proposal 1971-39 Log #103: I would like to go on record as finding the "Light Degradation Test" as fallacious. While the intent of the test is worthy, the task group and the committee have failed in demonstrating that the mode of moisture barrier failure on which the test is based is truly the cause of the Breathetex degradation problem. No evidence has been ever been provided that UV degradation alone (even along with the laundering and heat conditioning) adequately explains the phenomena observed in the field. The fact that the chosen conditions would render most outer shell materials to a completely unusable state, remembering that it would be the outer shell that is attenuating the vast majority of UV light exposure, is proof positive that the selected test conditions fail to appropriately mimic the conditions of Breathetex failure. I understand that the task group expended a great effort in developing the proposed requirements, but the commitment of these resources in of itself does not constitute a valid reason for adding this requirement. Consider that if Breathetex degradation had been instead the result of a product defect, either in the film or manufacturing process or both, that was limited to only a portion

of the material placed in the marketplace, then the proposed test would have no value whatsoever. I believe the committee should reconsider the test on the basis of its merits only as compared the original direction of the task group to prevent "Breathetex-like failures."

Proposal 1971-41 Log #87: An additional part of the substantiation should include the IAFF Indianapolis Study, "Field Evaluation of Protective Clothing Effects on Fire Fighter Physiology: Predictive Capability of Total Heat Loss Test," which provided the basis of the selected requirement of 170 W/m^2.

Proposal 1971-45 Log #23: It is my hope that when the committee set the criteria for strength for hook and pile closures that they minimum limits were established above current aramid hook and pile closures as these closures are considered to have less than adequate strength/durability. This practice would then provide a target for improvement of such closures to overcome their current limitations.

Proposal 1971-75 Log #107: How can the committee use the substantiation of an "industrial" based method as the basis for a fire fighter helmet? Both footwear and gloves are subjected to the proposed higher heat flux flame because they are tested as "whole" items as is the helmet. The exemption of helmets from the same practice while permitting a longer afterflame time show a glaring inconsistency in the standard to apply minimum performance criteria for evaluating the ensemble in the same manner.

Proposal 1971-86 Log #85: I do not understand the reasons compelling the committee to accept another emergency condition test (we already have the TPP test, which can yield further information if additional results are reported). The charter of the Thermal Task Group was to investigate test methods that evaluate burn injuries that occur in situations under "ordinary" fire ground conditions where destruction of the outer shell is not observed. The proposed test does not fulfill this direction. Further, it has not received an adequate review and is dubious for providing additional results for characterizing composite performance.

Proposal 1971-118 Log #27: The submitter is misinformed on the basis of the shower test. A longer shower test is predicated on the fact that additional time is necessary for inward leakage to manifest itself on the inner liquid absorptive garment. Given that the three layer construction of structural fire fighting protective clothing, the longer duration is necessary to provide an adequate assessment of liquid integrity. EMS clothing on the other hand is one or two layers, lacking a relatively thick insulative thermal barrier. Furthermore, the decision to move to a 8 minute shower test for NFPA 1999 was controversial, resulting in a split vote at the committee ROC meeting requiring the tiebreaker to be cast by the chairperson.

Proposal 1971-124 Log #118: The conditioning requirement does not make sense. No where in the conditioning procedure is the amount of moisture specified. Rather, the amount of water that is absorbed by the respective thermal barrier material is dependent on the material itself and the conditions of the blotting paper and laboratory wringer. No substantiation has been provided for the basis of the 30% weight by mass requirement for Aralite as a justifiable moisture condition. I note that this requirement was apparently written within the meeting without full committee review (at the meeting).

NFPA 1971 has also been submitted to letter ballot of the **Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment**, which consists of 21 voting members; of whom 21 voted affirmatively.

Mr. Stull voted affirmatively with this comment:

I believe the committee has done a great job in assembling the ROP document that included consolidation of two standards, a formatting change, and several comprehensive issues. While I am voting in favor of the document, I would like to express my opinions on several different actions since I was unable to attend the last two committee meetings due to health reasons.

Proposal 1971-8 Log #106, Proposal 1971-9 Log #109, and Proposal 1971-10 Log #108: While I understand the committee's position to move the decision on definitions to the TCC, I firmly believe that the current definitions for the moisture barrier (Log #106), outer shell (Log #109), and thermal barrier (Log #108) are clearly out of date and are inaccurate. These definitions have remained unchanged since earlier editions and have failed to capture the increased multifunctional performance aspects of these layers as addressed in the addition of new requirements implemented in the past couple of revisions. I further feel that the committee is negligent is specifically addressing facings, which often can be an entirely different material than the moisture barrier and that should be evaluated for the same properties as the moisture barrier.

Proposal 1971-24 Log #115 and Proposal 1971-25 Log #116: It is inappropriate for a performance requirement and test method to establish a design requirement. Current test requirements for CCHR establish a requirement for reinforcements on the shoulders and knees. Whereas in the current edition, this may have meant no reinforcement at all for the shoulder areas, the newly proposed requirement for a CCHR requirement of 25 as applied to both areas will necessitate the use of additional layers in the construction of this clothing for reinforcement. The committee must specify some minimum area and position of the reinforcements, which of course can be exceeded by the manufacturer in their respective designs. The proposed requirements are consistent with the sample requirements specified in the test method.

Proposal 1971-28 Log #104: While I think this proposal is an outstanding idea, I do not believe that it should mandatory to have a drag rescue device in all clothing. Certainly, similar devices could be created on the SCBA to achieve the same purpose with less effect on the clothing.

Proposal 1971-31 Log #99: I find it incredulous as much as the committee deliberated on establishing a minimum weight requirement for footwear that it should then accept a proposal to increase the minimum height of footwear and therefore essentially mandate a higher burden to the fire fighter. The committee judiciously decided to forego a minimum weight requirement in anticipation of a detailed ergonomic study that addressed footwear and other elements. The incorporation of improved design requirements for ensuring that the moisture barrier extends higher in the footwear will partly address concerns for liquids leaking through footwear. Fire fighters should be extended the same choices for footwear height as afforded by the current edition of the standard.

Proposal 1971-39 Log #103: I would like to go on record as finding the "Light Degradation Test" as fallacious. While the intent of the test is worthy, the task group and the committee have failed in demonstrating that the mode of moisture barrier failure on which the test is based is truly the cause of the Breathetex degradation problem. No evidence has been ever been provided that UV degradation alone (even along with the laundering and heat conditioning) adequately explains the phenomena observed in the field. The fact that the chosen conditions would render most outer shell materials to a completely unusable state, remembering that it would be the outer shell that is attenuating the vast majority of UV light exposure, is proof positive that the selected test conditions fail to appropriately mimic the conditions of Breathetex failure. I understand that the task group expended a great effort in developing the proposed requirements, but the commitment of these resources in of itself does not constitute a valid reason for adding this requirement. Consider that if Breathetex degradation had been instead the result of a product defect, either in the film or manufacturing process or both, that was limited to only a portion of the material placed in the marketplace, then the proposed test would have no value whatsoever. I believe the committee should reconsider the test on the basis of its merits only as compared the original direction of the task group to prevent "Breathetex-like failures."

Proposal 1971-41 Log #87: An additional part of the substantiation should include the IAFF Indianapolis Study, "Field Evaluation of Protective Clothing Effects on Fire Fighter Physiology: Predictive Capability of Total Heat Loss Test," which provided the basis of the selected requirement of 170 W/m^2.

Proposal 1971-45 Log #23: It is my hope that when the committee set the criteria for strength for hook and pile closures that they minimum limits were established above current aramid hook and pile closures as these closures are considered to have less than adequate strength/durability. This practice would then provide a target for improvement of such closures to overcome their current limitations.

Proposal 1971-75 Log #107: How can the committee use the substantiation of an "industrial" based method as the basis for a fire fighter helmet? Both footwear and gloves are subjected to the proposed higher heat flux flame because they are tested as "whole" items as is the helmet. The exemption of helmets from the same practice while permitting a longer afterflame time show a glaring inconsistency in the standard to apply minimum performance criteria for evaluating the ensemble in the same manner.

Proposal 1971-86 Log #85: I do not understand the reasons compelling the committee to accept another emergency condition test (we already have the TPP test, which can yield further information if additional results are reported). The charter of the Thermal Task Group was to investigate test methods that evaluate burn injuries that occur in situations under "ordinary" fire ground conditions where destruction of the outer shell is not observed. The proposed test does not fulfill this direction. Further, it has not received an adequate review and is dubious for providing additional results for characterizing composite performance.

Proposal 1971-118 Log #27: The submitter is misinformed on the basis of the shower test. A longer shower test is predicated on the fact that additional time is necessary for inward leakage to manifest itself on the inner liquid absorptive garment. Given that the three layer construction of structural fire fighting protective clothing, the longer duration is necessary to provide an adequate assessment of liquid integrity. EMS clothing on the other hand is one or two layers, lacking a relatively thick insulative thermal barrier. Furthermore, the decision to move to a 8 minute shower test for NFPA 1999 was controversial, resulting in a split vote at the committee ROC meeting requiring the tiebreaker to be cast by the chairperson.

Proposal 1971-124 Log #118: The conditioning requirement does not make sense. No where in the conditioning procedure is the amount of moisture specified. Rather, the amount of water that is absorbed by the respective thermal barrier material is dependent on the material itself and the conditions of the blotting paper and laboratory wringer. No substantiation has been provided for the basis of the 30% weight by mass requirement for Aralite as a justifiable moisture condition. I note that this requirement was apparently written within the meeting without full committee review (at the meeting).

Mr. Trivette voted affirmatively with comment:
The TCC should not be used as a tool for personal agenda. The notes that the TCC put in 1971 should have been in the ROP or left for the ROC.

This document when adopted will be redesignated as NFPA 1971, **Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.**

Report II: The Technical Committee proposes for adoption, a withdrawal to NFPA 1976, **Standard on Protective Ensemble for Proximity Fire Fighting**, 2000 edition. NFPA 1976-2000 is published in Volume 12 of the 2004/2005 National Fire Codes and in separate pamphlet form.

NFPA 1976 has been submitted to letter ballot of the **Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment**
which consists of 33 voting members; of whom 28 voted affirmatively, and 5 ballots were not returned (Allen, Carlin, Swope, Winer, Hay).

NFPA 1976 has also been submitted to letter ballot of the **Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment,** which consists of 21 voting members; of whom 21 voted affirmatively.

Report III: The Technical Committee proposes for adoption, a complete revision to NFPA 1983, **Standard on Fire Service Life Safety Rope and System Components**, 2001 edition. NFPA 1983-2001 is published in Volume 12 of the 2004/2005 National Fire Codes and in separate pamphlet form.

NFPA 1983 has been submitted to letter ballot of the **Technical Committee on Special Operations Protective Clothing and Equipment,** which consists of 18 voting members; of whom 15 voted affirmatively, and 3 ballots were not returned (Ghorashi, Sisson, Stanhope).

NFPA 1983 has also been submitted to letter ballot of the **Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment,** which consists of 21 voting members; of whom 21 voted affirmatively

Report IV: The Technical Committee proposes for adoption, a complete revision to NFPA 1994, **Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents**, 2001 edition. NFPA 1994-2001 is published in Volume 12 of the 2004/2005 National Fire Codes and in separate pamphlet form.

NFPA 1994 has been submitted to letter ballot of the **Technical Committee on Hazardous Materials Protective Clothing and Equipment**, which consists of 22 voting members; of whom 22 voted affirmatively.

Mr. Stull voted affirmatively with this comment:
1. The committee is reminded that the both the challenge and end points (for establishing performance criteria) on barrier testing bear further investigation and harmonization with levels established for respiratory protection (at least for challenge concentrations). A similar analysis is needed for establishing the integrity levels for all Classes.
2. The Man-In-Simulant-Test requires further standardization and preparation as a stand-alone method to replace military procedures for greater accessibility for the PPE industry.
3. The proposed particulate resistance test is an ISO Final Draft International Standard that is set for approval and publication in late 2004. A review of this method is needed to succinctly determine appropriate pass/fail levels for Class 4 ensembles.
4. The committee should consider the use of surrogate chemical agents for testing at least for the follow-on testing requirements.
5. Greater design flexibility is needed in the standards to permit manufacturers to provide innovative products that can provide the protection at each class. For example, current footwear requirements appear to be design-restrictive.

NFPA 1994 has also been submitted to letter ballot of the **Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment,** which consists of 21 voting members; of whom 21 voted affirmatively

Mr. Curtis voted affirmatively with this comment:
The ROP clearly and appropriately discriminates between Class 2 and Class 3 through the Class 2 requirement to withstand the “SF6” challenge. The TCC’s note to “investigate” the MIST method should not be taken as a way to reduce the challenges for Class 2. The MIST does not discriminate against inorganics and is far less challenging.

Mr. Stull voted affirmatively with this comment:
1. The committee is reminded that the both the challenge and end points (for establishing performance criteria) on barrier testing bear further investigation and harmonization with levels established for respiratory protection (at least for challenge concentrations). A similar analysis is needed for establishing the integrity levels for all Classes.
2. The Man-In-Simulant-Test requires further standardization and preparation as a stand-alone method to replace military procedures for greater accessibility for the PPE industry.
3. The proposed particulate resistance test is an ISO Final Draft International Standard that is set for approval and publication in late 2004. A review of this method is needed to succinctly determine appropriate pass/fail levels for Class 4 ensembles.
4. The committee should consider the use of surrogate chemical agents for testing at least for the follow-on testing requirements.
5. Greater design flexibility is needed in the standards to permit manufacturers to provide innovative products that can provide the protection at each class. For example, current footwear requirements appear to be design-restrictive.

Note: To assist in review and comment, a draft of NFPA 1971 is available and downloadable from the NFPA website at www.nfpa.org. It is also in CD ROM and print versions available from NFPA upon request by calling Customer Service at 1-800-344-3555.

1971-1 Log #113 FAE-SPF **Final Action: Accept in Principle**
(Entire Document)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: To Provide option for certification of NFPA 1971 ensemble for additional chemical/biological protection. Add the following sections:

Optional Criteria for Firefighter Protection Clothing with Chemical/ Biological Terrorism Agent Protection.

1. Scope - Recognition of optional certification category.

2. Definitions - Add the following definitions from NFPA 1994 - Biological Terrorism Incidents, Chemical/Biological Barrier material, Chemical/Biological Terrorism Agents, Chemical Terrorism Agents, Chemical Warfare (CW) Agents, Dual-Use Chemicals.

3. Certification - Add section addressing special inspections, design evaluation, and performance assessment of firefighter protective clothing with optional chemical/biological terrorism agent protection, including recerticification. Add provision, that optional chemical/biological terrorism agent protection certification may only be performed on a complete ensemble that includes garments, helmet, hoods, gloves, and footwear. No separate element certifications to be permitted.

4. Labeling - Provide new distinct label for products meeting optional criteria for optional chemical/biological terrorism agent protection.

5. User Information/technical Data Package - Add new requirement for providing performance data of product against chemical and biological terrorism agents.

6. Performance Requirements - Add the following:

- Performance of chemical/biological barrier material against the material requirements currently specified in NFPA 1994 for Class 2.
- Performance of entire ensemble in Man-In-Simulant Test (MIST) with minimum protection factor of 100.

7. Test Methods - Add the following:

- Permeation test method (based on ASTM F 739)
- Puncture Propagation tear resistance test (base on ASTM D 2582)
- Man-In-Simulant Test Integrity Methods (based on U.S. Army TOP method)

Substantiation:

Overview of Proposed Requirements for Optional Criteria to Address Chemical and Biological Protection Provided by Structural Fire Fighting Protective Clothing and Equipment

Increasing concerns for firefighters in large, metropolitan areas and other locations to become engaged in events involving weapons of mass destruction cannot be adequately addressed through the specification of NFPA 1994 clothing. Whereas the current NFPA 1971 clothing is not effective in providing protection against many chemical and biological, the vast majority of firefighter first responders are unlikely to be provided with any supplemental protective clothing that meets NFPA 1994 requirements. NFPA 1994 currently precludes certification of NFPA 1971 clothing to NFPA 1994 and further entails different classes that could be easily misrepresented in its protection of front line firefighters. The proposed requirements provide a level of option improved chemical and biological protection that can be selected for those departments which are concerned about first response to WMD events.

This is a detailed overview for the public proposal 1971-1 (Log 113) for the addition of optional chemical/biological protection criteria to NFPA 1971.

As stated in my public proposal, increasing concerns for fire fighters in large metropolitan areas and other locations to become engaged in events involving weapons of mass destruction cannot be adequately addressed. Whereas the current NFPA 1971 clothing is not effective in providing protection against many chemical and biological agents (contrary to the statements in the "3/30" rule), the vast majority of fire fighter first responders are unlikely to be provided with any supplemental protective clothing that meets NFPA 1994 requirements. NFPA 1994 entails different classes that could be easily misrepresented in its protection of front line fire fighters. The proposed requirements provide an option of improved chemical and biological protection that can be selected by those departments that are concerned about first responders to WMD terrorism incidents.

The proposed changes are not predicated on any specific current or proposed material, design, or ensemble technology. Rather, these requirements are solely based on my best attempt to consider and apply the requirements of NFPA 1994 to structural fire fighting protective clothing and equipment in a necessary and practical manner.

It is important to point out that NFPA 1994 is on a parallel revision cycle as NFPA 1971, and significant changes are taking place with the revision of that document as well. These changes include:

1. Moving Class 1 from NFPA 1994 into NFPA 1991 and making the NFPA 1991 ensemble the "super ensemble" by making chemical agent testing mandatory (*this has already been accomplished*).
2. Maintaining Class 2 and Class 3 type protection in NFPA 1994 (with their current designations) but aligning the challenge levels with SCBA use and PAPR/APR use, respectively (based on the work performed by NIOSH for the CBRN qualification of respirators).
3. Changing the end points for toxic industrial chemicals from breakthrough times to appropriate permissible skin exposure levels (as is currently done for chemical warfare agents).
4. Replacing the SF_6 test with the MIST test for ensemble integrity determinations.
5. Requiring Class 3 ensembles to have some level of breathability.
6. Adding a new Class 4 to address biological and particulate hazards only (where no chemical hazards exist).

The proposed new requirements are consistent with the above strategy; however, it is still necessary to include specific changes in NFPA 1971 (and not rely on "dual" certification of products to both NFPA 1971 and NFPA 1994) for the following reasons:

- NFPA 1994 requirements are predicated on a single actual exposure. Significant durability requirements are not included and are not expected to be added during the next edition to address reuse.
- The design and performance of NFPA 1971 ensembles and ensemble elements are based on providing protection against a variety of hazards with multiple tradeoffs in several performance properties. These tradeoffs must be accounted for in the application of supplement criteria.
- Chemical and biological terrorism agent protection can only be applied to ensembles, not individual elements. A combination of design and performance criteria specific to structural fire fighting protective clothing and equipment are required to achieve this goal.

Summary of Requirements

The acceptability of products against the proposed requirements will be the performance of an overall ensemble, not individual elements. This approach is being made because the effectiveness of protective ensemble is highly dependant on the many interfaces that exist between elements that cannot be separately assessed without consideration of the full ensemble. Thus, only specified ensembles, consisting of garments, helmet, hood (if not already part of the garment), gloves, footwear, and an identified specific NFPA 1981 certified SCBA with additional CBRN protection will be permitted to be certified to these proposed optional requirements.

Design criteria have been proposed to address possible difference in ensemble configurations and design approaches for ensuring complete and continuous protection of the wearer.

The table summarizes the specific proposed performance criteria. A second table will be provided at the meeting which offers a description and the history of each test method.

Recommended Specific Properties, Test Methods, Conditioning, Measurements and Requirements

Evaluation or Property	Test Method	How Applied	Required Sample Conditioning	Measurement	Proposed Requirement
Inward leakage resistance	New test method	Entire ensemble: garment, helmet, gloves, footwear, hood, specified CBRN SCBA	5 wash cycles for whole garments, hoods, and gloves; 100,000 flexes of footwear	Percent leakage (protection factor)	≤ 1% (equivalent to protection factor of 100)
Liquid-tight integrity	ASTM F 1359	Same as above	Same as above	Observation of liquid penetration	No visible liquid penetration to inner garment
Permeation resistance	ASTM F 739-99a (modified);	Barrier layer in garments, hoods, gloves, and footwear	Same conditioning proposed for moisture barrier (successive pocket laundering and heat exposures) plus rigorous flexing	Cumulative permeation ($\mu g/cm^2$) for chemical agents Breakthrough time (min)	≤ 1.25 $\mu g/cm^2$ for Sarin (GB) ≤ 4.0 $\mu g/cm^2$ for Mustard (GD) ≥ 60 min for industrial chemicals
Burst strength	ASTM D 3787	Same as above	Room temperature conditioning	Burst force	≥ 156 N (35 lb_f)
Puncture propagation tear resistance	ASTM D 2582	Same as above	Room temperature conditioning	Puncture-tear force	≥ 31 N (7 lb_f)
Cold temperature performance	ASTM D 747 (modified)	Same as above	Room temperature conditioning	Bending moment (N)	≤ 0.057 N-m (≤ 1/2 in.-lb_f) at angular deflection of 60 degrees at -25°C (-13°F)
Seam strength	ASTM D 1683	Same as above	Before and after 5 cycles of laundering	Seam strength (N)	≥ 180 N (40 lb_f): internal ≥ 334 N (75 lb_f): external
Cut resistance	ASTM F 1790	Exterior barrier layers for gloves and footwear	Room temperature conditioning	Distance of blade travel at specific load (mm)	≥ 25 mm (1-in.); Footwear cover – 800 g Gloves – 400 g
Puncture resistance	ASTM F 1342	Same as above	Room temperature conditioning	Puncture force (N)	≥ 36 N (8 lb_f): gloves ≥ 200 N (45 lb_f): gloves
Abrasion resistance	ASTM D 3884	Same as above	Room temperature conditioning	Cycles to wear-through	≥ 3,000 cycles

Committee Meeting Action: Accept in Principle

Add new text as follows.

See the entire ROP draft for text in all chapters of the document.

Committee Statement: The Committee reviewed an update of the proposal submitted by Mr. Stull and agreed with the intent. The Committee did general editing in order to reflect similar terminology style used throughout the document and renumbered and reformatted as necessary.

1971-2 Log #CP1 FAE-SPF **Final Action: Accept**
(Entire Document (MOS))

Submitter: Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment

Recommendation: Completely revise entire document to comply with the NFPA Manual of Style as follows:

1. Revise Chapter 1 to contain administrative text only as follows:
(show revised text here or indicate where revised text can be found)
2. Revise Chapter 2 to contain only referenced publications cited in the mandatory portions of the document.
3. Revise Chapter 3 to contain only definitions.
4. Revise so that all units of measure in document are converted to SI units with inch/pound units in parentheses.
5. Appendices are to be restructured and renamed as "Annexes."
6. All mandatory sections of the document must be evaluated for usability, adoptability, and enforceability language. Generate necessary committee proposals as shown (or indicate where shown).
7. Reword exceptions as requirements.
8. Single sentences per requirement as shown (or indicate where shown).

Substantiation: Editorial restructuring, to conform with the 2000 edition of the NFPA Manual of Style.

Committee Meeting Action: Accept

Committee Statement: The standard was revised to comply to the NFPA Manual of Style.

1971-3 Log #CP2 FAE-SPF **Final Action: Accept**
(Entire Document)

TCC Action: The TCC supports the incorporation of the option for additional chemical, biological, and radiological protection in structural fire fighting protective clothing ensembles that addresses the entire ensemble as a complete system (garments, helmets, gloves, footwear, hoods, respiratory protection, and other interface items) in terms of certification, labeling, design, and performance requirements. The TCC specifically directs the TC to:

1. Ensure that the chemical, biological, and radiological protection does not diminish the minimum performance requirements that have been established for structural fire fighting protective ensembles. Further there shall be a justification for the additional chemical, biological, and radiological performance requirements based on established threat assessments.

2. Review design criteria and wherever possible permit flexibility in developing new product designs, particularly in interface areas that are currently not addressed in the current edition of NFPA 1971. The proposed criteria for the optional chemical, biological, and radiological protection should reconcile the existing proposed design requirements with a systems approach that anticipates different non-conventional configurations of ensemble elements.

3. Further investigate and validate the proposed material barrier and overall ensemble integrity requirements, particularly accounting for demonstrated durability of these properties over the anticipated service life of the ensemble. The proposed criteria should take into consideration the latest test methodologies for chemical agent and toxic industrial chemical exposure concentrations and test end points. The proposed levels of barrier and integrity performance should be reconciled with the performance levels proposed in revision of NFPA 1994 for Class 2 ensemble performance.

4. Review performance requirements and wherever possible incorporate additional criteria for ensemble element and material performance that address areas including but not limited to,

• interface effectiveness,

• contamination resistance of the outer shell,

• thermal stability of all materials layers and components (for exhibiting continued performance),

• durability of the ensemble element layers responsible for the additional chemical/biological protection, and

• physiological and ergonomic properties of the ensembles.

Submitter: Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment

Recommendation: The Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment, proposes a complete revision to NFPA 1971, Standard on Protective Ensemble For Structural Fire Fighting, as shown at the end of this report. The revised document will be titled "Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting."

Substantiation: The standard was revised to comply to the NFPA Manual of Style. This revision incorporates the requirements for protective ensembles for proximity fire fighting currently found in NFPA 1976, Standard on Protective Ensemble for Proximity Fire Fighting. See Propoosal 1976-17 (Log #CP1) which recommends withdrawal of NFPA 1976. Additionally, proposals with affirmative actions were incorporated into this complete revision of the

document.
Committee Meeting Action: Accept

1971-4 Log #29 FAE-SPF **Final Action: Reject**
(1.1.1.1 and 1.1.1.2)

Submitter: Harry P. Winer, U.S. Navy
Recommendation: Add text to read as follows:
1.1.1.1 The requirements for Class 1 shall apply to fire fighters protective coats, protective trousers, and protective coveralls. A Class 1 ensemble protects you from flame and thermal exposure, viral protection, and Liquid penetration.
1.1.1.2 The requirements for Class 2 shall apply to fire fighters protective coats, protective trousers, and protective coveralls. A Class 2 ensemble protects you from flame the thermal exposures and limited liquid protection.
Substantiation: During the last few revisions of the standard we have added protection from other hazards other than fire. This has basically made a fire fighters ensemble an all-purpose suit, with increased costs. Adding the Class 2 suits will offer the fire department an option where they could procure a fire fighters suit that offers flame and thermal protection with limited liquid protection. The suit may be lighter in weight, and may also have an increase in total heat loss, which will reduce the heat stress of the fire fighter.
Committee Meeting Action: Reject
Committee Statement: The Technical Committee believes, based on its experience, that the structural fire fighting ensemble must continue to provide protection against all of the expected hazards fire fighters encounter when performing their various functions, and therefore existing protection should not become optional.

1971-5 Log #4 FAE-SPF **Final Action: Reject**
(1.1.7)

NOTE:This proposal appeared as Comment 1971-3 (Log # 34) which was held from the F99 ROC on proposal 1971-132
Submitter: Kerry W. Gordon, Cairns & Brother, Inc.
Recommendation: Revise text:
1-1.7 The requirements of this standard ~~do not~~ apply to all accessories that can be attached to any element of the structural firefighting ensemble ~~unless specifically addressed herein~~ .
Substantiation: At present accessories fall outside the purview of the performance, test and certification requirements of this standard which allows products that in of themselves may not alter the performance of the component that they are attached to but may create significant hazards themselves (e.g., helmet mounted flashlights that may not degrade the performance of the helmet but may outgas, melt or explode.
Committee Meeting Action: Reject
Committee Statement: The variety and quantity of after-market accessories available make it impossible to address accessories in this standard. In response to this problem, the Technical Correlating Committee has established a policy that product standards within this project will not attempt to address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard. Also see Committee Action on 1971-36 (Log #9).

1971-6 Log #92 FAE-SPF **Final Action: Reject**
(1.3, 4-1 (selected paragraphs))

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
Trim. Retroreflective and fluorescent material or retroreflective material attached to the outermost surface of the protective ensemble element for visibility enhancement. Retroreflective materials enhance nighttime visibility, and fluorescent materials enhance daytime visibility.
4-1.12* Garments shall have ~~fluorescent and retroreflective~~ trim permanently attached to the outershells of garments to meet visibility requirements. Trim shall be at least 50 mm (2 in.) wide ~~and shall have both retroreflective and fluorescent surfaces. The retroreflective surface of trim shall be at least 160 mm (5/8 in.) wide. Fluorescent and retroreflective areas of trim shall appear to be continuous for the length of the trim, with gaps between areas of retroreflectivity of not more than 3 mm (1/8 in.).~~
4-1.12.1 Gaps between areas of retroreflectivity shall be not more than 6 mm (1/4 in.).
4-1.12.2 When trim consists of both retroreflective and fluorescent surfaces, the retroreflective surface of trim shall be at least 160 mm (5/8 in.) wide and fluorescent and retroreflective areas of trim shall appear to be continuous for the length of the trim.
~~4-1.12.1~~ 4-1.12.3 When trim consists of both retroreflective and fluorescent surfaces, trim used to meet the minimum trim pattern requirements shall have a minimum fluorescent surface of 50 mm ^{2} /linear mm (2 in. ^{2} /linear in.) of trim.
~~4-1.12.2~~ 4-1.12.4 When trim consists of both retroreflective and fluorescent surfaces, trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figures 4-1.14.5 and 4-1.15.3 shall be permitted to not meet the minimum fluorescent surface of 50 mm ^{2} /linear mm (2 in. 2 /linear in.) of trim.
4-1.13 Trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figures 4-1.14.5 and 4-1.15.3 shall be permitted to be obscured by components including, but not limited to, pockets, storm flaps, and reinforcing patches as long as the minimum trim pattern is not obscured.
4-1.14 In lieu of trim, garments shall be permitted to use retroreflective outer shell material provided that the outer shell material meets the requirements in 5-1.22. If a retroreflective outer shell material, at least 90 percent of the exposed clothing surface area must consist of the retroreflective outer shell material.
Renumber other paragraphs.
Substantiation: This proposal addresses several issues related to visibility of fire fighters and the manner of providing visibility components in firefighter protective clothing. It is intended to recognize possible emerging technology and provide alternatives for providing firefighter visibility.
There is a continuing debate about the adequacy for the amount of fluorescent material on firefighter turnout clothing in providing acceptable levels of daytime visibility and conspicuity (for example, there is nothing in the standard to prevent the use of yellow fluorescent material on a yellow outer shell). Prior assessments have identified nighttime visibility (retroreflectivlty) to be a substantially higher priority than daytime visibility (fluorescence). Therefore, an option has been proposed to permit trim to consist of retroreflective material only.
The proposal also permits the option of an outershell material that offers retroreflective performance consistent with current trim retroreflectivity requirements.
Lastly, the size of an allowable gap has been increased from 1/8 in. to 1/4 in. This practice would permit manufacturers to not have to sew trim into seams, which is one of the leading areas for trim abrasion. By permitting a 1/4 gap, trim edges could be butted together along seams and conceivably lessen trim wear with negligible loss of firefighter visibility.
Committee Meeting Action: Reject
Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

1971-7 Log #3 FAE-SPF **Final Action: Reject**
(1.3 Accessories)

NOTE:This proposal appeared as Comment 1971-4 (Log # 31) which was held from the F99 ROC on Proposal 1971-132
Submitter: Kerry W. Gordon, Cairns & Brother, Inc.
Recommendation: Revise text:
Accessories.* Those additional items that are attached to a protective ensemble element ~~but designed in such a manner to be removable from the protective ensemble~~ and that are not necessary for that element to meet the requirements of this standard. Such accessories include but are no limited to, utility belts, harnesses, back packs, tools, tool packs, radios, radio packs, suspenders, lights, and heat-sensing devices.
Substantiation: "Design in such a manner to be removable" is vague and misleading. Proposed verbiage more adequately defines "Accessory".
Committee Meeting Action: Reject
Committee Statement: The variety and quantity of after-market accessories available make it impossible to address accessories in this standard. In response to this problem, the Technical Correlating Committee has established a policy that product standards within this project will not attempt to address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard. Also see Committee Action on 1971-36 (Log #9).

1971-8 Log #106 FAE-SPF **Final Action: Reject**
(1.3.77 and New 1.3.x.x)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text as follows:
1-3.77 Moisture Barrier. The portion of the protective ensemble element composite, including facings in those areas of garments where employed, designed to prevent the transfer of liquids that may include but not be limited to, water, hot water, certain hazardous materials, and blood borne pathogens. The moisture barrier also attenuates the passage of steam and contributes to the thermal insulation provided by the composite.
1-3.XX Facing. A material used in the construction of garments that is intended to provide the functionality of a moisture barrier in the areas of the garment where used.
Substantiation: Facing materials are used in firefighter protective clothing to provided continuous moisture protection to the wearer (see current paragraph 4-1.5). Even though used as part of the overall moisture protection of the wearer, facings are not tested to the same requirements of the moisture barrier

in the current edition of NFPA 1971.
Committee Meeting Action: Reject
Committee Statement: The Technical Correlating Committee has directed the Technical Committees to use TCC project definitions and to avoid including any information beyond the basic definition of the specific term. In addition, the TC did not feel that the proposed new definition for "facing" was appropriate. The term "facing" can be used in many different ways in garment construction. Further, the TC believes the requirements related to moisture barriers the submitter was attempting to address in the definition of facing are already covered by the standard in existing paragraph 4-1.4. Should additional performance requirements be desired, they should be placed in the performance chapter and not in a definition.

1971-9 Log #109 FAE-SPF **Final Action: Reject**
(1.3.79)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise to read:
1-3.79 Outer Shell. The outermost layer of the composite with the exception of trim, hardware, reinforced material, and wristlet material, that is intended to provided the principal physical protection for the composite and contribute the composite's resistance to flame resistance, heat resistance, and thermal insulation.
Substantiation: The current definition does not recognize the functional performance of outer shell and its role in overall clothing composite.
Committee Meeting Action: Reject
Committee Statement: The Technical Correlating Committee has directed the Technical Committees to use TCC project definitions and to avoid including any information beyond the basic definition of the specific term in the definition.

1971-10 Log #108 FAE-SPF **Final Action: Reject**
(1.3.124)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise to read:
1-3.124 Thermal barrier. The portion of protective ensemble element composites that is designed to provide the principal portion of thermal protection.
Substantiation: The current definition does not recognize that other layers of the composite also provide thermal protection, namely, the outer shell and moisture barrier layers.
Committee Meeting Action: Reject
Committee Statement: Technical Correlating Committee has directed the Technical Committees to use TCC project definitions and to avoid including any information beyond the basic definition of the specific term in the definition. In addition, this definition has been revised and may address the submitter's concern.

1971-11 Log #126 FAE-SPF **Final Action: Reject**
(2.2.7)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Change first sentence to read:
"The certification organization shall have a follow up inspection program of the manufacturing facilities of the certified product, with at least <u>one</u> random and unannounced visit per <u>three month</u> period."
Substantiation: This change reflects the current policies of third party certifiers used on our industry today. This change will not change what is actually happening with the major certifiers but will serve to insure future certifiers will continue this current level.
Committee Meeting Action: Reject
Committee Statement: The requirements for follow-up inspections are addressed project wide by the TCC. The current TCC boiler plate text will be included in our ROP.

1971-12 Log #7 FAE-SPF **Final Action: Reject**
(2.3.1.5)

NOTE:This proposal appeared as Comment 1971-28 (Log # 37) which was held from the F99 ROC on proposal 1971-132
Submitter: Allen S. Williams, Anne Arundel County EMS/Fire/Rescue, MD
Recommendation: Address the flammability of the trim.
Substantiation: On December 14, 1998, two of our fire fighters suffered burns while attempting to locate as trapped victim at a dwelling fire. One fire fighter was on disability leave for over a month. During the injury analysis, their gear was thoroughly inspected. While completing this process, there appeared to be a correlation between the damaged liner of the turnout coat and the location of reflective trim. I spoke with Ms. Patricia Freeman, a Technical Services Manager for Glove who also serves on the technical Committee for NFPA 1971. She reported that several other customers have identified a similar correlation and the flammability of the trim may be an issue. In reviewing the Report on Proposals, there is debate on reflective trim, but the issues seem to be whether or not to make it optional. Ironically, the recommendation to make trim option is based upon he fact that the submitter witnessed burns under the trim. I am glad to see the committee rejected these proposals, but am concerned that there appears to be little effort to address what may be a flammability concern. I am aware of the Heat and Thermal Resistance Test that exposes the trim to 500°F for five minutes. However, as indicated on page 1181 of the Report on Proposals, the committee clearly states this is not intended to duplicate a fire fighting environment. It appears that a test that does duplicate a fire fighting environment is necessary for the reflective trim. I am aware of the new testing protocol for full manikin flame testing of turnout clothing, but am concerned this would not have prevented our injuries.
Note: Supporting material is available for review at NFPA Headquarters.
Committee Meeting Action: Reject
Committee Statement: Heat resistance and flammability of trim were addressed in the 2000 edition of NFPA 1971. The Committee believes this has had a positive effect on trim.

1971-13 Log #8 FAE-SPF **Final Action: Accept in Principle**
(2.3.7, 2.3.8, 2.3.9)

NOTE:This proposal appeared as Comment 1971-33 (Log # 38) which was held from the F99 ROC on Proposal 1971-132
Submitter: Cy Long, Texas Comm. on Fire Protection
Recommendation: Revise Chapter 2 Certification:
2-3 Inspection and Testing.
~~2-3.7 Where certification testing includes an element with an accessory or accessories, each accessory shall be certified as complying with Section 4-8.~~
~~2-3.8 Any change in e 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.~~
2-3.9 ~~9The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the product or any product component prior to the product's submission for evaluation and testing by the certification organization. The certification organization shall accept, from the manufacturer for evaluation and testing for certification, only product or product components that are the same in every respect to the actual final product or product component.~~ The certification organization shall not allow the substitution, repair, or modification, other than as specifically permitted herein, or any product or any product component during testing.
Substantiation: With regards to above three sections there are some accessories and materials being added to an element of protective clothing that are not being tested or can not be tested uniformly be a certification organization in accordance to the above three sections. I have been told by some certification organizations that this is due to subjective test methods leaving it up to the discretion of that certification organization or the lack of a test method(s) in some cases. It also appears when asking about some accessories and or materials and if testing has been done, the response is no and or maybe with the element clearly marked with a certification organization mark.
Committee Meeting Action: Accept in Principle
Committee Statement: The TC believes it was the submitter's desire to address accessories and the TC has taken actions to do so. See Committee Action on Proosal 1971-36 (Log #9). However, the paragraphs in this proposal are incorrectly referenced and/or do not deal with accessories. Therefore, these paragraphs will not be deleted from the standard.

1971-14 Log #102 FAE-SPF **Final Action: Accept in Principle**
(2.6.2, 2.6.3, 2.6.4 and 7.1.2.8)

Submitter: Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment
Recommendation: 1. Revise 2-6.2 to read:
"The manufacturer shall be registered to ISO 9001, Quality Management Systems - Requirements."
2. Revise 2-6.3 to read:
"Where the manufacturer is currently registered to the 1994 edition of ISO 9001, Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing, the manufacturer shall be permitted to be registered to the 1994 edition of ISO 9001 until 15 December 2003."
3. Revise 2-6.4 to read:
"Where the manufacturer is currently registered to the 1994 edition of ISO 9001, Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing, the manufacturer shall be permitted to be registered to the 2000 edition of ISO 9001, specified in 2-6.2, at any time prior to 15 December 2003."
4. Revise 7-1.2.8 to add:
ISO 9001, Quality Management Systems - Requirements, 2000.
Substantiation: Submitters Reason: ISO has revised the 9000 series of standards covering quality management systems. ISO 9001, 2000 edition, has taken the place of the former series of documents. The new standard takes full effect in 15 December 2003. Manufacturers who are already registered to the 1994 edition of ISO 9001 have until 15 December 2003 to become registered to the 2000 edition, but can be registered to the 2000 edition at any time prior to 15 December 2003. The TIA text reflects this grace period. Notification to

all manufacturers at this time allows them time become certified to the 2000 edition of ISO 9001, and remain in compliance with the standards.
The emergency nature of these TIAs is the mandatory references in these NFPA documents must be updated to reflect the new ISO 9001, 2000 edition document. So there is no interruption of certified personal protective equipment availability to the fire and emergency services, manufacturers can remain in compliance and certification organizations can certify product in accordance with the NFPA standards.
Committee Meeting Action: Accept in Principle
Committee Statement: The Committee agrees with the intent of the proposal and the current text for quality assurance programs can be found in Section 4.5 of the ROP.

1971-15 Log #124 FAE-SPF **Final Action: Reject**
(3.1.7)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Add:
(10) TPP values for the garment's composite
(11) THL values for the garment's composite
Substantiation: The TPP and THL values would be valuable information for the user.
Committee Meeting Action: Reject
Committee Statement: No other performance test results are listed on the label and the information could be easily misconstrued to create confusion over the level of protection provided by an element. There was also discussion about the normal and usual variability in test results and whether the number would reflect the initial certification or the recertification result, which are typically not the same value.

1971-16 Log #114 FAE-SPF **Final Action: Accept in Principle**
(3.3 Technical Data Package (New))

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new section as follows:
3.3 Technical Data Package.
3.3.1 Upon the request of the authority having jurisdiction, the manufacturer shall provide a list of all materials and components that are used in the construction of the ensemble element. The list shall identify each unique material by generic or trade name.
Substantiation: End users should have the ability to know all of the components used in the construction of their protective elements. This information is only required when requested by the authority having jurisdiction.
Committee Meeting Action: Accept in Principle
Add new text as follows.
5.3 Technical Data Package.
5.3.1 General.
5.3.1.1* Upon the request of the authority having jurisdiction, the manufacturer shall furnish a technical data package with each type of protective ensemble and element.
5.3.1.2* The technical data package shall contain all documentation required by this standard and the data showing compliance with this standard.
5.3.1.3 In the technical data package, the manufacturer shall describe the protective ensemble or individual elements in terms of manufacturer trade name, model number, manufacturer replaceable components and component parts, and available options such as accessories, testing devices, and sizes.
5.3.1.4 In the technical data package, the manufacturer shall describe the available sizes protective ensemble or individual element. For those ensembles or elements where indivdual custom sizing is provided, descriptions of sizes shall include the range or key dimensions of the ensemble or element.
5.3.2 Material and Component Descriptions.
5.3.2.1 Where specific elements, component parts or accessories are required for certifying the protective ensemble or individual element as compliant with this standard, the manufacturer shall list these elements or component parts in the technical data package.
5.3.2.2 The manufacturer shall provide, in the technical data package, the list and descriptions of the following ensemble or individual element materials and component parts, where applicable:
(1) Garment material(s)
(2) Helmet material(s)
(3) Glove material(s)
(4) Footwear material(s)
(5) Material seam types, stitch types and thread or sealing material(s)
(6) Zipper/closure type and materials of construction
5.3.2.3 All descriptions of material composition shall specify either the generic material names or trade names if the composition of the material is proprietary.
Committee Statement: The Committee reviewed an update of the proposal submitted by Mr. Stull and agreed with the intent, renumbering and reformatting as necessary. However, the Committee did not feel that the proposed annex material was necessary to meet the intent of the Technical Data Package and it was not included.

1971-17 Log #95 FAE-SPF **Final Action: Accept in Principle**
(4.1)

Submitter: Scott Somers Mesa, AZ
Recommendation: Add new text to read:
Coats shall be equipped with a self-contained rescue harness. The harness shall be placed between the outer shell and inner lining of the coat and when deployed shall secure the wearer under both arms. Access to the handle of the harness shall be at the nape of the garment below the collar and placed in such a way as to operate properly without interference from self-contained breathing apparatus. The handle of the harness shall be protected from the environment and weather by an access flap that is secured with Velcro or similar fashioning device. The harness shall be constructed of Kevlar or similar material. The harness shall be easily accessible for periodic inspection.
Substantiation: Currently, there is no standard for a firefighter rescue device to assist rescue operations for incapacitated firefighters. While a number of departments are using fabricated straps to attach to a firefighter's self-contained breathing apparatus, these devices take time to attach and there may be situations where firefighters are not wearing SCBA. Self-contained rescue harnesses built into structural firefighting coats have been developed by various public and private sector organizations and are in use by some municipal fire department and fire brigades. However, the widespread retrofitting of such devices is being hampered, in part, by a lack of a standard for such a device. The inclusion of a standard for self-contained rescue harnesses in NFPA 1971 would provide the impetus for retrofitting these devices or placing them in new structural firefighting coats, which would enhance firefighter rescue operations.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 1971-28 (Log #104).

1971-18 Log #101 FAE-SPF **Final Action: Accept in Principle**
(4.1, 14.3)

Submitter: Patricia A. Freeman, Globe Manufacturing Co., Inc.
Recommendation: Revise text to read as follows:
Coats shall have a composite collar at least ~~100~~ 50 mm (~~4~~ 2 in.) in height at any point when measured from the top of the collar down and shall have a closure system. The collar and closure system shall consist of an outer shell, a moisture barrier, and a thermal barrier, or of materials that meet all applicable performance requirements as specified in Section 5.1.
Substantiation: Several of our customers have indicated that when the collar is in the raised position, it can cause the helmet to become unseated. Since NFPA 1500 requires that both a hood and a helmet be worn with the coat, the current requirement for a 4 in. collar may actually be causing a problem.
Committee Meeting Action: Accept in Principle
Revise 4.1.14.3 as follows.
6.1.14.3 (4.1.14.3) Coats shall have a composite collar at least 75 mm (3 in.) in height at any point when measured from the top of the collar down and shall have a closure system. (The remainder of the paragraph is unchanged.)
Committee Statement: The Committee agreed with the submitter's proposal to reduce collar height, but felt 2 in. was too great of a reduction. Recognizing that hood requirements have been added, including a minimum length for hoods, since the time that the 4 in. collar height was established, the Committee agreed to a minimum collar height of 3 in.

1971-19 Log #15 FAE-SPF **Final Action: Accept**
(4.1.3)

NOTE:This proposal appeared as Comment 1971-51 (Log #183) which was held from the F99 ROC on proposal 1971-132
Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Revise text:
"Garments shall have a means of securing the moisture barrier and thermal barrier to the outer shell in such a means as to permit the visual inspection of both the interior and exterior surfaces of each barrier ."
Substantiation: The user must be able to access the barrier and tape portion of the moisture barrier and the insulation portion of the thermal barrier in order to inspect the barriers for damage and wear.
Committee Meeting Action: Accept

1971-20 Log #25 FAE-SPF **Final Action: Accept in Part**
(4.1.12)

Submitter: Claude Barbeau, Securitex Inc.
Recommendation: Revise text to read as follows:
Trim shall be ~~at least 50 mm (2 in.)~~ not more than 53 mm (2 1/8 in.) wide. The retro reflective surface of trim shall be at least ~~160~~ 16 mm (5/8 in.) wide.
Substantiation: 1. Limiting trim width increases safety by limiting the amount of material that can potentially contribute to burn injury.
2. It also increases comfort by increasing the surface area of the gear that is

breathable, by increasing shell flexibility and by reducing garment weight.

3. Error: 16 mm = 5/8 in.; 160 mm = 6 in.

Committee Meeting Action: Accept in Part

Committee Statement: The Committee agrees that the error in conversion needs to be addressed and accepts that portion of the log; however, the Committee does not wish to prohibit the use of 3 in. trim.

1971-21 Log #80 FAE-SPF **Final Action: Reject**
(4.1.12)

Submitter: David Elsner, Reflec USA Corporation

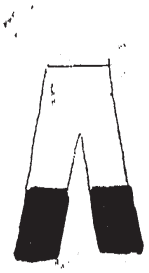
Recommendation: Revise text to read as follows:

4.1.12 Garments shall either have fluorescent and retroreflective trim permanently attached to the outer shells of garments or garments shall use retroreflective fabric to meet visibility requirements. Trim shall be at least 50 mm wide and shall have both retroreflective and fluorescent surfaces. When using retroreflective fabric which is not fluorescent, a minimum 1.375 in. wide fluorescent material or treatment will be permanently attached to the outer shell of the garments. Minimum reflective fabric patterns are illustrated in Figure 4.1.15.3(A). The retroreflective surface of trim shall be at least 160 mm wide. Fluorescent and retroreflective trim shall appear to be continuous for the length of the trim, with gaps between areas of retroreflectiveity of not more than 3 mm (1/8 in.).

(Option 1)

Front View (Option 1)

Back View (Option 1)



(Option 2)

Front View (Option 2)

Back View (Option 3)

Figure 4.1.15.3(A) Minimum Required Coat Retroreflective Fabric Patterns.

Substantiation: **Executive Summary**

_A new form of retro-reflective technology, which allows the retroreflective optical elements to be incorporated into the weave of a variety of fabrics and distributed over the entire surface of a garment, has been tested against the needs of the fire service industry and has been found to provide significant enhancements to the existing NFPA 1971 standards and the ANSI 107-1999 standards. This technology is generically referred to **as silhouette reflectivity** because of its inherent ability to retro-reflect light in the shape of the person wearing the garment, thus increasing recognition of the wearer to drivers and fellow rescue workers.

The benefits of this new technology to the fire fighting industry are:

1. Improved Visibility

Wearer is more recognizable as a human being on public roads reducing the chances of being involved in an accident.

Wearer is easier to locate in a smoke filled environment.

2. Improved Flame Resistance

Greater retained reflectivity following flashover conditions with nearly 50 percent of the original reflectivity retained reflectivity when exposed to a Mannequin Test of 80kw for 8 seconds vs. zero retained reflectivity of traditional retro reflective trim tapes.

3. Improved Breathability

Eliminates the build up of vapour under traditional reflective trim tapes providing less chance of burns and stress resulting from the heat build-up.

4. Reduced Weight of Turnout Gear

Retroreflective fabric is a fraction of the weight of existing trim which aids in reducing overall weight of the turnout gear.

Details

The issue of safety is of paramount importance to the fire service industry. A

major area of concern relates to the sustained visibility of fire fighters at structural fires and incidents on public roads.

The need for enhanced visibility is required in two distinct areas:

Fire Ground Accountability

_Fires are typically fought in low light conditions often made worse from smoke. It is essential that a fire fighter's location be known at all times especially in the moments of greatest danger. If a fire fighter collapses or is caught in a fire, it is important that their colleagues can quickly locate them. In many cases, this will require the use of a flashlight. The current trim technology is limited to strips applied to the torso, arms and legs of the turnout gear and as a result a person's body is not clearly delineated. There will be situations where the body of a fire fighter would not be seen at all with the current trim configurations. For example if a firefighter were to collapse and only there shoulders were protruding in to the hallway currently this person would not be visible in low light condition however with the new technology the whole body of the firefighter could be visible.

Incident Management Visibility

_Motorist colliding with fire personnel is a significant issue and the adoption of ANSI compliant high visibility garments by the NFPA is an important first step in providing visibility enhancement to fire service personnel. Through application of the new technology to turn-out gear, the human form is delineated to create a more visible fire-fighter to the oncoming driver, thus providing tremendous enhancements to the current ANSI 107-1999 standard.

Increased benefit and safety enhancement can be provided to the fire service personnel through use of this new retroreflective technology. The problem areas are:

Burns as a result of moisture build-up under trim and flammability of trim.

There have been numerous reports of 2nd and 3rd degree burns under trim. *"When we compared the size of burns, as well as their location…there appeared to be a direct correlation with the reflective tape used on the turnout gear and the location of the burns. When the turnout gear was examined layer by layer, there appeared to be areas where heat conduction had occurred and these areas were directly beneath the reflective tape, particularly on the back. The width of the reflective tape coincides with the width of the burn on the forearm, as well as on the back"(A)* Over the years, several public comments have been submitted to the NFPA asking to address concerns with traditional retroreflective trim products and their potential cause of burns on the upper shoulders and arms. There are currently no test standards that address flashover conditions. The addition of a Mannequin Test would address this need. Results carried out by BTTG using a Mannequin Test showed that retro-reflective print technology did not negatively impact the results of turnout gear and that after 80kw for 8 seconds 50% of the original reflective levels were still recorded. In comparison traditional retro-reflective trim was fully burnt and melted leaving, no reflectivity.

Heat stress

_**The contribution of traditional trim to heat stress appears to be fairly common knowledge within the fire service. Since traditional trim does not breathe and specialized breathable membrane systems such as Crosstech by W.L.Gore are specified, traditional trim will eliminate the breathability of these high performance fabrics wherever the trim is applied. Eliminating the use of traditional trim on the shoulders and arms will reduce the number of injuries resulting from vapour burns and heat stress.**

Visibility on the fire ground and on public roads

_The summary below of the currently perceived requirements for retroreflective nighttime conspicuity clothing present compelling support for a new approach, based on whole-body **silhouette reflectivity**. However, the importance of also maximizing daytime conspicuity must not be overlooked. This can follow the traditional method of applying fluorescent trim, treatments, or fabrics.

The adoption by NFPA 1971 of the ANSI107-1999 standards for high visibility clothing can be significantly enhanced through the use of silhouette reflective arms on turnout gear. This could also eliminate the problems resulting from moisture build-up under trim on arms, resulting in burns and heat stress caused by heat build up under traditional trim. Suggested language changes to NFPA 1971 would allow for the benefits of silhouette reflective technology to be specified by fire service personal on turnout gear.

Silhouette reflectivity summary

_The process by which a motorist reacts to an incident on the road is known as the perception-reaction time (PRT). The six stages to PRT are:

Stage1

Detection - This is when the brain is first aware that there is something of significance. Perhaps a form of lighting of some type.

Stage 2

Recognition - This is the critical stage where the brain determines what it is actually seeing. Out of all of the thousands of possibilities is this in fact a person on or approaching the roadway?

Stage 3

Evaluation - The brain now assesses the situation taking into account all of the different factors that prevail at that moment of time.

Stage 4

Decision - The brain decides upon a course of action.

Stage 5

Reaction - The body reacts to the commands of the brain.

Stage 6.

Response - The vehicle responds to the actions of the driver vehicle.

The new technology provides a significant improvement to the existing retroreflective trim as it dramatically improves the speed and accuracy by which a motorist can complete stage 2 and recognize an object on the road as being a human being and as such requiring a different evaluation (stage 3).

There are several factors that influence the factors above including: age, alcohol, experience, distractions (e.g. cell phone), familiarity, memory, vision, weather, and the lighting conditions.

Regarding the latter point, US statistics for the past 20 years have shown that fatal collision rates are over three times higher (on a mileage basis) at night than during daylight hours (2). People are generally not aware of their hazardous situation and greatly overestimate their visibility to oncoming drivers.

The principal reason people are at such a high risk in darkness is because they are not conspicuous to vehicle drivers. Early field experiments (3) involving the visibility of dark-clothed mannequins from cars with dipped headlights indicated that the upper limit safe approach speed was only 15 mph for 90% of drivers.

The assured clear distance ahead (ACDA) rule, which holds the operator of a motor vehicle responsible to avoid collision with any obstacle that might appear in the vehicle's path, is routinely violated by most driver under nighttime conditions (4). The maximum safe speed of travel is the central concern of the ACDA rule. This limit is governed by the total stopping distance (TSD), which is determined by a combination of human and mechanical factors. The TSD = V (P& RT) + BD, where Vis the vehicle velocity, P & RT is the time to perceive the situation and respond by depressing the brake pedal, and BD is the braking distance. Traffic engineers assume 2.5 seconds as a useful guideline to a driver's P & RT. Studies have shown that the recognition distance of an unexpected dark-clad pedestrian, by an average young driver using low-beam headlights, can be as short as 18 yards, which is much shorter than the TSD (by 1.2 to 3 times at only 25 mph). Recognition distance depends on the conditions; it is longer (twice as great) with high beam headlights or a reflective object, and shorter when confronted with glare from oncoming headlights or during inclement weather. All road users should be apprised of the limitations of visibility at night and while drivers should be encouraged to travel more slowly and not to under use their high beams, it is important that fire-fighters take measures to increase their own conspicuity.

Most collisions between automobiles and humans occur under comparatively short distances. In a study of 2,100 pedestrian accidents, dart-out (excluding at an intersection) accounted for twenty-four percent.

A person can increase their conspicuity at night by wearing reflective clothing, especially if containing retroreflective materials that reflect maximum light from a car's headlights directly back to the driver. But it doesn't necessarily follow that the nighttime conspicuity of pedestrians can be boosted in this way solely by increasing the stimuli confronting drivers. The mere fact that a target can be detected from a far distance is no guarantee that the driver is aware of what that target is, and whether or not it is in fact on the roadway.

Shinar (5) studied the distances at which people could be detected and recognised, under various combinations of driver's expectancy (i.e., to see a pedestrian on the road), pedestrian clothing characteristics (dark clothing, light clothing, and dark clothing with retro-reflective tags) and the detection criterion (i.e. pedestrian versus retro-reflective tag). When the pedestrian is unexpected the usefulness of the tag is significant only if the driver can rely on it as a criterion for detection (by prior knowledge of the association between the tags and the pedestrian). Retro-reflective materials may therefore under-perform if drivers cannot rely on them to identify a pedestrian unambiguously.

Because detection of a target doesn't automatically ensure recognition, it is important to develop retroreflective clothing that allows pedestrians to be immediately recognized as such.

Hughes & Cole (6) differentiated between *attention conspicuity* (an object that attracts a driver's attention even when unaware of its presence) and *search conspicuity* (when the observer is directed to search for the object) and they demonstrated that laboratory studies using movie films and projected coloured slides provide a reasonable prediction of the assessment of conspicuity obtained from field experiments.

The accurate detection of pedestrians by drivers can occur at greater distance when retroreflective clothing is configured to highlight the pedestrian's limbs. Blomberg et.al (7) equipped individual pedestrian with either reflective dangle tags, portable flashlights, a joggers vest or a set of retroreflective rings attached to the pedestrian' s head, wrists, belt and ankles; they were positioned on the roadway facing the traffic and walking on the spot. Drivers with low-beam headlights saw the flashlight from further away but the retroreflective rings gave the greatest recognition distance (133m), suggesting that an anthropomorphic shape is critical in providing a target signature recognizable from distance.

Johansson (8,9) was first to demonstrate the importance of biological motion for target recognition. By attaching a dozen point-light sources to the joints of the human body walking in darkness, subjects were able to recognise the moving array of lights as a person when exposed to the stimulus for as short as one-tenth of a second. But when stationary the display was generally unidentifiable. More recently Owens et.al. (10) filmed a jogger at night wearing four different types of clothing (a control with dark clothing only, a simple jogger's vest incorporating a reflector, five retroreflective strips at arbitrary positions and an outfit with eleven retroreflective strips positioned on the extremities of the limbs) from a car travelling at 25 mph with dipped headlights. The Retroreflective materials were detected at greater distance (average 70m) relative to the joggers vest (50m) and the dark-clothed control pedestrian (12m), but detection-distance (average 75m) were even greater when the retroreflective

strips were positioned in biological motion configuration. Furthermore 85% of subjects reported that the biological motion situation was easiest to see.

In a later study Luoma et.al, (11) confirmed that retroreflective markings on the limbs, in comparison to those on the torso, significantly increase (by about 60-80%) the nighttime recognition distance of pedestrians. However the latest study involving biological motion, carried out by Moberly (12), did not support the hypothesis that biological motion affords recognition at greater distance that does standard motion. This confusion may be the result of disregarding in the experimental details two important fundamentals; in general the use of larger areas of Retroreflective material (13) and use of brighter retroreflective material(13,14) will both increase pedestrian nighttime conspicuity. Furthermore, other important differences in the designs of the experiments (car speed, external lighting conditions, jogging versus walking on the spot, pedestrian orientation vis-à-vis the direction of travel of the car) may have influenced the conclusion.

Not withstanding this confusion over the importance of biological motion, it is now being increasingly accepted that conventional retroreflective trim or tape can be easily misidentified. As early as 1970 Allen (15,p180) stated "A pedestrian carrying a dangling reflector or reflector attached to his shoes or clothing may be identified as a pedestrian by the motion of the reflector as he walks; but if he stands still the reflection might be construed to be from a fence post, a car, or even a discarded can.

A report (16) concerning retro-reflective markings on fire-fighter's protective clothing states that this is most effective if drivers of approaching motor-vehicles immediately recognize the human form; recognition must take place in a rather short time(0.3-1.0 sec) and from a relatively long distance (100-200m). A special requirement for fire fighters is that they must be recognizable as such without help from their body movements, since many of their tasks are performed in a semi-permanent posture. Furthermore, extremely limited time is often available for perception in relevant traffic situations. As a basic principle for retro-reflective design the authors of this report (16) suggest a coarse version of a geodesic grid with an emphasis on the human form.

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Committee Meeting Action: Reject

Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

1971-22 Log #26 FAE-SPF **Final Action: Reject**
(4.1.12.1)

Submitter: Claude Barbeau, Securitex Inc.
Recommendation: Revise text to read as follows:

Trim used to meet the minimum trim pattern requirements shall have a minimum fluorescent surface of ~~50~~ 30 mm ^{2} /linear mm (~~2~~ 1 3/16 in. ^{2} /linear in.) of trim.

Substantiation: See justification by submitter for reducing trim width [paragraph 4-1.12]. In order for dimensions of fluorescent area to be proportional to that reduced width, the required fluorescent area must be reduced. [n.b. these dimensions are consistent with 50 mm (2 in.) wide 3M triple trim].

Committee Meeting Action: Reject

Committee Statement: The Committee believes that the current minimum requirement for daytime visibility, the fluorescent component, is appropriate and that it should not be reduced by making this allowance.

1971-23 Log #21 FAE-SPF **Final Action: Accept in Principle**
(4.1.13 and 4.1.15.3)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: 4-1.13 - Add proposal.

4-1.15.3 - Remove corresponding sentence.

Add new text to read as follows:

Where trim intersects a zipper or major A seam, a maximum gap in the trim of 25 mm (1 in.) shall be permitted.

Substantiation: Currently, small 1 in. gaps of trim are permitted on trouser zippers and this variance should be carried over to zippers on coats and a similar gap at major A seams would permit a much smoother surface and eliminate some of the bulk of a seam and reduce overall weight.

Committee Meeting Action: Accept in Principle

Rewrite last sentence of current section 4-1.14.5

"Where trim on the coat intersects a zipper, and on the innermost seam of each sleeve , a maximum gap in the trim of 25 mm (1 in.) shall be permitted."

Rewrite last sentence of current section 4-1.15.3

"Where trim on the trouser intersects a zipper, and on the innermost seam of each pant leg , a maximum gap in the trim of 25 mm (1 in.) shall be permitted."

Committee Statement: The Committee agrees with the submitter, but only in areas of high abrasion.

1971-24 Log #115 FAE-SPF **Final Action: Reject**
(4.1.14 (New))

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new section as follows:

4-1.14.X The shoulder areas of the protective coat shall be reinforced such that the reinforcement area covers a distance of at least 100 mm (4 in.) along the crown of the shoulder and extending down from the crown of the shoulder on both the front and back of the garment for a distance of at least 50 mm. The crown of the shoulder area shall be the uppermost line of the shoulder when the garment is laying flat on an inspection surface with all closures fastened.

Substantiation: No specification is provided for a shoulder reinforcement, though a requirement exists for the testing of the shoulder reinforcement area for conductive and compressive heat resistance. The proposed requirement is taken from the 6-51.2.1.1 in the CCHR test method.

Committee Meeting Action: Reject
Committee Statement: The Committee felt this would be unnecessarily design restrictive. The area to be tested for conductive and compressive heat resistance is defined in the test method and it may not be necessary to have a reinforcement to meet the requirement.

1971-25 Log #93 FAE-SPF **Final Action: Accept in Principle**
(4.1.14.3)

Submitter: Patricia A. Freeman, Globe Manufacturing Co., Inc.
Recommendation: Revise text to read as follows:

"Coats shall have composite collar at least ~~100~~ 50 mm (~~4~~ 2 in.) in height at any point when measured form the top of the collar down and shall have a closure system. The collar and closure system shall consist of an outer shell, a moisture barrier, and a thermal barrier, or of materials that meet all applicable performance requirements as specified in Section 5.1."

Substantiation: Several of our customers have indicated that when the collar is in the raised position, it can cause the helmet to become unseated. Since NFPA 1500 requires that both a hood and a helmet be worn with the coat, the current requirement for a 4 in. collar may actually be causing a problem, rather than addressing one.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action taken on Proposal 1971-18 (Log #101).

1971-26 Log #116 FAE-SPF **Final Action: Reject**
(4.1.15 (New))

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add a new section as follows:
4-1.15.X The knee areas of the protective pants shall be reinforced such that the reinforcement area covers a height of at least 200 mm (8 in.) and a width of 200 mm (8 in.).
Substantiation: No specification is provided for a knee reinforcement, though a requirement exists for the testing of the knee reinforcement area for conductive and compressive heat resistance.
Committee Meeting Action: Reject
Committee Statement: The Committee felt this would be unnecessarily design restrictive. The area to be tested for conductive and compressive heat resistance is defined in the test method and it may not be necessary to have a reinforcement to meet the requirement.

1971-27 Log #81 FAE-SPF **Final Action: Reject**
(4.1.15.3)

Submitter: David Elsner, Reflec USA Corporation
Recommendation: Revise the second sentence to read as follows:
"The minimum trim pattern for the trousers shall consist of two circumferential bands of trim with one band around each leg between the bottom hem and knee areas or retroreflective fabric in pattern consistent with the diagrams in Figure 4.1.15.3(A) ."
See Figure 4.1.15.3(A) as shown in the recommendation on 1971- (Log #80).
Substantiation: **Executive Summary**
A new form of retro-reflective technology, which allows the retroreflective optical elements to be incorporated into the weave of a variety of fabrics and distributed over the entire surface of a garment, has been tested against the needs of the fire service industry and has been found to provide significant enhancements to the existing NFPA 1971 standards and the ANSI 107-1999 standards. This technology is generically referred to **as silhouette reflectivity** because of its inherent ability to retro-reflect light in the shape of the person wearing the garment, thus increasing recognition of the wearer to drivers and fellow rescue workers.
The benefits of this new technology to the fire fighting industry are:
1. Improved Visibility
Wearer is more recognizable as a human being on public roads reducing the chances of being involved in an accident.
Wearer is easier to locate in a smoke filled environment.
2. Improved Flame Resistance
Greater retained reflectivity following flashover conditions with nearly 50 percent of the original reflectivity retained reflectivity when exposed to a Mannequin Test of 80kw for 8 seconds vs. zero retained reflectivity of traditional retro reflective trim tapes.
3. Improved Breathability
Eliminates the build up of vapour under traditional reflective trim tapes providing less chance of burns and stress resulting from the heat build-up.
4. Reduced Weight of Turnout Gear
Retroreflective fabric is a fraction of the weight of existing trim which aids in reducing overall weight of the turnout gear.
Details
The issue of safety is of paramount importance to the fire service industry. A major area of concern relates to the sustained visibility of fire fighters at structural fires and incidents on public roads.
The need for enhanced visibility is required in two distinct areas:
Fire Ground Accountability
Fires are typically fought in low light conditions often made worse from smoke. It is essential that a fire fighter's location be known at all times especially in the moments of greatest danger. If a fire fighter collapses or is caught in a fire, it is important that their colleagues can quickly locate them. In many cases, this will require the use of a flashlight. The current trim technology is limited to strips applied to the torso, arms and legs of the turnout gear and as a result a person's body is not clearly delineated. There will be situations where the body of a fire fighter would not be seen at all with the current trim configurations. For example if a firefighter were to collapse and only there shoulders were protruding in to the hallway currently this person would not be visible in low light condition however with the new technology the whole body of the firefighter could be visible.
Incident Management Visibility
Motorist colliding with fire personnel is a significant issue and the adoption of ANSI compliant high visibility garments by the NFPA is an important first step in providing visibility enhancement to fire service personnel. Through application of the new technology to turn-out gear, the human form is delineated to create a more visible fire-fighter to the oncoming driver, thus providing tremendous enhancements to the current ANSI 107-1999 standard.
Increased benefit and safety enhancement can be provided to the fire service personnel through use of this new retroreflective technology. The problem areas are:
Burns as a result of moisture build-up under trim and flammability of trim.
There have been numerous reports of 2nd and 3rd degree burns under trim. *"When we compared the size of burns, as well as their location…there appeared to be a direct correlation with the reflective tape used on the turnout gear and the location of the burns. When the turnout gear was examined layer by layer, there appeared to be areas where heat conduction had occurred and these areas were directly beneath the reflective tape, particularly on the back. The width of the reflective tape coincides with the width of the burn on the forearm, as well as on the back"(A)* Over the years, several public comments have been submitted to the NFPA asking to address concerns with traditional retroreflective trim products and their potential cause of burns on the upper shoulders and arms. There are currently no test standards that address flashover conditions. The addition of a Mannequin Test would address this need. Results carried out by BTTG using a Mannequin Test showed that retro-reflective print technology did not negatively impact the results of turnout gear and that after 80kw for 8 seconds 50% of the original reflective levels were still recorded. In comparison traditional retro-reflective trim was fully burnt and melted leaving, no reflectivity.
Heat stress
The contribution of traditional trim to heat stress appears to be fairly common knowledge within the fire service. Since traditional trim does not breathe and specialized breathable membrane systems such as Crosstech by W.L.Gore are specified, traditional trim will eliminate the breathability of these high performance fabrics wherever the trim is applied. Eliminating the use of traditional trim on the shoulders and arms will reduce the number of injuries resulting from vapour burns and heat stress.
Visibility on the fire ground and on public roads
The summary below of the currently perceived requirements for retroreflective nighttime conspicuity clothing present compelling support for a new approach, based on whole-body **silhouette reflectivity**. However, the importance of also maximizing daytime conspicuity must not be overlooked. This can follow the traditional method of applying fluorescent trim, treatments, or fabrics.
The adoption by NFPA 1971 of the ANSI107-1999 standards for high visibility clothing can be significantly enhanced through the use of silhouette reflective arms on turnout gear. This could also eliminate the problems resulting from moisture build-up under trim on arms, resulting in burns and heat stress caused by heat build up under traditional trim. Suggested language changes to NFPA 1971 would allow for the benefits of silhouette reflective technology to be specified by fire service personal on turnout gear.
Silhouette reflectivity summary
The process by which a motorist reacts to an incident on the road is known as the perception-reaction time (PRT). The six stages to PRT are:
Stage1
Detection - This is when the brain is first aware that there is something of significance. Perhaps a form of lighting of some type.
Stage 2
Recognition - This is the critical stage where the brain determines what it is actually seeing. Out of all of the thousands of possibilities is this in fact a person on or approaching the roadway?
Stage 3
Evaluation - The brain now assesses the situation taking into account all of the different factors that prevail at that moment of time.
Stage 4
Decision - The brain decides upon a course of action.
Stage 5
Reaction - The body reacts to the commands of the brain.
Stage 6.
Response - The vehicle responds to the actions of the driver vehicle.
The new technology provides a significant improvement to the existing retroreflective trim as it dramatically improves the speed and accuracy by which a motorist can complete stage 2 and recognize an object on the road as being a human being and as such requiring a different evaluation (stage 3).
There are several factors that influence the factors above including: age, alcohol, experience, distractions (e.g. cell phone), familiarity, memory, vision, weather, and the lighting conditions.
Regarding the latter point, US statistics for the past 20 years have shown that fatal collision rates are over three times higher (on a mileage basis) at night than during daylight hours (2). People are generally not aware of their hazardous situation and greatly overestimate their visibility to oncoming drivers.
The principal reason people are at such a high risk in darkness is because they are not conspicuous to vehicle drivers. Early field experiments (3) involving the visibility of dark-clothed mannequins from cars with dipped headlights indicated that the upper limit safe approach speed was only 15 mph for 90% of drivers.
The assured clear distance ahead (ACDA) rule, which holds the operator of a motor vehicle responsible to avoid collision with any obstacle that might appear in the vehicle's path, is routinely violated by most driver under nighttime conditions (4). The maximum safe speed of travel is the central concern of the ACDA rule. This limit is governed by the total stopping distance (TSD), which is determined by a combination of human and mechanical factors. The TSD = V (P& RT) + BD, where Vis the vehicle velocity, P & RT is the time to perceive the situation and respond by depressing the brake pedal, and BD is the braking distance. Traffic engineers assume 2.5 seconds as a useful guideline to a driver's P & RT. Studies have shown that the recognition distance of an

unexpected dark-clad pedestrian, by an average young driver using low-beam headlights, can be as short as 18 yards, which is much shorter than the TSD (by 1.2 to 3 times at only 25 mph). Recognition distance depends on the conditions; it is longer (twice as great) with high beam headlights or a reflective object, and shorter when confronted with glare from oncoming headlights or during inclement weather. All road users should be apprised of the limitations of visibility at night and while drivers should be encouraged to travel more slowly and not to under use their high beams, it is important that fire-fighters take measures to increase their own conspicuity.

Most collisions between automobiles and humans occur under comparatively short distances. In a study of 2,100 pedestrian accidents, dart-out (excluding at an intersection) accounted for twenty-four percent.

A person can increase their conspicuity at night by wearing reflective clothing, especially if containing retroreflective materials that reflect maximum light from a car's headlights directly back to the driver. But it doesn't necessarily follow that the nighttime conspicuity of pedestrians can be boosted in this way solely by increasing the stimuli confronting drivers. The mere fact that a target can be detected from a far distance is no guarantee that the driver is aware of what that target is, and whether or not it is in fact on the roadway.

Shinar (5) studied the distances at which people could be detected and recognised, under various combinations of driver's expectancy (i.e., to see a pedestrian on the road), pedestrian clothing characteristics (dark clothing, light clothing, and dark clothing with retro-reflective tags) and the detection criterion (i.e. pedestrian versus retro-reflective tag). When the pedestrian is unexpected the usefulness of the tag is significant only if the driver can rely on it as a criterion for detection (by prior knowledge of the association between the tags and the pedestrian). Retro-reflective materials may therefore under-perform if drivers cannot rely on them to identify a pedestrian unambiguously.

Because detection of a target doesn't automatically ensure recognition, it is important to develop retroreflective clothing that allows pedestrians to be immediately recognized as such.

Hughes & Cole (6) differentiated between *attention conspicuity* (an object that attracts a driver's attention even when unaware of its presence) and *search conspicuity* (when the observer is directed to search for the object) and they demonstrated that laboratory studies using movie films and projected coloured slides provide a reasonable prediction of the assessment of conspicuity obtained from field experiments.

The accurate detection of pedestrians by drivers can occur at greater distance when retroreflective clothing is configured to highlight the pedestrian's limbs. Blomberg et.al (7) equipped individual pedestrian with either reflective dangle tags, portable flashlights, a joggers vest or a set of retroreflective rings attached to the pedestrian' s head, wrists, belt and ankles; they were positioned on the roadway facing the traffic and walking on the spot. Drivers with low-beam headlights saw the flashlight from further away but the retroreflective rings gave the greatest recognition distance (133m), suggesting that an anthropomorphic shape is critical in providing a target signature recognizable from distance.

Johansson (8,9) was first to demonstrate the importance of biological motion for target recognition. By attaching a dozen point-light sources to the joints of the human body walking in darkness, subjects were able to recognise the moving array of lights as a person when exposed to the stimulus for as short as one-tenth of a second. But when stationary the display was generally unidentifiable. More recently Owens et.al. (10) filmed a jogger at night wearing four different types of clothing (a control with dark clothing only, a simple jogger's vest incorporating a reflector, five retroreflective strips at arbitrary positions and an outfit with eleven retroreflective strips positioned on the extremities of the limbs) from a car travelling at 25 mph with dipped headlights. The Retroreflective materials were detected at greater distance (average 70m) relative to the joggers vest (50m) and the dark-clothed control pedestrian (12m), but detection-distance (average 75m) were even greater when the retroreflective strips were positioned in biological motion configuration. Furthermore 85% of subjects reported that the biological motion situation was easiest to see.

In a later study Luoma et.al, (11) confirmed that retroreflective markings on the limbs, in comparison to those on the torso, significantly increase (by about 60-80%) the nighttime recognition distance of pedestrians. However the latest study involving biological motion, carried out by Moberly (12), did not support the hypothesis that biological motion affords recognition at greater distance that does standard motion. This confusion may be the result of disregarding in the experimental details two important fundamentals; in general the use of larger areas of Retroreflective material (13) and use of brighter retroreflective material(13,14) will both increase pedestrian nighttime conspicuity. Furthermore, other important differences in the designs of the experiments (car speed, external lighting conditions, jogging versus walking on the spot, pedestrian orientation vis-à-vis the direction of travel of the car) may have influenced the conclusion.

Not withstanding this confusion over the importance of biological motion, it is now being increasingly accepted that conventional retroreflective trim or tape can be easily misidentified. As early as 1970 Allen (15,p180) stated "A pedestrian carrying a dangling reflector or reflector attached to his shoes or clothing may be identified as a pedestrian by the motion of the reflector as he walks; but if he stands still the reflection might be construed to be from a fence post, a car, or even a discarded can.

A report (16) concerning retro-reflective markings on fire-fighter's protective clothing states that this is most effective if drivers of approaching motor-vehicles immediately recognize the human form; recognition must take place in a rather short time(0.3-1.0 sec) and from a relatively long distance (100-200m). A special requirement for fire fighters is that they must be recognizable as such without help from their body movements, since many of their tasks are performed in a semi-permanent posture. Furthermore, extremely limited time is often available for perception in relevant traffic situations. As a basic principle for retro-reflective design the authors of this report (16) suggest a coarse version of a geodesic grid with an emphasis on the human form.

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(2) National Safety Council (Annual), *Accident Facts*. Washington DC.

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(4) Leibowitz, H.W., Owens, D.A. and Tyrrell, R.A., (1998), The assured clear distance ahead rule: Implications for nighttime traffic safety and the law, *Accident Analysis and Prevention,30*, 93-99.

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(10) Owens, D.A., Antonoff, R.J. and Francis, E.L. (1994), Biological motion and nighttime pedestrian conspicuity, *Human Factors, 36*, 718-

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(16) Ebell-Vonk, E.M., Ebell R.J.E.V., Groot-Kaper, M., Groot, R.E., Theevis-von der Stoop, M.E., Theevis, S.R., (1987, July) Development of a result oriented design for retroreflective marking on fire-fighter's protective clothing, *IWACC: Lange Weide 6:* 1631, D L Oudendijk: The Netherlands.

Committee Meeting Action: Reject

Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

Committee Meeting Action: Reject

Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

1971-28 Log #104 FAE-SPF **Final Action: Accept in Principle**
(4.1.18.8 and A.4.1.18.8)

Submitter: Alan V. Brunacini, City of Phoenix Fire Department

Recommendation: Add new text as follows:

4.1.4.8 Protective coats shall incorporate a means to facilitate the removal of an unconscious firefighter. The method used shall not interfere with the protective capabilities or donning of the coat or with the donning of the SCBA. The method shall be designed in a manner that stores the components of the rescue system in safe deployable positions until needed and shall assure that a firefighter can be dragged or carried effectively.

A-4.14.8 The removal on an unconscious firefighter from a building is very difficult. The SCBA cannot be relied upon as a means to carry or drag the firefighter. Systems are available in the marketplace that incorporates a strap or straps into a protective coat that allow firefighters to drag an unconscious firefighter to safety. Any such system, when installed, should not interfere with the normal use of the protective coat. The system should be a normal part of the protective coat, out of the way of normal operations but in a place that can be readily accessed when needed.

Substantiation: The removal of an unconscious firefighter from a building is

very difficult. The SCBA cannot be relied upon as a means to carry or drag the firefighter. Systems are available in the marketplace that incorporates a strap or straps into a protective coat that allow firefighters to drag an unconscious firefighter to safety. This would improve the ability of a RIC Team to perform the rescue of an unconscious firefighter.

Committee Meeting Action: Accept in Principle

Add text as follows.

DESIGN

6-1.14.8 (New) **Drag Rescue Device Design Requirements**

6-1.14.8.1 All protective coats and coveralls shall have a DRD. The DRD shall be located on the upper torso portion of the garments.

6-1.14.8.2 The DRD shall be located inside the outer shell in order to shield the device while allowing easy access for visual inspection.

6-1.14.8.3 The DRD shall be designed so that when deployed, the drag rescue device secures the fire fighter by the upper torso or shoulders so that the device pulls directly on the body, not the garment.

6-1.14.8.4 An access point shall be located on the outer shell of the garment to allow access to the handle of the DRD. The access point shall prevent accidental deployment of the handle and DRD.

6-1.14.8.5 The DRD shall be designed in such a manner that deployment and operation of the DRD is possible while the incapacitated fire fighter is wearing an SCBA. The operation of the DRD shall not cause the SCBA to be removed from the fire fighter and the wearing of an SCBA shall not interfere with the deployment and operation of the DRD.

PERFORMANCE:

5.1.4 (vertical flame) Add Drag Rescue Device materials to the list of items tested.

5.1.6 (heat resistance) Add Drag Rescue Device materials to the list of items tested.

5.1.10 (thread heat) Add Drag Rescue Device to list of items tested.

5.1.x (strength of materials and seams) Drag Rescue Device materials and seams shall be tested for material strength as specified in Section 6.XX and shall have a minimum tensile strength of 13.5 kN (3034 lbs.).

5.1.x (function) Protective coats and coveralls with the DRD installed shall be tested for functionality as specified in 6.XX, Drag Rescue Device Function Test, and shall allow for the mannequin to be dragged for a minimum of 2.5 m (5 ft).

TEST METHODS:

Flame:

6-2.1.1 Add Drag Rescue Device materials to the list of items this test applies to.

6-2.1.9 Modifications to the test method for testing Drag Rescue Device materials shall be as specified in 6.2.16.

6.2.16 Specific requirements for testing Drag Rescue Device materials.

6.2.16.1 Five specimens of the materials used in the construction of the Drag Rescue Device shall be tested.

6.2.16.2 Drag Rescue Device materials shall be at least 305 mm (12 in) in length by the widest width of the material used in the device.

6.2.16.3 Testing shall be performed in only one direction.

6.2.16.4 Test shall be performed as specified in 6.2.2 through 6.2.7.

Committee Statement: The Committee agreed with the submitter and provided standardized text to conform to the style of the document.

1971-29 Log #88 FAE-SPF **Final Action: Reject**
(4.2.2(6))

Submitter: Robert Tutterow, Charlotte Fire Dept.

Recommendation: Delete 4-2.2(6) and all subsequent requirements related to it.

Substantiation: The faceshield/goggle requirement is not necessary. There is no time during structural fire fighting when face/eye protection is required that does not require the use of the SCBA facepiece.

The faceshield/goggle requirement adds unnecessary weight to the helmet and added stress to the firefighter. Weight reduction has been identified as an issue that needs to be addressed.

The faceshield/goggle requirement creates retention problems for the firefighter.

The faceshield/goggle requirement normally exposes the faceshield/goggle to the harsh elements of firefighting. This causes significant reduction in visibility.

A very high number of firefighters across the United States have started to ignore or have always ignored the requirement. There is no adverse impact known as a result.

Committee Meeting Action: Reject

Committee Statement: Eye and face protection could be compromised by removing the face shield/goggle component or by making them optional. This could lead to firefighters acquiring face/eye protection that does not meet needed requirements.

1971-30 Log #122 FAE-SPF **Final Action: Accept in Principle**
(4.3.5.3)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C

Recommendation: Add:

two additional glove sizes (f) XXL and (g) Jumbo and adjust dimensions to address typical fire service hand dimensions.

and require each glove size to be available in 3 figure lengths; CADET (1/2 in. shorter than standard), STANDARD and LONG (1/2 in. longer than standard)

Substantiation: RAND report listed fire service gloves as an item needing major improvement. Proper glove sizing will do more to improve dexterity and function of gloves than any other effort.

Committee Meeting Action: Accept in Principle

Revise text as follows.

6.3.5.2 (4.3.5.2) In order to label or otherwise represent a glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in the following sizes: Extra, Extra Small (XXS), Extra Small (XS), Small (S), Medium (M), Large (L), Extra Large (XL), and Extra, Extra Large (XXL). The glove sizes from XS through XL indicated on the label shall be determined by the hand dimensions given in Tables 6.3.5.3 (a) through (e). The sizes for XXS shall be smaller than the sizing indicated in Table 6.3.5.3 (a) and Size XXL shall be larger than sizes indicated in Table 6.3.5.3 (e).

Committee Statement: The Committee agreed with the submitter that additional required sizing on both ends of the spectrum is needed. However, the committee felt that the addition of cadet sizing created too many sizes and made glove selection more expensive because more sizes and styles of gloves would have to be stocked.

1971-31 Log #99 FAE-SPF **Final Action: Accept in Principle**
(4.4.3)

Submitter: Tim Durby, Phoenix Fire Department

Recommendation: Revise text to read as follows:

4.4.3 Footwear height shall be a minimum of ~~200~~ 305 mm ~~(8 in.)~~ (12 in.). The height shall be determined by measuring inside the boot from the center of the insole at the heel up to a perpendicular reference line extending across the width of the boot at the lowest point of the top line. Removable insole inserts shall be removed prior to measurement.

Substantiation: Run off water at fires many times will exceed the height of shorter boots. Run off water at fires contain many different chemicals. If the boot height is not tall enough to prevent liquid from coming over the top, a moisture barrier is of no use. A 12 in. boot will not prevent this, but is much better than 8 in. This will increase the long term health of Fire Fighters.

Committee Meeting Action: Accept in Principle

Revise text as follows.

4.4.3 Footwear height shall be a minimum of 250 mm (10 in.) The height shall be determined by measuring inside of the boot from the center of the insole at the heal up to a perpendicular reference line extending across the width of the boot at the lowest point along the top line. Removable insole inserts shall be removed prior to measurement.

Committee Statement: The Committee agreed with the proposal to raise the minimum boot height, but felt that 10 in. was more appropriate for a minimum requirement.

1971-32 Log #125 FAE-SPF **Final Action: Accept in Principle**
(4.4.3)

Submitter: Vern Scott, Denver Fire Department

Recommendation: Revise text to read as follows:

4.4.3 Footwear height shall be a minimum of 500 (305) mm 8 in. (12 in.). The height shall be determined by measuring inside of boot from the center of the insole at the heal up to a perpendicular reference line extending across the width of the boot at the lowest point of the top line. Removable insole inserts shall be removed prior to measurement.

Substantiation: 8 in. is not high enough to prevent contaminants from coming into the boat from over the top. 12 in. cannot stop this, but is better than 8 in.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action taken on Proposal 1971-31 (Log #99).

1971-33 Log #14 FAE-SPF **Final Action: Reject**
(4.4.3.1 (New))

NOTE:This proposal appeared as Comment 1971-95 (Log #166) which was held from the F99 ROC on Proposal 1971-132

Submitter: Donna P. Brehm, Virginia Beach Fire Department

Recommendation: Add a new 4-4.3.1 to read:

"Footwear height shall be no greater than 400 mm (16 in.) for men's boots and no greater than 350 mm (14 in.) for women's boots."

Substantiation: Numerous manufacturer's have recognized that women as a group are shorter than men and consequently have shorter legs than men. A standard 16 in. boot is too tall for the average woman and cuts into the lower thigh when crawling, kneeling and stooping. Once boots meet the minimum height of 8 in. there is no need to increase the height to a point where it becomes a liability and a hindrance to performance. Limiting the height will not reduce performance or safety levels and may help improve performance and reduce fatigue.

Committee Meeting Action: Reject

Committee Statement: The Committee felt the proposed limitations were

overly design restrictive and could unnecessarily limit design options. The requested styles are already available in the market.

1971-34 Log #10 FAE-SPF **Final Action: Reject**
(4.4.8.2)

NOTE:This proposal appeared as Comment 1971-96 (Log # 58) which was held from the F99 ROC on Proposal 1971-132
Submitter: Peter Wirth, FireGear Inc.
Recommendation: Revise text:

4-4.8.2 Manufacturers shall be required to establish sizing ~~and provide for 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.

Substantiation: Under the current standard manufacturers of footwear are required to provide upon request a conversion chart for each style or model based on the Brannock Measuring Device. Getting proper fit is an issue with a few of the footwear manufacturers since the last NFPA revision, because they aren't required to size using the Brannock Scientific Foot Measuring Device. Requiring all footwear manufacturers to use this nationally accepted measuring device as a means to size their footwear would eliminate a lot of the sizing problems that we are seeing in the field. Brand A's size would be the same as brand B's size. This would also eliminate some manufacturers that provide the required three widths but don't provide a narrow size, to manufacture using this accepted device as the base line for sizing. Some of the footwear manufacturers already use this system.
Committee Meeting Action: Reject
Committee Statement: See Committee Action taken on Proposal 1971-35 (Log #11).

1971-35 Log #11 FAE-SPF **Final Action: Reject**
(4.4.8.2)

NOTE:This proposal appeared as Comment 1971-97 (Log #70) which was held from the F99 ROC on Proposal 1971-132
Submitter: Michael F. McKenna, Sacramento County Fire, CA
Recommendation: Revise text:

4-4.8.2 Manufacturers shall be required to establish and provide sizing ~~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.

Substantiation: Getting the proper fit is a serious issue because manufacturers are not required to use the Brannock Scientific Foot Measuring Device. Every manufacturer's boot fits slightly different. 4-4.8.1 requires manufacturers to provide sizing in half size increments and in three widths. There is no requirement to make narrow boots. Sizing and width sizing is completely discretionary to the manufacturer's. If the Brannock Scientific Foot Measuring Device is required then all boots of the same size will be comparable for fit. A few manufacturers use the device while others simply size the boots, narrow, medium and wide or extra wide.
Committee Meeting Action: Reject
Committee Statement: Since this proposal was submitted, boot manufactures have developed and implemented the "shoe-fit" concept which has greatly improved fit making the proposed changes unnecessary.

1971-36 Log #9 FAE-SPF **Final Action: Accept in Principle**
(4.8, 4-8.1, 4-8.2)

NOTE:This proposal appeared as Comment 1971-99 (Log #40) which was held from the F99 ROC on Proposal 1971-132
Submitter: Cy Long, Texas Comm. on Fire Protection
Recommendation: Delete the following in Chapter 4 Design Requirements:

~~4-8 Accessory Design Requirements.~~

~~4-8.1 Any accessories attached to any element of the protective ensemble shall not interfere with the function of the element or with the function of any of the element's component parts.~~

~~4-8.2 Any accessories attached to any element of the protective ensemble shall not degrade the designed protection or performance of the element below the requirements of this standard.~~

Substantiation: With regards to above two sections there are some accessories and materials being added to an element of protective clothing that are not being testing or can not be tested uniformly be a certification organization in accordance to the above two sections. I have been told by some certification organizations that this is due to subjective test methods leaving it up to the discretion of that certification organization or the lack of a test method(s) in some cases. It also appears when asking about some accessories and or materials and if testing has been done, the response is no and or maybe with the element clearly marked with a certification organization mark.
Committee Meeting Action: Accept in Principle
Modify text as follows.

1. Add the following statements to the administration chapter:

1.1.X This standard shall not address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard.

1.3.X The requirements of this standard shall not apply to any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard.

2. Delete the definition for Accessories, 1-3.1 and the associated annex item A-1-3.1.

3. In the Certification chapter, delete 2-3.10.

4. In the Design Requirements, delete 4-8, 4-8.1, and 4-8.2.

5. Add the following statement to the annex.

A-1-X.X Accessories : Fire and emergency response organizations are cautioned that accessories are not a part of the certified product, but could be attached to the certified product by a means not engineered, manufactured, or authorized by the manufacturer.

Fire and emergency response organizations are cautioned that if the accessory or its means of attachment causes the structural integrity of the certified product to be compromised, the certified product might not comply with the standard for which it was designed, manufactured, and marketed. Additionally, if the accessory or its attachment means are not designed and manufactured from materials suitable for the hazardous environments of emergency incidents, the failure of the accessory or its attachment means could cause injury to the emergency responder.

Because the aftermarket for certified product accessories is so broad, fire and emergency response organizations are advised to contact both the manufacturer of the accessory and the manufacturer of the certified product and verify that the accessory and its means of attachment are suitable for use in the intended emergency response environment. Fire and emergency response organizations should seek and receive written documentation from both the accessory manufacturer and the manufacturer of the certified product to validate the following information:

1) The accessory for a certified product, and its attachment method, will not degrade the designed protection or performance of the certified product below the requirements of the product standard to which it was designed, manufactured, tested and certified.

2) The accessory, when properly attached to the certified product, shall not interfere with the operation or function of the certified product, or with the operation or function of any of the certified product's component parts.

Users are also cautioned that the means of attachment of the accessory that fail to safely and securely attach the accessory to the certified product can cause the accessory to be inadvertently dislodged from the certified product and create a risk to the wearer, or other personnel in the vicinity.
Committee Statement: The Committee agrees with the submitter. In addition, the Technical Correlating Committee has established a policy that product standards within this project will not attempt to address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard.

1971-37 Log #1 FAE-SPF **Final Action: Reject**
(4.8.1, 4-8.2)

NOTE:This proposal appeared as Comment 1971-100 (Log #20) which was held from the F99 ROC on Proposal 1971-132
Submitter: Michael J. Barthold, Cairns & Brother, Inc.
Recommendation: Revise text:

4-8.1 Any accessories attached to any element of the protective ensemble shall not ~~interfere with the function of the element or with the function of any of the element's component parts~~ prevent the element, or element component parts, from meeting all of the Design Requirements specified in Chapter 4 .

4-8.2 Omit entire paragraph from Section 4-8.

Substantiation: Chapter 4 lists the design requirements for each element of the protective ensemble. The design requirements for elements with attached accessories, which are listed in Section 4-8, do not specify that the accessory shall not affect the element's ability to meet the design requirements. This requirement should be added to Section 4-8. Paragraph 4-8.2 specifies the performance requirement of an element with attached accessories. Any performance requirements for accessories should be listed in Chapter 5: Performance Requirements.
Committee Meeting Action: Reject
Committee Statement: The variety and quantity of after-market accessories available make it impossible to address accessories in this standard. In response to this problem, the Technical Correlating Committee has established a policy that product standards within this project will not attempt to address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard. Also see Committee Action on 1971-36 (Log #9).

1971-38 Log #5 FAE-SPF **Final Action: Reject**
(4.8.1, 4-8.2)

NOTE:This proposal appeared as Comment 1971-101 (Log #35) which was held from the F99 ROC on Proposal 1971-132
Submitter: Kerry W. Gordon, Cairns & Brother, Inc.
Recommendation: Revise text:

4-8.1 ~~Any accessories~~ All accessories shall be designed that, when attached to any element of the protective ensemble they shall not interfere with the function or performance of the element or with the function or performance of

any of the element's component parts.

4-8.2 Delete entirely and move to "Performance Requirements" as 5-7.

Substantiation: Clarification of the design requirement to be placed on "accessories".

Committee Meeting Action: Reject

Committee Statement: The variety and quantity of after-market accessories available make it impossible to address accessories in this standard. In response to this problem, the Technical Correlating Committee has established a policy that product standards within this project will not attempt to address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard. Also see Committee Action on 1971-36 (Log #9).

1971-39 Log #103 FAE-SPF **Final Action: Accept in Principle**
(Chapter 5 and 6)

Submitter: Elizabeth P. Easter, Textile Testing Lab

Recommendation: Specimens of the Moisture Barrier layer of turnout gear shall be tested for resistance to degradation light by exposure to a Xenon light source for 60 hours using a modification of ASTM G155 Standard Practice for Operating Xenon Arc Light Apparatus. The conditions of the test should include an inner and outer filter of Borosilicate "S", irradiance of 340 nm wavelength at 50% RH and 63 º C/43 º C black panel temperature. The light exposure should be a continuous exposure of light for a maximum of 60 hours. After exposure the moisture barrier specimen shall be tested for resistance to liquid penetration as specified in Section ___, Liquid Penetration Resistance Test.

Substantiation: The recommendation of 60 hours exposure is based on extensive research on the degradation of moisture barriers to light exposure. Our findings showed that Breathetex moisture barriers failed after exposure to 40-60 hours of Xenon light exposure. In my opinion, anything less that 60 hours of exposure would enable materials to enter the market that may deteriorate before the 3-5 year estimated service life of turnout gear. I recommend that testing be limited to only the moisture barrier layer because the materials used in this layer have demonstrated failure due to light exposure.

Committee Meeting Action: Accept in Principle

Add new text as follows.

7-1.XX Garment moisture barrier materials shall be tested for resistance to light degradation as specified in Section 6-XX, Light Degradation Resistance Test, and shall have a minimum water penetration resistance of 13.8 kPa (2 psi).

8-XX Light Degradation Resistance Test

8-XX.1 Application. This test shall apply to moisture barrier materials.

8-XX.2 Samples.

8-XX.2.1 Samples for conditioning shall be at least 380-mm (15-in.) square and shall consist of a composite constructed using a layer of 7.5-oz natural Nomex®, the moisture barrier, a layer of Q9 thermal barrier material, and another layer of 7.5-oz. Natural Nomex®. The four-layer composite sample shall be stitched around the entire periphery.

8-XX.2.2 Where the layer intended to be the moisture barrier is configured of a composite that includes outer shell, moisture barrier, or thermal barrier combinations, the samples to be preconditioned shall be constructed using those materials.

8-XX.2.3 The moisture barrier layer shall be removed from the four layer composite samples after all preconditioning has been completed and shall become the moisture barrier specimen.

8-XX.2.4 Where the moisture barrier is configured as indicated in 6-XX.2.2, specimens shall be permitted to be a composite of layers provided that the layer intended to be the moisture barrier will face the light source in the test apparatus and provided that the specimen was preconditioned according to 6-XX.2.2.

8-XX.3 Sample Preparation.

8-XX.3.1 Sample composites shall be subjected to two cycles of the following conditioning.

(1) The sample shall first be subjected to the procedure specified in 6-1.2.

(2) The sample shall then be conditioned a specified in 6-1.3.

(3) The sample shall then be conditioned as specified in 6-1.5.

(4) The sample shall then be conditioned at a temperature of 21° C, ±3°C (70°F, ± 5°F) and a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8-XX.4 Specimen Preparation.

8-XX.4.1 The moisture barrier material will be removed from the conditioned sample composite and be cut into specimens at least 150mm (6 in.) square.

8-XX.4.2 A minimum of four specimens shall be tested.

8-XX.5 Procedure.

8-XX.5.1 Light resistance testing shall be conducted in accordance with ASTM G-155, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, using Cycle 8 Exposure Conditions. Both inner and outer filters shall be Borosilicate. Exposure duration shall not include dark cycles.

***8-XX.5.2** For each specimen, cut a piece of cardstock equal in dimensions to the specimen. Staple the specimen to the cardstock at each corner with the film side of the specimen away from the cardstock. Clip the card stock-backed specimen into the test apparatus, insuring clips do not contact the specimen and the film side of the specimen is oriented toward the light source.

* A readily available white cardstock material of 1.29 mm (0.05 in) thickness is suitable for use as a backing material to keep the material flat and unaffected by the air currents created in the test apparatus.

8-XX.5.3 Specimens shall be subjected to 40 hours of continuous light exposure.

8-XX.5.4 Specimens shall be removed from the test apparatus and conditioned in a dark environment at a temperature of 21° C, ±3°C (70°F, ± 5°F) and a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8-XX.5.5 Specimens shall be tested in accordance with ASTM D 751, Standard Methods for Testing Coated Fabrics, Hydrostatic Resistance, Procedure B – Rising Column Water Method, Procedure 2, Sections 46-49, with the following modifications:

(a) Alternative test apparatus shall be permitted provided that the exposed area of the specimen is at least 108 mm (4 _ in.) in diameter and the pressure can be applied uniformly over the exposure period at a precision of ± 0.1 kPa (± 0.2 psi).

(b) The applied pressure shall be 13.8 kPa (2 psi) for an exposure period of 1 minute.

(c) Restraining materials shall not be used.

8-XX.5.5.1 The moisture barrier specimen shall be placed in the apparatus with the film side facing away from the water source.

8-XX.5 Reports. The pass or fail performance for each specimen shall be recorded and reported.

8-XX.6 Interpretation.

8-XX.6.1 Failing performance shall be if any water appears on the surface of the specimen during the exposure period as discerned by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 305 mm (12 in.) with standard room illumination.

8-XX.6.2 One or more test failures of any specimen shall constitute failure of material.

Committee Statement: The Committee agrees with the submitter that moisture barriers should be tested for resistance to degradation by light and has proposed a new test including many of the test parameters the submitter has recommended with the exception of the use of ASTM D751 instead of the Liquid Penetration Resistance Test and a total light exposure of 40 hours instead of 60 hours.

1971-40 Log #30 FAE-SPF **Final Action: Reject**
(5.1.2.4 and 6.5.2)

Submitter: Harry P. Winer, U.S. Navy

Recommendation: Add new text (Stored Energy) to read as follows:

5-1.24 Garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for stored energy as specified in 6-52, Stored Energy Test (SET), and shall not demonstrate a burn injury within the designated time period.

6-52. Stored Energy Test.

5-52.1 Application. This test method shall apply to multiplayer protective garment composites.

6-52.2 Specimens. The stored Energy testing shall be conducted on three specimens. Specimens shall measure 6 in. x 6 in. and shall consist of all layers representative of the clothing item to be tested.

6-52.3 Sample Precondition. Specimens shall be tested both before and after preconditioning as specified in 6-1.2 and then conditioning as specified in 6-1.3.

6-52.3.1 Sample size shall be three specimens.

6.52.4 Apparatus. The test apparatus shall consist of specimen holder assembly, sensor assembly, conductive/convective heat source, protective shutter and automated data acquisition equipment.

6-52.4.1 The sensor shall conform to 6-10.4.1.5.

6-52.4.2 The automated data acquisition equipment shall conform to 6-10.4.1.6.

6-52.4.3 The protective shutter shall be placed vertical between the heat source and specimen. The protective shutter shall be capable of completely dissipating thermal load from the thermal heat source of the time periods before and after specimen exposure.

6-52.4.4 The apparatus shall be a highly insulated rectangular chamber with the protective shutter on one short end of the assembly operating vertically. The conductive/convective the source shall be able to supply a constant air temperature of 500°F to the chamber for not less than 1 hr. The conductive/convective heat source shall be shielded from the specimen so that there isn't any direct radiation from the heat source applied to the specimen.

6-52.5 Test Procedure.

6-52.5.1 The test assembly shall be preheated to 180°F for a period of 30 minutes with the protective shutter in the closed position. At the conclusion of the 30 minute warm-up the shutter shall be raised exposing the sample/sensor assembly to the convective/conductive air source for a period of 15 minutes. At the end of the 15 minutes the shutter shall be closed.

6-52.5.2 The data acquisition shall be electronically started when the shutter is raised and the specimen exposed to the heat source and continue data collection for 20 minutes. The data collected shall be compared the the

Henriques model.

6-52.6 Report. The individual time for the sample data to intersect the Henriques model shall be reported.

6-52.7 Interpretation. Pass determination shall be that no individual specimen data curve intersects the Henriques model within 15 minutes of the start of the test.

Substantiation: To evaluate the amount of heat that can be stored in a fire fighters ensemble and at what rate it will be transmitted to the fire fighter.
Committee Meeting Action: Reject
Committee Statement: The Submitter advised the Committee that the test method was not ready at this time.

1971-41 Log #87 FAE-SPF **Final Action: Accept in Principle**
(5.1.3)

Submitter: Nicholas J. Curtis, Lion Apparel, Inc.
Recommendation: Change 5-1.3 to read as follows:

Garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for evaporative heat transfer as specified in Section 6-34, Total Heat Loss Test, and shall have a total heat loss of not less than ~~130~~ 230 W/m^2.

Substantiation: The present value of 130 W/m^2 effectively serves only to differentiate between breathable and virtually non-breathable systems, and is the consequence of earlier attempts to establish a value which would offer the absolute minimum acceptable degree of stress reduction for moderate levels of work. Due to empirical evidence that was perceived to be in conflict during the revision for the 2000 edition, this minimum level was set, primarily, in consideration of what was expected as reasonably attainable performance. However, three years later, there is proof that dramatically higher evaporative heat loss is attainable, and strong evidence that added relief is provided by wearing those composites; and further, that relief is recognizable by fire fighters even at levels of work which may be classified as higher than "moderate". From empirical physiological data that was available, but questioned, during the last revision an increment of 65 W/m^2 is the "THL spread" (95% confidence level) at which physiological benefits between two composites can be realized by the wearer. From that data, and with today's evidenced relief via higher THL numbers (some over three increments of 65 beyond "non-breathable"), two 2 increments of 65 W/m^2 over and above the threshold for non-moisture vapor breathable composites (<100 W/m^2) is warranted as a minimum requirement (100+65+65=230). Paragraph 5-1.3 provided a meaningful breakthrough in stress reduction for the fire fighter. Now its time to move two steps forward.
Committee Meeting Action: Accept in Principle
Revise text as follows.

5.1.3 Garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for evaporative heat transfer as specified in Section (6-34), Total Heat Loss Test, and shall have a total heat loss of not less than 170 W/m^2.

Committee Statement: The Committee agrees the THL number should be raised but is concerned given the reported variability among labs and inconsistencies of fabrics that the recommended value is too high. The Committee raised the THL number to 170 based upon the information generated by the Indy study.

1971-42 Log #105 FAE-SPF **Final Action: Accept in Principle**
(5.1.3)

Submitter: Richard M. Duffy, Int'l Assn. of Fire Fighters
Recommendation: 5-1.3 Garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for evaporative heat transfer as specified in Section 6-34, Total Heat Loss Test, and shall have a heat loss of not less that 250 ~~130~~ W/m^2.
Substantiation: The current THL requirement is nothing more than an accommodation of marginal product that failed to take into account the health and safety of firefighters. As has been demonstrated in the product offerings in the past couple of years, composite test data have shown THL results into the 300's with many composite well above the proposed level of 250 W/m 2 . This proposed requirement will provide a better tradeoff for clothing composite thermal insulation and stress relief performance than currently afforded.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action taken on Proposal 1971-41 (Log #87).

1971-43 Log #19 FAE-SPF **Final Action: Reject**
(5.1.4, 5-1.4.2)

NOTE: This proposal appeared as Comment 1971-116 (Log #214) which was held from the F99 ROC on Proposal 1971-132
Submitter: Donald Aldridge, Lion Apparel, Inc.
Recommendation: Delete the padding from the list of items to be tested in 5-1.4 and add padding to the list in 5-1.4.3.
Substantiation: There are items used in boots and gloves which protect the fire fighter but because they are inside the item they are not exposed to the flame testing. Also, elastic, hook and pile fasteners are not subject to the flame test unless they come in contact with the wearer's skin (see 5-1.4.3).
Committee Meeting Action: Reject
Committee Statement: See Committee Action taken on Proposal 1971-46 (Log #24).

1971-44 Log #16 FAE-SPF **Final Action: Reject**
(5.1.4.1)

NOTE:This proposal appeared as Comment 1971-117 (Log #187) which was held from the F99 ROC on proposal 1971-132
Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Delete 5-1.4.1 for labels.
Substantiation: Flame resistant (FR) labels are now available within our industry and should be used in an FR garment.
Committee Meeting Action: Reject
Committee Statement: The Committee believes that legibility is an important issue with labels. The Committee does not feel that FR labels provide the long term legibility desired by the fire service.

1971-45 Log #23 FAE-SPF **Final Action: Accept in Principle**
(5.1.4.1)

Submitter: Donald Aldridge, Lion Apparel, Inc.
Recommendation: Revise text to read as follows:

5-1.4.1 Labels and hook and pile fasteners shall meet the performance requirements specified in 5-1.4 only where placed on the exterior of the garment.

Substantiation: During mannequin testing hook and pile fasteners that are placed on the outside of the garment often catch fire and continue to burn even after the test is completed. This flame will contribute to the burns recorded during the mannequin as well as the fire fighter in cases where this occurs in the field. If this comment is accepted then the committee needs to remove hook and pile fasteners from 5-1.4.3 .
Committee Meeting Action: Accept in Principle
Add the following text.
Delete current 4.1.7.
Add the following new text:

7.X.X Hook and loop fastener tapes shall be tested for flame resistance as specified in Section 8-6 Hook and Loop Flame Resistance Test, and shall have a char length of not more than 150 mm (6 in.), an afterflame of not more than 15 seconds, and shall not have drips that burn for more than 3 seconds after falling.

7.X.X Hook and loop fastener tapes shall be tested for shear strength as specified in Section 8.xx Shear Strength Test, and shall have a sheer not less than 44.8 kPa (6.5 psi).

7.X.X Hook and loop fastener tapes shall be tested for peel strength as specified in Section 8.xx Peel Strength Test, and shall have a peel strength not less than 0.05 N/mm width (0.3 pounds per inch width).

8.1.12 Cycling Procedure for Hook and Pile Fastener Tapes.
8.1.12.1 Insert cycling procedure.

8.6 Flame Resistance Test Five

8.6.1 Application. This test shall apply to hook and loop used on protective garments.

8.6.2 Samples. Samples shall be conditioned as specified in 8.1.3.

8.6.3 Specimens. A minimum of three specimens of hook and three specimens of loop of a size appropriate to the test apparatus shall be tested.

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

8.6.5 Procedure

8.6.5.1 A Bunsen burner with a 9mm (3/8in.) nominal I.D. tube shall be adjusted to give a flame of 38mm ±1.5mm (1 _ in. ± 1/16 in) in height.

8.6.5.2 The minimum flame temperature measured by a thermocouple pyrometer in the center of the flame must be 843°C ± 10°C (1550°F ± 18°F).

8.6.5.3 The specimen shall be supported vertically and the lower edge of the specimen shall be 19mm (3/4 in.) above the top edge of the burner.

8.6.5.4 The flame shall be applied to the center line of the lower edge of the specimen for a period of 60 seconds, then removed.

8.6.5.5 Each specimen shall be examined for evidence of afterflame, melting or dripping and the char length shall be determined.

8.6.6 Report

8.6.6.1 Afterflame time and char length shall be reported for each specimen. The average afterflame time and char length for each material shall be calculated and reported.

8.6.6.2 The afterflame time shall be reported to the nearest 0.2 second and the char length to the nearest 3.2 mm (1/8 in.).

8.6.6.3 The afterflame of any fallen drips shall be reported for each specimen.

8.6.7 Interpretation.

8.6.7.1 Pass/fail shall be based on the average afterflame time, the average char length and the afterflame time of any fallen drips.

8.xx Shear Strength Test

8.xx.1 Application. This test method shall apply to each width of Hook and Pile Fastener Tapes used in garments.

8.xx.2 Specimens. Specimens shall be as specified in ASTM D5169,

Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners.

8.xx.3 Sample Preparation. Specimens shall be conditioned as specified in 6.1.11.

8.xx.4 Procedure. Specimens shall be evaluated in accordance with ASTM D5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners*.

8.xx.5 Report. The average shear strength shall be reported for all specimens tested.

8.xx.6 Interpretation. The average peel strength shall be used to determine pass or fail performance.

8.xx Peel Strength Test

8.xx.1 Application. This test method shall apply to each width of Hook and Pile Fastener Tapes used in garments.

8.xx.2 Specimens. Specimens shall be as specified in ASTM D 5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners*.

8.xx.3 Sample Preparation. Specimens shall be conditioned as specified in 6-1.11.

8.xx.4 Procedure. Specimens shall be evaluated in accordance with ASTM D 5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners*.

8.xx.5 Report. The average peel strength shall be reported for all specimens tested.

8.xx.6 Interpretation. The average peel strength shall be used to determine pass or fail performance.

Committee Statement: The committee agreed there should not be an exclusion for aramid hook and loop, but rather there should be performance requirements which would allow for aramids, if they meet those requirements. The Committee added those requirements.

1971-46 Log #24 FAE-SPF **Final Action: Reject**
(5.1.4.2)

Submitter: Donald Aldridge, Lion Apparel, Inc.
Recommendation: Revise text to read as follows:
Zippers, padding and seam-sealing materials shall meet the performance requirements specified in 5-1.4 only where located on the exterior of the garment or located where they will directly contact the wearer's body.
Substantiation: The requirement in 5-1.4 restricts some very good thermal enhancements from being offered to the fire service. These better products could prevent knee injury and other compression type burns. Padding materials are not subject to exposure to flame as they are buried in the system and are covered and protected by other layers that meet the requirements in 5-1.4. Other items of the ensemble such as boots, helmets and gloves have padding, thermal liners, webbing, molded parts and other such items even though they may come in contact with the skin but are not required to meet the requirements of 5-1.4 because it is felt the items will never be exposed to direct flame. With the attempt by the committee to assure all items of the ensemble meets the same requirements it is only fair that padding is eliminated from the list of items required to be test in 5-1.4. Padding is currently tested for stability to Heat and Thermal Shrinkage (5-1.6). This test will eliminate materials that may shrink during exposure thus eliminate the air space that is normally found in a garment. I agree that this test should be left as is and that it is a much more important test to discriminate between good and bad padding. If this comment is accepted then the committee needs to go back to 5-1.4 and remove padding from that paragraph.
Committee Meeting Action: Reject
Committee Statement: Some outer shell material might embrittle during a flashover situation and expose padding. The potential for reducing the safety factor was not acceptable to the Committee.

1971-47 Log #127 FAE-SPF **Final Action: Reject**
(5.1.6)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Add to last sentence:
"..., and shall not have any portion melt, separate, ignite, vaporize, or be consumed".
Substantiation: Current language would allow a portion of a material or item to disappear by vaporization or consumption and pass this traditional oven test.
Committee Meeting Action: Reject
Committee Statement: The Committee did not believe this change addressed a need. The Committee was also concerned about the nebulous nature of the words "vaporize" and "consumed."

1971-48 Log #48 FAE-SPF **Final Action: Reject**
(5.1.14 and 6.27)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Delete performance requirement and test method.
Substantiation: The water penetration test is more of a coating or laminate strength test than it is a determination of barrier performance. Both the liquid penetration resistance test (6-28) and the viral penetration resistance test (6-29) serve to adequately address the barrier performance and durability of the moisture barrier.
Committee Meeting Action: Reject
Committee Statement: The Committee believes that if properly applied this test can discriminate between materials and should remain in the standard.

1971-49 Log #17 FAE-SPF **Final Action: Accept in Principle**
(5.1.22)

NOTE:This proposal appeared as Comment 1971-129 (Log #189) which was held from the F99 ROC on Proposal 1971-132
Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Add a requirement for the degree of fluorescence in trim and a test method.
Substantiation: Fluorescence is required for trim but there is no test or pass/fail criteria.
Committee Meeting Action: Accept in Principle
Modify text as follows.

Performance Requirements - Revise current 5-1.22.

7-1.22 (5-1.22) Garment trim shall be tested for retroreflectivity and fluorescence as specified in Section 8.46, Retroreflectivity and Fluorescence Test. The garment trim shall have a Coefficient of Retroreflection (R_a) of not less than 100 cd/lux/m^2 (cd/fc/ft^2) and the chromaticity shall lie within one of the areas defined in Table 7-1.22, Color, and the luminance factor (Cap Y) shall exceed the corresponding minimum.

Table 7-1.22, Color

Color	Chromaticity Coordinates		Minimum Luminance Factor (Cap Y)
Fluorescent Yellow-Green	0.387	0.610	70
	0.356	0.494	
	0.398	0.452	
	0.460	0.540	
Fluorescent Orange-Red	0.610	0.390	40
	0.535	0.375	
	0.570	0.340	
	0.655	0.344	
Fluorescent Red	0.655	0.344	25
	0.570	0.340	
	0.595	0.315	
	0.690	0.310	

Test Methods - Insert the following in place of the existing 6-46.4.2

8-46.4.2 Evaluation of Fluorescence

8-46.4.2.1 Trim fluorescence shall be determined by its colorimetric properties. The chromaticity shall lie within one of the areas defined in Table 5-1.22, Color, and the luminance factor (Cap Y) shall exceed the corresponding minimum.

The color shall be measured in accordance with the procedures defined in ASTM E991, E2152 and E2153 utilizing D65 illumination and 45°/0° or 0°/45° geometry and 2° standard observer. The specimen shall be measured with a black underlay with a reflectance (luminance) less than 4.

8-46.4.2.2 Specimens that lie within one of the areas defined in Table 5-1.22, Color, and meet or exceed the minimum corresponding luminance factor (Cap Y) for that color shall be de designated as acceptable.

Committee Statement: The Committee agreed with the submitter and added a performance requirement and a test method.

1971-50 Log #82 FAE-SPF **Final Action: Reject**
(5.1.22)

Submitter: David Elsner, Reflec USA Corporation
Recommendation: Revise the first line to read as follows:
"Garment trim and/or retroreflective fabrics shall be tested for retroreflectivity and fluorescence...".
Substantiation: **Executive Summary**
_A new form of retro-reflective technology, which allows the retroreflective optical elements to be incorporated into the weave of a variety of fabrics and distributed over the entire surface of a garment, has been tested against the needs of the fire service industry and has been found to provide significant enhancements to the existing NFPA 1971 standards and the ANSI 107-1999 standards. This technology is generically referred to **as silhouette reflectivity** because of its inherent ability to retro-reflect light in the shape of the person wearing the garment, thus increasing recognition of the wearer to drivers and fellow rescue workers.
The benefits of this new technology to the fire fighting industry are:
1. Improved Visibility
Wearer is more recognizable as a human being on public roads reducing the

chances of being involved in an accident.
Wearer is easier to locate in a smoke filled environment.

2. Improved Flame Resistance

Greater retained reflectivity following flashover conditions with nearly 50 percent of the original reflectivity retained reflectivity when exposed to a Mannequin Test of 80kw for 8 seconds vs. zero retained reflectivity of traditional retro reflective trim tapes.

3. Improved Breathability

Eliminates the build up of vapour under traditional reflective trim tapes providing less chance of burns and stress resulting from the heat build-up.

4. Reduced Weight of Turnout Gear

Retroreflective fabric is a fraction of the weight of existing trim which aids in reducing overall weight of the turnout gear.

Details

The issue of safety is of paramount importance to the fire service industry. A major area of concern relates to the sustained visibility of fire fighters at structural fires and incidents on public roads.

The need for enhanced visibility is required in two distinct areas:

Fire Ground Accountability

Fires are typically fought in low light conditions often made worse from smoke. It is essential that a fire fighter's location be known at all times especially in the moments of greatest danger. If a fire fighter collapses or is caught in a fire, it is important that their colleagues can quickly locate them. In many cases, this will require the use of a flashlight. The current trim technology is limited to strips applied to the torso, arms and legs of the turnout gear and as a result a person's body is not clearly delineated. There will be situations where the body of a fire fighter would not be seen at all with the current trim configurations. For example if a firefighter were to collapse and only there shoulders were protruding in to the hallway currently this person would not be visible in low light condition however with the new technology the whole body of the firefighter could be visible.

Incident Management Visibility

Motorist colliding with fire personnel is a significant issue and the adoption of ANSI compliant high visibility garments by the NFPA is an important first step in providing visibility enhancement to fire service personnel. Through application of the new technology to turn-out gear, the human form is delineated to create a more visible fire-fighter to the oncoming driver, thus providing tremendous enhancements to the current ANSI 107-1999 standard.

Increased benefit and safety enhancement can be provided to the fire service personnel through use of this new retroreflective technology. The problem areas are:

Burns as a result of moisture build-up under trim and flammability of trim.

There have been numerous reports of 2nd and 3rd degree burns under trim. *"When we compared the size of burns, as well as their location…there appeared to be a direct correlation with the reflective tape used on the turnout gear and the location of the burns. When the turnout gear was examined layer by layer, there appeared to be areas where heat conduction had occurred and these areas were directly beneath the reflective tape, particularly on the back. The width of the reflective tape coincides with the width of the burn on the forearm, as well as on the back"(A)* Over the years, several public comments have been submitted to the NFPA asking to address concerns with traditional retroreflective trim products and their potential cause of burns on the upper shoulders and arms. There are currently no test standards that address flashover conditions. The addition of a Mannequin Test would address this need. Results carried out by BTTG using a Mannequin Test showed that retro-reflective print technology did not negatively impact the results of turnout gear and that after 80kw for 8 seconds 50% of the original reflective levels were still recorded. In comparison traditional retro-reflective trim was fully burnt and melted leaving, no reflectivity.

Heat stress

The contribution of traditional trim to heat stress appears to be fairly common knowledge within the fire service. Since traditional trim does not breathe and specialized breathable membrane systems such as Crosstech by W.L.Gore are specified, traditional trim will eliminate the breathability of these high performance fabrics wherever the trim is applied. Eliminating the use of traditional trim on the shoulders and arms will reduce the number of injuries resulting from vapour burns and heat stress.

Visibility on the fire ground and on public roads

The summary below of the currently perceived requirements for retroreflective nighttime conspicuity clothing present compelling support for a new approach, based on whole-body **silhouette reflectivity**. However, the importance of also maximizing daytime conspicuity must not be overlooked. This can follow the traditional method of applying fluorescent trim, treatments, or fabrics.

The adoption by NFPA 1971 of the ANSI107-1999 standards for high visibility clothing can be significantly enhanced through the use of silhouette reflective arms on turnout gear. This could also eliminate the problems resulting from moisture build-up under trim on arms, resulting in burns and heat stress caused by heat build up under traditional trim. Suggested language changes to NFPA 1971 would allow for the benefits of silhouette reflective technology to be specified by fire service personal on turnout gear.

Silhouette reflectivity summary

The process by which a motorist reacts to an incident on the road is known as the perception-reaction time (PRT). The six stages to PRT are:

Stage1

Detection - This is when the brain is first aware that there is something of significance. Perhaps a form of lighting of some type.

Stage 2

Recognition - This is the critical stage where the brain determines what it is actually seeing. Out of all of the thousands of possibilities is this in fact a person on or approaching the roadway?

Stage 3

Evaluation - The brain now assesses the situation taking into account all of the different factors that prevail at that moment of time.

Stage 4

Decision - The brain decides upon a course of action.

Stage 5

Reaction - The body reacts to the commands of the brain.

Stage 6.

Response - The vehicle responds to the actions of the driver vehicle.

The new technology provides a significant improvement to the existing retroreflective trim as it dramatically improves the speed and accuracy by which a motorist can complete stage 2 and recognize an object on the road as being a human being and as such requiring a different evaluation (stage 3).

There are several factors that influence the factors above including: age, alcohol, experience, distractions (e.g. cell phone), familiarity, memory, vision, weather, and the lighting conditions.

Regarding the latter point, US statistics for the past 20 years have shown that fatal collision rates are over three times higher (on a mileage basis) at night than during daylight hours (2). People are generally not aware of their hazardous situation and greatly overestimate their visibility to oncoming drivers.

The principal reason people are at such a high risk in darkness is because they are not conspicuous to vehicle drivers. Early field experiments (3) involving the visibility of dark-clothed mannequins from cars with dipped headlights indicated that the upper limit safe approach speed was only 15 mph for 90% of drivers.

The assured clear distance ahead (ACDA) rule, which holds the operator of a motor vehicle responsible to avoid collision with any obstacle that might appear in the vehicle's path, is routinely violated by most driver under nighttime conditions (4). The maximum safe speed of travel is the central concern of the ACDA rule. This limit is governed by the total stopping distance (TSD), which is determined by a combination of human and mechanical factors. The TSD = V (P& RT) + BD, where Vis the vehicle velocity, P & RT is the time to perceive the situation and respond by depressing the brake pedal, and BD is the braking distance. Traffic engineers assume 2.5 seconds as a useful guideline to a driver's P & RT. Studies have shown that the recognition distance of an unexpected dark-clad pedestrian, by an average young driver using low-beam headlights, can be as short as 18 yards, which is much shorter than the TSD (by 1.2 to 3 times at only 25 mph). Recognition distance depends on the conditions; it is longer (twice as great) with high beam headlights or a reflective object, and shorter when confronted with glare from oncoming headlights or during inclement weather. All road users should be apprised of the limitations of visibility at night and while drivers should be encouraged to travel more slowly and not to under use their high beams, it is important that fire-fighters take measures to increase their own conspicuity.

Most collisions between automobiles and humans occur under comparatively short distances. In a study of 2,100 pedestrian accidents, dart-out (excluding at an intersection) accounted for twenty-four percent.

A person can increase their conspicuity at night by wearing reflective clothing, especially if containing retroreflective materials that reflect maximum light from a car's headlights directly back to the driver. But it doesn't necessarily follow that the nighttime conspicuity of pedestrians can be boosted in this way solely by increasing the stimuli confronting drivers. The mere fact that a target can be detected from a far distance is no guarantee that the driver is aware of what that target is, and whether or not it is in fact on the roadway.

Shinar (5) studied the distances at which people could be detected and recognised, under various combinations of driver's expectancy (i.e., to see a pedestrian on the road), pedestrian clothing characteristics (dark clothing, light clothing, and dark clothing with retro-reflective tags) and the detection criterion (i.e. pedestrian versus retro-reflective tag). When the pedestrian is unexpected the usefulness of the tag is significant only if the driver can rely on it as a criterion for detection (by prior knowledge of the association between the tags and the pedestrian). Retro-reflective materials may therefore under-perform if drivers cannot rely on them to identify a pedestrian unambiguously.

Because detection of a target doesn't automatically ensure recognition, it is important to develop retroreflective clothing that allows pedestrians to be immediately recognized as such.

Hughes & Cole (6) differentiated between *attention conspicuity* (an object that attracts a driver's attention even when unaware of its presence) and *search conspicuity* (when the observer is directed to search for the object) and they demonstrated that laboratory studies using movie films and projected coloured slides provide a reasonable prediction of the assessment of conspicuity obtained from field experiments.

The accurate detection of pedestrians by drivers can occur at greater distance when retroreflective clothing is configured to highlight the pedestrian's limbs. Blomberg et.al (7) equipped individual pedestrian with either reflective dangle tags, portable flashlights, a joggers vest or a set of retroreflective rings attached to the pedestrian' s head, wrists, belt and ankles; they were positioned on the roadway facing the traffic and walking on the spot. Drivers with low-beam headlights saw the flashlight from further away but the retroreflective rings

gave the greatest recognition distance (133m), suggesting that an anthropomorphic shape is critical in providing a target signature recognizable from distance.

Johansson (8,9) was first to demonstrate the importance of biological motion for target recognition. By attaching a dozen point-light sources to the joints of the human body walking in darkness, subjects were able to recognise the moving array of lights as a person when exposed to the stimulus for as short as one-tenth of a second. But when stationary the display was generally unidentifiable. More recently Owens et.al. (10) filmed a jogger at night wearing four different types of clothing (a control with dark clothing only, a simple jogger's vest incorporating a reflector, five retroreflective strips at arbitrary positions and an outfit with eleven retroreflective strips positioned on the extremities of the limbs) from a car travelling at 25 mph with dipped headlights. The Retroreflective materials were detected at greater distance (average 70m) relative to the joggers vest (50m) and the dark-clothed control pedestrian (12m), but detection-distance (average 75m) were even greater when the retroreflective strips were positioned in biological motion configuration. Furthermore 85% of subjects reported that the biological motion situation was easiest to see.

In a later study Luoma et.al, (11) confirmed that retroreflective markings on the limbs, in comparison to those on the torso, significantly increase (by about 60-80%) the nighttime recognition distance of pedestrians. However the latest study involving biological motion, carried out by Moberly (12), did not support the hypothesis that biological motion affords recognition at greater distance that does standard motion. This confusion may be the result of disregarding in the experimental details two important fundamentals; in general the use of larger areas of Retroreflective material (13) and use of brighter retroreflective material(13,14) will both increase pedestrian nighttime conspicuity. Furthermore, other important differences in the designs of the experiments (car speed, external lighting conditions, jogging versus walking on the spot, pedestrian orientation vis-à-vis the direction of travel of the car) may have influenced the conclusion.

Not withstanding this confusion over the importance of biological motion, it is now being increasingly accepted that conventional retroreflective trim or tape can be easily misidentified. As early as 1970 Allen (15,p180) stated "A pedestrian carrying a dangling reflector or reflector attached to his shoes or clothing may be identified as a pedestrian by the motion of the reflector as he walks; but if he stands still the reflection might be construed to be from a fence post, a car, or even a discarded can.

A report (16) concerning retro-reflective markings on fire-fighter's protective clothing states that this is most effective if drivers of approaching motor-vehicles immediately recognize the human form; recognition must take place in a rather short time(0.3-1.0 sec) and from a relatively long distance (100-200m). A special requirement for fire fighters is that they must be recognizable as such without help from their body movements, since many of their tasks are performed in a semi-permanent posture. Furthermore, extremely limited time is often available for perception in relevant traffic situations. As a basic principle for retro-reflective design the authors of this report (16) suggest a coarse version of a geodesic grid with an emphasis on the human form.

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(4) Leibowitz, H.W., Owens, D.A. and Tyrrell, R.A., (1998), The assured clear distance ahead rule: Implications for nighttime traffic safety and the law, *Accident Analysis and Prevention,30*, 93-99.

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(10) Owens, D.A., Antonoff, R.J. and Francis, E.L. (1994), Biological motion and nighttime pedestrian conspicuity, *Human Factors, 36*, 718-

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(12) Moberly, NJ., Pedestrian conspicuity at night: a case for biological motion? School of *Cognitive and computing Sciences*, University of Sussex.

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(16) Ebell-Vonk, E.M., Ebell R.J.E.V., Groot-Kaper, M., Groot, R.E., Theevis-von der Stoop, M.E., Theevis, S.R., (1987, July) Development of a result oriented design for retroreflective marking on fire-fighter's protective clothing, *IWACC: Lange Weide 6:* 1631, D L Oudendijk: The Netherlands.

Committee Meeting Action: Reject

Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

Committee Meeting Action: Reject

Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

1971-51 Log #86 FAE-SPF **Final Action: Reject**
(5.1.22)

Submitter: Charles Dunn, Soutern Mills inc.

Recommendation: Revise text to read as follows:

Section 5-1.22 ~~Garment trim shall be tested for retroreflectivity and fluorescence as specified in Section 6-46, Retroreflectivity and Fluorescence Test, and shall have a Coefficitent of Retroreflectivity (Ra) of not less than 100 cd/lux/m^2 and shall be designated as fluorescent.~~

Retroreflective areas of the garment shall be tested for retroreflectivity as specified in Section 6-46. The minimum percent garment coverage with retroreflective elements shall be determined by:

$\%_{rc} = 544/R_a$

where R_a is the measured coefficient of retroreflection and $\%_{rc}$ is the percentage of the outer shell fabric covered with retroreflective elements.

When retroreflective materials other than trim are used on a garment, the retroreflective materials should be uniformly distributed over the outer shell. In the event that trim is used on the garment it will be applied as per 4.1.14.5.

Substantiation: The current standard for visibility of turnout gear specifies trim in specific locations on the exterior of the garment. This specification is design restrictive. The revised specification is performance based and will allow for the use of new technology, which is under development, and has the potential for improved performance. Specifically, new retro-reflective technologies have the potential for improving firefighter safety by minimizing stored energy effects while optimizing overall garment breathability, moisture vapor transmission rates and nighttime visual conspicuity.

The current standard specifies the R_a of the retro-reflective element, which is a small-scale measure of the brightness of reflected light. This proposed change in the standard uses R_{LG} or the Coefficient of Luminous Intensity of the garment outer shell (which is a measure of the overall brightness of reflected light from the garment). R_{LG} is defined as:

$R_{LG} = R_a * A_{re}$

Where R_a = Coefficient of retroreflection and

A_{re} = area of reflective material on the garment (m^2)

For a set of NFPA 1971, 2000 edition, size 46 turnout gear the minimum R_a = 100 candelas per lux per m^2 and A_{re} = 210 square in. or 0.135 m^2. Therefore, the minimum R_{LG} for a NFPA 1971 set of turn out gear is:

R_{LG} = 13.5 candelas/lux (Turnout system with Trim)

We propose that the new standard maintain the Coefficient of luminous intensity of the garment outer shell (R_{LG}) of the turnout system at the current level of 13.5 candelas/lux but not limit the turnout manufacturer to the currently design restrictive use of trim. This can be accomplished by relating the R_{LG} to the R_a of the retroreflective elements of the gear and the percent of gear covered with retroreflective elements. That is:

$R_{LG} = R_a * A_{re}$ (1)

$A_{re} = \%_{rc} * A_g / 100$ (2)

Where $\%_{rc}$ = percentage of the outer shell fabric covered with retroreflective elements,

A_g = area of outer shell fabric on the garment (m^2)

A_{re} = area of retroreflective elements on the outer shell fabric

If we combine (1) and (2) we obtain:

$R_{LG} = R_a * \%_{rc} * A_g / 100$ (3)

However, for a standard NFPA 1971 compliant turnout system we know that:

R_{LG} = 13.5 candelas/lux and

A_g = 2.91 sq yd = 2.48 m^2 (approximate measurement)

If we substitute these known quantities into (3) and rearrange the equation we obtain:

$\%_{rc} = 544/R_a$

$\%_{rc}$	R_a
54.4	10
27.2	20
18.1	30
13.6	40

The above combinations of R_a and $\%_{rc}$ should give turnout garments the

equivalent brightness to current gear. Initial field evaluations using car headlights on a dark road, confirm that the above bead coverage levels do (to the eye) correspond to a garment brightness level, which is at least equivalent to the current trim only system. These field brightness measurements be continued to further confirm this in greater detail.

Committee Meeting Action: Reject

Committee Statement: The Committee believes that although alternative area reflective materials may provide visual enhancement to the ensemble, adequate supporting data and information is not available at this time. To properly define and specify performance requirements, visual (reflective and fluorescent) and durability, more time and evaluation is required. The Committee believes that the current standard does not prohibit the use of these materials in addition to a base trim pattern.

1971-52 Log #100 FAE-SPF **Final Action: Accept in Part**
(5.1.23 and 6.51)

Submitter: Tim Durby, Phoenix Fire Department

Recommendation: Revise text to read as follows:

5.1.23 The garment composite from the shoulder areas and the knee areas shall be tested for resistance to heat transfer as specified in Section 6-51, Conductive and Compressive Heat Resistance (CCHR) test and shall have a minimum CCHR rating of ~~13.25~~ 25 for the shoulder areas and the knee areas, when tested in the wet condition.

It will also be necessary to change the test method:

6.51 Conductive and Compressive Heat Resistance (CCHR) Test.

6.51.1 Application. This test method shall apply to the shoulder areas and the knee areas of protective garments.

6.51.2 Samples.

6.51.2.1 Samples shall consist of composites representative of all layers of the shoulder areas and knee areas used in the actual construction of the protective garment. Different samples shall be made representing each different composite combination used by the garment manufacturer.

6.51.2.1.1 Samples of garment shoulder areas shall be representative of the area in the actual garment that measures at least 100 mm (4 in.) along the crown of the shoulder and extending down from the crown on both the front and back of the garment at least 50 mm (2 in.). The crown of the shoulder shall be the uppermost line of the shoulder when the garment is laying flat on an inspection surface with all closures fastened.

6.51.2.1.2 samples of garment knee areas shall be representative of the knee area in the actual garment that measures at least 150 mm x 150 mm (6 in. x 6 in.).

6.51.2.2 Samples shall measure 200 mm x 200 mm (8 in. x 8 in.) and shall be prepared of the composite layers. The sample of the composite layers shall be sewn along two adjacent sides, with the layers arranged in the same order and orientation as intended to be worn.

6.51.2.3 All samples shall be first be preconditioned as specified in 6.1.2.

6.51.3 Specimen Preparations.

6.51.3.1 A minimum of ~~six~~ three specimens for testing shall be taken from the samples after the preconditioning specified in 6.51.2.3.

6.51.3.2 The specimens shall measure 150 mm x 150 mm (6 in. x 6 in.) and shall be cut from the sample excluding the sewn areas so that the composite layers comprising the specimen are not sewn together at any point.

6.51.3.3 Specimens for ~~both~~ wet condition testing ~~and dry condition testing~~ shall then be conditioned as specified in 6.1.3.

6.51.3.4 For wet condition testing ~~only,~~ the innermost layer of the composite specimen shall then be further conditioned as follows prior to testing:

(1)Blotter paper measuring 225 mm x 225 mm (9 in. x 9 in.) shall be saturated in distilled water.

(2) Two sheets of the saturated blotter paper shall be run together through a wringer that meets the requirements of 10.2 of AATCC 70, Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test.

(3) The innermost layer of the composite specimen shall be placed between the tow sheets of blotting paper.

(4) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be placed into a 4-L (1-gal) size air- and liquidtight bag and the bag shall be sealed closed.

(5) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be conditioned in the air- and liquidtight bag at room temperature for at least 24 hours, and shall not be removed from conditioning more than 5 minutes prior to testing.

(6) After removal from conditioning, the innermost layer shall be removed from the blotting paper, and the composite specimen shall be resembled with all layers arranged in the same order and orientation as intended to be worn.

6.51.4 Procedure.

6.51.4.1 A minimum of ~~six~~ three specimens shall be tested for shoulder areas, ~~three for wet condition testing, and three for dry condition testing.~~ A minimum of ~~six~~ three specimens shall be tested for knee areas~~, three for wet condition testing and three for dry condition testing~~.

6.51.4.2 Specimens shall be tested in accordance with ASTM 1060, Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact, with the modifications specified herein.

6.51.4.3 Specimens shall be tested using an exposure temperature of 280°C, +3°/-0°C (536°F, +5°/-0°F).

6.51.4.4 For the shoulder area CCHR rating, the sensor assembly shall be modified so that the pressure applied to the test specimens shall be 8 g/cm^2, ±0.8 g/cm^2 (2 psi, ±0.2 psi).

6.51.4.5 For the knee area CCHR rating, the sensor assembly shall be modified so that the pressure applied to the test specimens shall be 32 g/cm^2, ±3/2 cm^2 (8 psi, ±0.08 psi).

6.51.4.6 The CCHR rating for each specimen in each test shall be the time in seconds to achieve a temperature rise of 24°C (75°F).

6.51.4.7 For purposes of calculating the time to a 24°C (75°F) temperature rise, the room temperature in the testing area shall be determined immediately prior to starting the test and that temperature shall be used as the base temperature in determining the 24°C (75°F) rise. The time shall be measured to the nearest tenth of a second. Time "zero" shall be the time that the sensor and specimen are placed in direct contact with the exposure.

6.51.5 Report.

6.51.5.1 The individual CCHR rating for each specimen in each test shall be reported.

6.51.5.2 The average CCHR rating for the shoulder area wet condition test specimens shall be separately calculated and reported. ~~The average CCHR rating for the shoulder area dry condition test specimens shall be separately calculated and reported.~~

6.51.5.3 The average CCHR rating for the knee area wet condition test specimens shall be separately calculated and reported. ~~The average CCHR rating for the knee area dry condition test specimens shall be separately calculated and reported.~~

6.51.6 Interpretation.

6.51.6.1 Pass/fail determination for shoulder area wet condition test specimens shall be based on the average reported CCHR rating of all wet specimens. ~~Pass/fail determination for shoulder area dry condition test specimens shall be based on the average reported CCHR rating of all dry specimens tested.~~ Failure of ~~either~~ the wet condition test set ~~or the dry condition test set~~ to achieve an average CCHR of at least ~~13.5~~ 25 shall constitute failing performance.

6.51.6.2 Pass/fail determination for knee area wet condition test specimens shall be based on the average reported CCHR rating of all wet specimens. ~~Pass/fail determination for knee area dry condition test specimens shall be based on the average reported CCHR rating of all dry specimens tested.~~

6.51.6.3 If an individual CCHR rating from any individual specimen varies more than ±8 percent from the average results for that test set, the results for that test set shall be discarded and another set of specimens shall be tested.

Substantiation: The majority feeling is that the CCHR requirement is too low and wet conditioning is the worse case scenario.

Committee Meeting Action: Accept in Part

Committee Statement: The Committee is accepting the increase in pass/fail for the CCHR performance requirement. However, the Committee is rejecting the change to the test method to remove the dry conditioning testing. Wet testing is not always the worst-case, and the Committee believes it is important to continue to test in both wet and dry condition.

1971-53 Log #119 FAE-SPF **Final Action: Reject**
(5.2)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C

Recommendation: Add text to read as follows:

Liquid Penetration Resistance Test and Viral Penetration Test to helmet earflaps

Substantiation: The helmet earflaps are an important component to the overall ensemble protective abilities and currently have NO minimum liquid or viral penetration requirements.

Committee Meeting Action: Reject

Committee Statement: The Committee did not believe there was a need for mositure protection in ear flaps.

1971-54 Log #120 FAE-SPF **Final Action: Accept in Principle**
(5.2)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C

Recommendation: Add text to read as follows:

"...a insulation test such as TPP or RPP to helment airflaps"

Substantiation: The helmet earflaps are an important component to the overall ensemble protective abilities and currently have NO minimum insulation requirement.

Committee Meeting Action: Accept in Principle

Add new text as follows.

7.2.22 (new) Helmet ear covers shall be tested for thermal insulation as specified in 8.10, Thermal Protective Performance (TPP) Test, and shall have an average TPP rating of at least 20.0.

Committee Statement: The Committee agreed with submitters request and added a TPP value for ear flaps of 20.

1971-55 Log #90 FAE-SPF **Final Action: Reject**
(5.4.2 and 6.9)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Delete current requirement and test method and replace with new performance requirement and test method based on Radiant Protective Performance (RPP) involving the testing of composite specimens taken from footwear at an exposure energy of 2.0 cal/cm^2 s per ASTM F 1939. Testing shall be conducted on all parts of the footwear where different composites are used.
Substantiation: The current radiant performance test is highly variable, inconsistently interpreted and lacks a basis for its performance criteria. A more detailed procedure will be provided during the public comment period.
Committee Meeting Action: Reject
Committee Statement: The Committee believes the current test method is appropriate and adequate.

1971-56 Log #91 FAE-SPF **Final Action: Reject**
(5.4.4 and 6.8)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Delete current requirement and test method and replace with new performance requirement and test method based on the current Conductive Heat Resistance Test One (ASTM F 1060) using the higher contact temperature specified in Section 6-9. Testing shall be conducted on the thinnest portion of the footwear.
Substantiation: The current conductive heat resistance testing for measuring footwear sole performance is highly variable, inconsistently interpreted and lacks a basis for its performance criteria. A more detailed procedure will be provided during the public comment period.
Committee Meeting Action: Reject
Committee Statement: The Committee believes the current test method is appropriate and adequate.

1971-57 Log #22 FAE-SPF **Final Action: Reject**
(5.5.3)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Remove labels from the list of required FLAME RESISTANT materials for hoods.
Substantiation: The TC has been told several times that there is no label available to meet the FLAME RESISTANCE requirements while also meeting the DURABILITY requirements for garments - hoods have the same requirements so it must be true for hoods as well.
Committee Meeting Action: Reject
Committee Statement: The requirement for flammability testing of hood labels is already in place and the submitter agreed that he did not want to see non-flammable hood labels.

1971-58 Log #70 FAE-SPF **Final Action: Accept**
(5.5.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Delete last sentence.
Substantiation: The instructions provided in this sentence are inconsistent with the test method procedures.
Committee Meeting Action: Accept

1971-59 Log #2 FAE-SPF **Final Action: Reject**
(5.7 (New))

NOTE:This proposal appeared as Comment 1971-187 (Log # 21) which was held from the F99 ROC on Proposal 1971-132
Submitter: Michael J. Barthold, Cairns & Brother, Inc.
Recommendation: Add new text:
5-7 Accessory Performance Requirements.
5-7.1 Any accessories attached to any element of the protective ensemble shall not prevent the element, or element component parts, from meeting all of the Performance Requirements specified in Chapter 5.
Substantiation: Chapter 5 lists the performance requirements for each element of the protective ensemble. Chapter 5 does not contain performance requirements for elements with attached accessories. This requirement should be added as a new Section 5-7.
Committee Meeting Action: Reject
Committee Statement: The variety and quantity of after-market accessories available make it impossible to address accessories in this standard. In response to this problem, the Technical Correlating Committee has established a policy that product standards within this project will not attempt to address requirements for any accessories that could be attached to the certified product, but are not necessary for the certified product to meet the requirements of this standard. Also see Committee Action on 1971-36 (Log #9).

1971-60 Log #6 FAE-SPF **Final Action: Reject**
(5.10)

NOTE:This proposal appeared as Comment 1971-188 (Log #36) which was held from the F99 ROC on Proposal 1971-132
Submitter: Benjamin F. Brenner, Atlantic City Fire Dept., NJ
Recommendation: Revise text:
"Thus, SCBA are required at all times during any firefighting, HazMat, or overhaul operations. NFPA Standard 1971 ."
Substantiation: Head protection and eye protection should be separate. To mandate eye protection be attached to the helmet seem ludicrous.
The facepiece of the SCBA, which is supposed to be worn at all times during structural firefighting including overhaul, provides eye protection during that phase. While this is going on, the attached eye protection, faceshield, goggles, etc., are being exposed to the worst heat and falling debris conditions possible during firefighting operations.
It seems that it would be more prudent to require eye protection be provided and the individual be responsible as to when best to put them on. Taken out of a pocket or special case will surely be more protective of the eye with less possible contaminant than the methods now required. Improvements may still be made to the goggles and also to when we wear them, but not to how we carry them on our person. I.E. Helmets.
All helmet tests appear to be performed with eye protection in the deployed position. If personnel are using SCBA as prescribed, 95 percent or more of the time during structural firefighting, the eye protection attached to helmets will be in the stowed position.
Thus, all testing should be performed with attached eye protection in the stowed position.
Committee Meeting Action: Reject
Committee Statement: See Committee Action taken on 1971-29 (Log #88).

1971-61 Log #12 FAE-SPF **Final Action: Accept in Part**
(6.1.2)

NOTE:This proposal appeared as Comment 1971-190 (Log #149) which was held from the F99 ROC on proposal 1971-132
Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change the paragraph to read:
"6-1.2 Washing and Drying Procedure for Garments, Gloves, Trim, Helmets, Gloves, Footwear, and Faceshield/Goggle Components. Specimens shall be subjected to ~~five~~ ten cycles of washing and drying...".
Substantiation: While laundering does not simulate all aspect of garment wear, it is expected that the average garment would be washed 10 times over its normal service life assuming a service life of 10 years and department compliance with NFPA 1500. Performance properties that are assessed after washing should be uniformly assessed after 10 cycles of laundering.
Committee Meeting Action: Accept in Part
Committee Statement: The committee accepted the increase from five to ten wash/dry cycles for the new moisture barrier durability test only. See Committee Action on 1971-39 (Log #103). However, all other wash/dry cycles will remain at current levels. The committee did not feel the increase was necessary for other components and elements.

1971-62 Log #79 FAE-SPF **Final Action: Accept**
(6.1.3.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
Specimens shall be conditioned at a temperature of 21°C ± 3°C (70°F ± 5°F) and a relative humidity of 65 percent, ±5 until equilibrium is reached as determined in accordance ~~with Section 4 of Federal Test Method Standard 191A, Textile Test Methods~~ ASTM D1776, Standard Practice for Conditioning Textiles for Testing, or for at least 24 hours, whichever is shorter. Specimens shall be tested within 5 minutes after removal from conditioning.
Add to Section 7.1.2.3:
ASTM D1776, Standard Practice for Conditioning Textiles for Testing, 1996.
Substantiation: The ASTM standard provides greater detail and is more accessible to industry.
Committee Meeting Action: Accept

1971-63 Log #78 FAE-SPF **Final Action: Accept**
(6.1.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change title to 6-1.4 Low Temperature Environmental Conditioning for Helmets and Faceshield/Goggle Components.
Substantiation: The conditioning method also applies to faceshield/goggle components.
Committee Meeting Action: Accept

1971-64 Log #77 FAE-SPF **Final Action: Accept**
(6.1.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change title to "Convective Heat Conditioning Procedure for Helmets, Faceshield/Goggle Components, Gloves, Footwear, Moisture Barriers, Moisture Barrier Seams, Labels, and Trim."
Substantiation: The conditioning method also applies to faceshield/goggle components.
Committee Meeting Action: Accept

1971-65 Log #76 FAE-SPF **Final Action: Accept**
(6.1.5(e))

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add to end of paragraph:
" Only one helmet shall be tested at a time."
Substantiation: Regardless of the size of the oven, only one helmet specimen should be conditioned at a time due to heat sink effects.
Committee Meeting Action: Accept

1971-66 Log #75 FAE-SPF **Final Action: Accept**
(6.1.5(f))

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change to "For gloves, footwear, trim, labels, moisture barriers, and moisture barrier seam specimens, the required testing shall be performed no sooner than 24 hours after removal from conditioning. Samples shall be suspended in the oven such there is a distance of at least 150 mm (6 in.) between items. "
Substantiation: The proposed language corrects an omission in the standard. Additional clarification is needed for placing samples in oven.
Committee Meeting Action: Accept

1971-67 Log #74 FAE-SPF **Final Action: Accept**
(6.1.11.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add text to read as follows:
6-1.11.1 The complete garment shall be washed with all closures fastened and the garment in its normal orientation. Garments with separable liners shall not be separated.
Substantiation: Additional detail is needed to consistently condition garments.
Committee Meeting Action: Accept

1971-68 Log #73 FAE-SPF **Final Action: Accept**
(6.1.11.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add text to read as follows:
6-1.11.5 The complete garment shall be dried with all closures fastened and the garment in its normal orientation. Garments with separable liners shall not be separated.
6-1.11.6 The garment shall be dried using a tumble dryer that meets the requirements of AATCC 135, Dimensional Changes in Automatic Home Laundering or Woven and Knit Fabrics, with a stack temperature of 38°C to 49°C (100°F to 120°F).
Renumber the remaining paragraphs.
Substantiation: Additional detail is needed to consistently condition garments.
Committee Meeting Action: Accept

1971-69 Log #72 FAE-SPF **Final Action: Accept**
(6.2.4, 6.2.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Replace Method 5903.1, Flame Resistance of Cloth; Vertical, of Federal Test Method Standard 191A, Textile Test Methods, with ASTM D6413, Standard Test Method for Flame Resistance of Textiles (Vertical Test).
Add to Section 7.1.2.3:
ASTM D6413, Standard Test Method for Flame Resistance of Textiles (Vertical Test), 1999.
Substantiation: The ASTM standard provides greater detail and is more accessible to industry.
Committee Meeting Action: Accept

1971-70 Log #69 FAE-SPF **Final Action: Accept**
(6.2.6.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-2.6.1 After-flame time and char length shall be reported for each specimen. the average after-flame and char length for each material shall be calculated and reported. The after-flame time shall be reported to the nearest ~~0.2~~ 0.1 sec and the char length to the nearest 3.2 mm (1/8 in.).
Substantiation: A more stringent reporting requirement is needed to avoid rounding errors.
Committee Meeting Action: Accept

1971-71 Log #71 FAE-SPF **Final Action: Accept**
(6.2.13.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new paragraph:
6.2.13.4 Testing shall be performed as specified in 6-2.2 through 6.2.7.
Substantiation: No instructions are provided to conducting the actual testing.
Committee Meeting Action: Accept

1971-72 Log #68 FAE-SPF **Final Action: Accept**
(6.2.15.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-2.15.1 Five specimens of helmet chin straps shall be tested ~~Helmet chin straps for flammability testing~~ Specimens shall be at least 305 mm (12.0 in.) in length by the widest width of chin strap used on the helmet.
Substantiation: The number of specimens should be specified.
Committee Meeting Action: Accept

1971-73 Log #67 FAE-SPF **Final Action: Accept**
(6.2.15.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add text to read as follows:
6-2.15.3 Samples for conditioning shall be full chin straps.
Renumber current 6-2.15.3 as 6-12.15.4.
Substantiation: No conditioning is currently specified in the standard for chin straps.
Committee Meeting Action: Accept

1971-74 Log #66 FAE-SPF **Final Action: Accept**
(6.2.15.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new paragraph:
"6-2.15.4 The specimen holder shall be modified to permit the testing of narrow specimens. The distances between the inside metal sides of the specimen holder shall be a minimum of 20 mm (4/5 in.) wide."
Substantiation: Many web materials may too narrow for the specimen holder. The modification of the specimen holder to accommodate these narrow specimens presents the most practice means of testing these items.
Committee Meeting Action: Accept

1971-75 Log #107 FAE-SPF **Final Action: Reject**
(6.3.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise sections 6-3.4.1 thru 6-3.4.3 to read as follows:
Recommended revised flame test apparatus for helmets:
6-3.4.1 The test apparatus shall consist of a burner, crucible tongs, support stand, utility clamp, stopwatch, butane gas, gas regulator valve system, and measuring scale.
(a) The burner shall be a high temperature, liquefied petroleum gas type Fisher burner.
(b) The stopwatch or other timing device shall measure the burning time to the nearest 0.1s.
(c) The butane shall be of commercial grade, 99.0 percent pure or better.
(d) The gas regulator system shall consist of a control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 17.3 kPa ± 1.7 kPa (2.5 psi ± 0.25 psi) at the reducing valve. The flame height shall be adjusted at the reducing valve producing a pressure of 0.7 kPa, ± 0.07 kPa (0.1 psi, ± 0.01 psi).
6-3.4.2 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.
6-3.4.3 A specimen support assembly shall be used to support the helmet specimen above the burner flame.

Substantiation: Garment materials are currently tested with a Bunsen style burner with the edge exposed 19 mm into a 38 mm high flame. However, gloves and footwear are tested as whole item or in composite form using a larger 75 mm high flame. Therefore, the approach used in helmet testing is inconsistent with the approach used for other full scale items.
Committee Meeting Action: Reject
Committee Statement: The proposed method is difficult to get a consistent flame height and is not believed to be appropriate for helmets. The current test is a recognized test for industrial applications and modifications have been made to further improve consistency.

1971-76 Log #112 FAE-SPF **Final Action: Accept in Principle**
(6.3.5.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text as follows:
6-3.5.2 The tip of the inner cone of a Bunsen burner flame of 25 to 38 mm (1 in. to 1 1/2 in.) in length shall be placed at the outer edge of the helmet shell at the front, sides, and rear , and on the underside of the helmet brim at the sides and rear such that the outer diameter of the burner barrel contacts the ear flaps with the top of the burner barrel one-half the distance of the flame height from the lowest parallel surface of the underside of the helmet brim. Where a helmet hangar is provided, the test flame shall be applied off the end of the helmet hangar at the shell edge.
Substantiation: The current test procedures are not sufficiently specified to provide uniform testing of all portions of the helmet. A manufacturer could use different materials of construction in the helmet that are susceptible to flame contact and flaming and yet those portions of the helmet would not be tested. The current provisions already recognize testing of different materials (a helmet hanger).
Committee Meeting Action: Accept in Principle
Add new text as follows.

7.2.21 (5-2.21) Where provided, faceshield/goggle component attachment hardware shall be tested for flame resistance as specified in 8.3 (6.3) Flame Resistance Test Two, Procedure D, and shall not show any visible afterflame 5.0 seconds after removal of the test flame.

8.3.5 Procedure A

8.3.5.1 The helmet shall be positioned on the ISO size J headform specified in Figure 8-16.4.1 according to the helmet's positioning index.

Modify Figure 8.3.5.1 and make it Figure 8.3.5.2 –

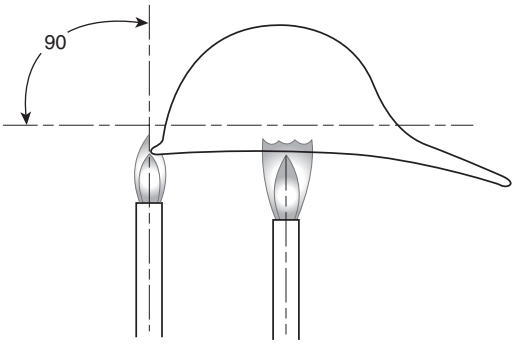


Figure 8.3.5.1

8.3.5.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ±1.5mm (2.0 in ± 1/16 in) blue flame with an inner cone of 25mm ± 1.5mm (1.0 in ± 1/16in). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200ºC ±100°C (2192°F ± 180ºF). The tip of the inner cone of the flame shall then be applied to the helmet shell from below the helmet at an angle of 90º to the basic plane as shown in Figure 8.3.5.2:

- at the intersection of the front edge of the brim and the midsagittal plane
- at the intersection of the each side edge of the brim and the coronal plane.
- at one random location on the brim to be determined by test laboratory.

8.3.5.3 The flame shall be applied for 15 seconds, +1/-0 second, the flame shall then be removed and the duration of the afterflame and afterglow shall be measured and recorded.

8.3.6 Procedure B

8.3.6.1 Specimens of faceshield/goggle components shall be attached to an appropriate test fixture so that the lower edge of the specimen is exposed. The test setup shall be as shown in Figure 8.3.6.1.

8.3.6.2 The flame of the Bunsen burner shall be adjusted to produce a 50mm ±1.5mm (2.0 in ± 1/16 in) blue flame with an inner cone of 25 mm ± 1.5mm (1.0in ± 1/16in). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200ºC ±100°C (2192°F ± 180ºF). The tip of the inner cone of the flame shall then be applied to the outer edge of the specimen at the lowest exposed edge of the specimen. The burner shall be held to the test point of the specimen at an angle of 45 degrees, ± 10 degrees.

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

8.3.7 Procedure C

8.3.7.1 The helmet shall be positioned on the ISO size J headform specified in Figure 8.16.4.1 according to the helmet's positioning index. The helmet shall then be placed under the radiant heat source specified in 8.1.6.4, with the basic plane of the headform parallel to the radiant heat source as shown in Figure 8.3.7.1.

8.3.7.2 The flame of the Bunsen burner shall be adjusted to produce a 50mm ±1.5mm (2.0 in ± 1/16 in) blue flame with an inner cone of 25 mm ± 1.5mm (1.0in ± 1/16in). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200ºC ±100°C (2192°F ± 180ºF).

8.3.7.3 Sample helmets shall be positioned so that the area to be tested receives a radiant heat flux of 1.0 W/cm^2 ±0.1 W/cm^2. After 60 seconds, +5/-0 seconds, exposure to the radiant flux and without removing the radiant heat source, the tip of the inner cone of the Bunsen burner flame shall be applied against the helmet test area. The application of the flame shall create an angle of 45 degrees, ±10 degrees, with the plane tangent to the test area at the point of contact.

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

8.3.8 Procedure D

8.3.8.1 Sample helmets with faceshield/goggle component attachment hardware in place shall be positioned on the ISO size J headform specified in Figure 8.16.4.1 according to the helmet's positioning index.

8.3.8.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ±1.5mm (2.0 in ± 1/16 in) blue flame with an inner cone of 25mm ± 1.5mm (1.0 in ± 1/16in). The temperature of the flame at the tip of the inner cone shall be measured and shall be 1200ºC ±100°C (2192°F ± 180ºF). The tip of the inner cone of the flame shall then be applied to each faceshield/goggle component attachment hardware location along the helmet brim line from below the brim of the helmet at an angle of 90º to the basic plane.

8.3.8.3 The flame shall be applied for 15 seconds, +1/-0 second, the flame shall then be removed and the duration of the afterflame and afterglow shall be measured and recorded.

8.3.9 Report.

8.3.9.1 Afterflame times shall be reported for each specimen at each flame impingement location.

8.3.9.2 The afterflame times shall be reported to the nearest 0.2 second.

8.3.10 Interpretation.

8.3.10.1 Pass/fail performance shall be based on the longest measured afterflame time.

Committee Statement: The Committee agrees with the intent of the proposal. However, the Committee has modified the flame test and those changes are preferred.
Committee Statement: The Committee agreed with the submitter's intent however the Committee made additional revisions to the test method renumbering and reformatting as necessary.

1971-77 Log #110 FAE-SPF **Final Action: Accept in Principle**
(6.4.2.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new text as follows:
6-4.2.4 Where the glove construction utilizes different composites in its construction, each different composite and its seams shall be tested.
Substantiation: There is no specification in the test method to address testing of additional areas of the gloves if those areas are different from primary composite used in the gloves composite.

Committee Meeting Action: Accept in Principle
Add new text as follows.
8.4 Flame Resistance Test Three
8.4.1 Application .
8.4.1.1 (New) This test method shall apply to protective gloves and glove gauntlets.
8.4.1.2 (New) Modifications to this test method for evaluation of glove body shall be as specified in 8.4.8
8.4.1.3 (New) Modifications to this test method for evaluation of glove gauntlets shall be as specified in 8.4.9
8.4.2 Specimens.
8.4.2.1 Three specimens shall be tested for each material.
8.4.3 Sample Preparation.
8.4.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2
8.4.3.2 All specimens to be tested shall be conditioned as specified in 8.1.3
8.4.8 (New) **Specific Requirements for Testing Glove Body Composites**
8.4.8.1 (New) Samples for conditioning shall be glove composite pouches as specified in 8.4.8.3.
8.4.8.2 (New) Specimens shall be representative of each glove body composite construction.
8.4.8.3 (New) For glove body composites, specimens for conditioning shall be in the form of an 200 mm X 200 mm (8 in. x 8 in.) pouch. The pouch will be made of two glove body composite swatches. The two composite swatches will be 200 mm X 200 mm (8 in. x 8 in.) and shall be constructed to simulate the actual layers of the glove, arranged in proper order. Each of the two composite swatches shall be stitched on all four sides using the same thread as used in the glove construction. The two composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction. (Addresses log 110).
8.4.8.4 (New) After conditioning, the pouch and necessary stitching shall be cut to form 50 mm x 150 mm (2 in. x 6 in.) specimens for testing.
8.4.9 (New) **Specific Requirements for Testing Protective Glove Gauntlets.**
8.4.9.1 (New) Samples for conditioning shall be glove gauntlet composite swatches as specified in 8.4.9.3.
8.4.9.2 (New) Specimens shall be representative of the glove gauntlet composite construction.
8.4.9.3 (New) For glove gauntlet composites, Samples for conditioning shall include glove material that is a minimum of 200 mm (8 in.) square consisting of the composite used in the actual glove gauntlet construction with the layers arranged in proper order and stitched using the same thread used in the construction of the glove gauntlet.
8.4.9.4 (New) After conditioning, the necessary stitching shall be cut to form 50 mm x 150 mm (2 in. x 6 in.) specimens for testing.
Committee Statement: The Committee agreed with the submitter's intent however, the Committee made additional revisions to the test method renumbering and reformatting as necessary.

1971-78 Log #31 FAE-SPF **Final Action: Accept**
(6.4.4.1, 6.5.4.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-6.4.1 The test apparatus shall consist of a burner, crucible tongs, support stand, utility clamp, stopwatch, butane gas, gas regulator valve system, and measuring scale.
(a) The burner shall be a high temperature, liquefied petroleum type Fisher burner.
(b) The stop watch or other device shall measure the burning time to the nearest 0.1 s.
(c) The butane shall be of commercial grade, 99.0 percent pure or better.
(d) The gas regulator valve system shall consist of a control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 17.3 kPa ± 1.7 kPa (2.5 psi ± 0.25 psi) at the reducing valve. The flame height shall be adjusted at the reducing valve producing a pressure at the burning of approximately 0.7 kPa (0.1 psi).
Substantiation: The specified test method is being discontinued.
Committee Meeting Action: Accept

1971-79 Log #111 FAE-SPF **Final Action: Accept**
(6.5.5.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text as follows:
6-5.5.2 With the specimen mounted in the support assembly, the burner shall be moved so that the flame contacts the specimen at a distance of 38 mm (1 1/2) at the angles in the areas shown in Figure 6-5.5.2 , and any additional areas at an angle of 90 degrees where the design of the footwear employs different materials or construction methods.
Substantiation: There is no specification in the est method to address testing of additional areas of the footwear if those areas are different from primary composite used in the gloves composite.
Committee Meeting Action: Accept

1971-80 Log #64 FAE-SPF **Final Action: Accept**
(6.6.4.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change paragraph to read:
"The test oven shall be horizontal flow circulating oven with minimum interior dimensions so that specimens can be suspended and are at last 50 mm (2 in.) from any interior oven surface. Unless otherwise specified, the spacing between specimens shall be at least 50 mm (2 in.). "
Substantiation: Separation between specimens will vary with the type of item being specified.
Committee Meeting Action: Accept

1971-81 Log #65 FAE-SPF **Final Action: Accept**
(6.6.4.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add text to read as follows:
6-6.4.1 The test oven shall be a horizontal flow circulating oven with minimum interior dimensions so that specimens can be suspended and are at least 50 mm (2 in.) from any interior oven surface. Unless otherwise specified, the spacing between specimens shall be at least 50 mm (2 in.).
Substantiation: Separation between specimens will vary with the type of item being specified.
Committee Meeting Action: Accept

1971-82 Log #63 FAE-SPF **Final Action: Accept**
(6.6.12.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add to end of paragraph:
" Only one helmet shall be tested at a time. "
Substantiation: Regardless of there size of the oven, only one helmet specimen should be tested at a time due to heat sink effects.
Committee Meeting Action: Accept

1971-83 Log #62 FAE-SPF **Final Action: Accept**
(6.6.13.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change second and third sentence to read:
"The opening of the glove shall be clamped together, and the specimens 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 and not less than 150 mm (6 in.) from specimens, and the airflow is parallel to the plane of the material."
Substantiation: The proposed language provides consistency in testing large items to avoid heat sink effects.
Committee Meeting Action: Accept

1971-84 Log #61 FAE-SPF **Final Action: Accept**
(6.6.14.6)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change to read:
"The footwear specimen shall be placed in the center of the test oven with the centerline of the front of the specimen facing the airflow. Only the footwear specimen shall be tested at a time."
Substantiation: The proposed language provides consistency in testing large items to avoid heat sink effects.
Committee Meeting Action: Accept

1971-85 Log #60 FAE-SPF **Final Action: Accept in Principle**
(6.7.2.1 , 6.7.7.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change to read:
"6-7.2.1 Samples for conditioning shall be whole gloves and boots. It shall be permitted to condition samples of glove composites that meet the specimen requirements specified in 6-7.7.2.
6-7.2.2 Specimens shall measure 100 mm x 150 mm (4 in. x 6 in.) and shall be stitched around the perimeter using the same thread used in the glove construction."
Substantiation: This procedure provides for more efficient testing without any compromise of the test procedures.
Committee Meeting Action: Accept in Principle
Revise text as follows.
8.7.2 Samples for conditioning shall be whole ~~gloves and~~ boots and glove composite pouches as specified in 8.7.7.2 .
8.7.4 (a) Specimens shall be tested using an exposure temperature of 280ºC (536ºF). ~~The pressure applied during the test shall be 3.45kPa, ±0.35 kPa (0.5 psi, ±0.05 psi).~~ The pressure applied during the test shall be as specified in 8.7.7 and 8.7.8 .

8.7.7 Specific Requirements for Testing Gloves

8.7.7.1 Specimens shall be representative of the glove body composite construction at the palm of the hand, palm side of the fingers, and at the back of the hand from the finger crotch to 25mm (1") beyond the wrist crease and includes the back of the thumb .

8.7.7.2 ~~Specimens shall be stitched around the perimeter using the same thread used in glove construction.~~ Specimens for conditioning shall be in the form of an 200 mm x 200 mm (8in. x 8in.) pouch. The pouch will be made of two glove body composite swatches. The two composite swatches will be 200 mm x 200 mm (8in. x 8in.) and shall be constructed to simulate the actual layers of the glove, arranged in proper order. Each of the two composite swatches shall be stitched on all four sides using the same thread as used in the glove construction. The two composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction . (This addresses log 60)

8.7.7.3 Specimens shall be tested after being subjected to the procedure specified in 8.1.3 both before and after laundering as specified in 8.1.2.

8.7.7.4 Specimens shall also be tested after being subjected to wet conditioning as specified in 8.1.8 both before and after laundering as specified in 8.1.2.

8.7.7.X (New) After the specimens are conditioned as specified above in 8.7.7.3 and 8.7.7.4, the pouch and necessary stitching shall be cut to form 100 mm x 150 mm (4in. x 6in.) specimens for testing.

8.7.7.5 Testing shall be performed as specified in 8.7.2 through 8.7.6. _

8.7.7.X (New) The pressure applied during the test shall be 3.45kPa, ±0.35 kPa (0.5 psi, ±0.05 psi) for specimens representative of the glove body composite construction at the palm of the hand and the palm side of the fingers.

8.7.7.X (New) The pressure applied during the test shall be 8g/cm2, ±0.8 g/cm2 (2 psi, ±0.2 psi) for specimens representative of the glove body composite construction at the back of the hand.

Committee Statement: The Committee agreed with the submitter's intent however the Committee made additional revisions to the test method renumbering and reformatting as necessary.

1971-86 Log #85 FAE-SPF **Final Action: Accept in Principle (6.10)**

Submitter: Richard Young, DuPont

Recommendation: Revise text to read as follows:

6-10.5.3 Test Procedure

6-10.5.3.5 The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 6-10.5.4.1. The start time of the exposure shall be indicated. Data will be collected during the 10 sec exposure and for 45 sec after the shutter has been engaged (closed). The exposure to cause a second-degree burn with stored energy will be determined for each composite. After data acquisition the recorder shall be stopped, the calorimeter shall be removed and cooled, and then the specimen holder and exposed sample shall be removed. The test is continued until an exposure that results in a second degree burn is determined.

6-10.5.5 Determination of Test Results.

The potential for a second-degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 6-10.5.4.1. The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the exposure start time resulting from heat transfer. The horizontal axis (time) shall be placed in line with the initial trace of the pen, keeping the overlay square with the recorder chart.

Substantiation: Current TPP rating system does not accurately rate protection from burn injury. New method includes stored energy which can cause burns long after initial explosion.

Figure shows the performance of a turnout composite using standard TPP performance criteria and Stored Energy TPP performance. The measured heat energy using the standard TPP crosses the Stoll curve after 21 sec, resulting in a TPP rating of 42. Utilizing the modified procedure, it can be seen that a second-degree burn injury can occur after only 9 seconds of exposure. Burn Injury occurs 17 seconds after the heat source is removed because of stored energy within the sample.

Committee Meeting Action: Accept in Principle

Add new text as follows.

Performance requirement:

7.1.x Garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for heat momentum as specified in 8.xx, Heat Momentum Test, and shall have an average time to burn of not less than 12 seconds.

Test Method:

8.xx Heat Momentum Test

8.xx.1 Application. This test method shall apply to multilayer protective garment composites.

8.xx.2 Samples

8.xx.2.1 Samples shall consist of outer shell, moisture barrier, and thermal barrier. Winter liners shall not be included in the test composite. Samples shall not include seams.

8.xx.2.2 All samples shall first be preconditioned as specified in 8.1.3

8.xx.3 Specimen Preparation

8.xx.3.1 A minimum of six specimens shall be tested.

8.xx.3.2 The specimens shall measure 150 mm x 150 mm, +/- 6 mm (6 in x 6 in, +/- _ in), and shall consist of the three base layers representative of the clothing item to be tested. Specimens shall not be stitched to hold individual layers together during testing.

8.xx.3.3 For dry condition testing only, no further preconditioning shall be conducted.

8.xx.3.4 For wet condition testing only, the innermost layer of the composite specimen shall then be further conditioned as follows prior to testing:

(1) Blotter paper measuring 225 mm x 225 mm (9 in x 9 in) shall be saturated in distilled water.

(2) Two sheets of the saturated blotter paper shall be run together through a wringer that meets the requirements of 10.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test.*

(3) The innermost layer of the composite specimen shall be placed between the two sheets of blotting paper.

(4) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be placed into a 4-L (1-gal) size air- and liquid tight bag and the bag shall be sealed closed.

(5) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be conditioned in the air- and liquid tight bag at room temperature for at least 24 hours, and shall not be removed from conditioning more than 5 minutes prior to testing.

(6) After removal from conditioning, the innermost layer shall be removed from the blotting paper, and the composite specimen shall be reassembled with all layers arranged in the same order and orientation as intended to be worn.

8.xx.4 Apparatus

(insert all language from 8.10.4)

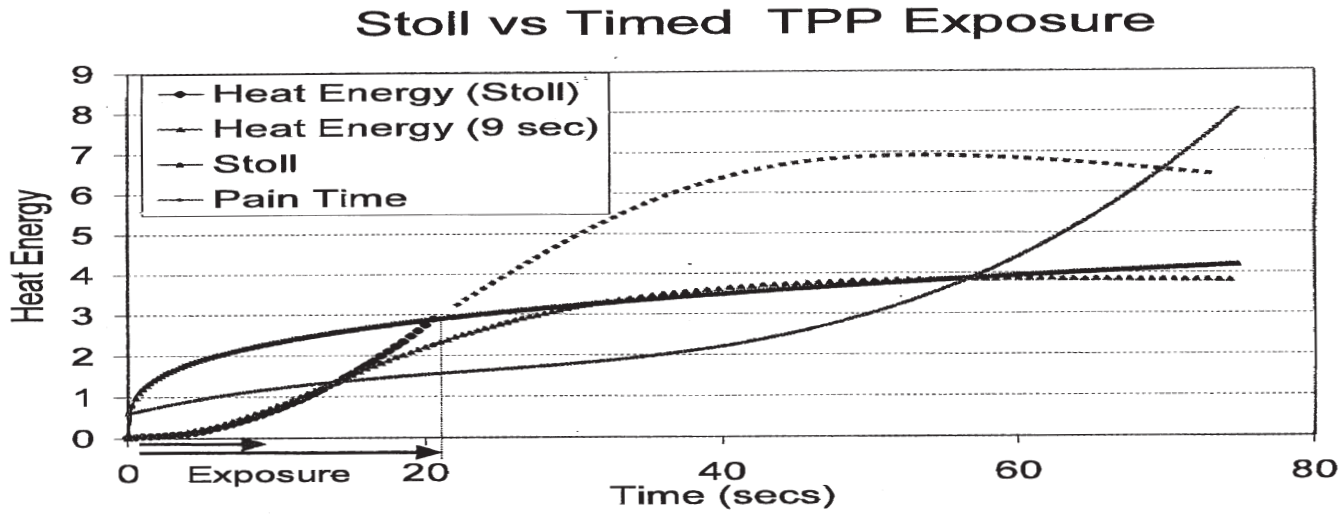
8.xx.5 Procedure.

8.xx.5.1 General Procedures - insert language from 8.10.5.1.1 through 8.10.5.1.2

8.xx.5.2 Calibration Procedure – insert language from 8.10.5.2.1 through 8.10.5.2.6

8.xx.5.3 Test Procedure

8.xx.5.3.1 insert 8.10.5.3.1



8.xx.5.3.2 insert 8.10.5.3.2
8.xx.5.3.3 insert 8.10.5.3.3
8.xx.5.3.4 insert 8.10.5.3.4
8.xx.5.3.5 The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 8.10.5.4.1. The start time of the exposure shall be indicated and the exposure shall be continued for 10 seconds. The protective shutter shall be engaged (closed), and the data acquisition shall continue for an additional 45 seconds.
8.xx.5.3.6 insert 8.10.5.3.6
8.xx.5.3.7 insert 8.10.5.3.7 and sub-paragraphs
8.xx.5.4 Preparation of Human Tissue Burn Tolerance Overlay.
8.xx.5.4.1 insert 8.10.5.4.1
8.xx.5.4.2 Computer Processing of the Data. The information provided in Table 8.10.5.4.1 shall be permitted to be used as the criteria of performance in the software of a computer program. In this case, the sensor response shall be compared with the thermal response, either pain sensation or second-degree burn in human tissue to determine the thermal end points.
8.xx.5.5 Determination of Test Results
8.xx.5.5.1 insert 8.10.5.5.1
8.xx.5.5.1.1 insert 8.10.5.5.1.1
8.xx.6 Report
8.xx.6.1 The individual Time to Burn of each specimen shall be reported. The average Time to Burn for dry and average Time to Burn for wet shall be separately calculated and reported. If no burn injury occurs, then the Time to Burn shall be reported as "no burn."
8.xx.7 Interpretation
8.xx.7.1 Pass/fail determination for the wet condition test specimens shall be based on the average reported Time to Burn of all wet specimens tested. Pass/fail determination for the dry condition test specimens shall be based on the average reported Time to Burn of all dry specimens tested. Failure of either the wet condition test set or the dry condition test set shall constitute failing performance.
8.xx.7.2 If no burn is achieved, this shall constitute passing performance.
8.xx.7.3 If an individual result from any test set varies more than +/- 8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.
Committee Statement: The Committee agreed with the submitter's intent however instead of modifying the existing TPP test, the Committee has included a new performance requirement and new Heat Momentum Test.

1971-87 Log #89 FAE-SPF **Final Action: Accept**
(6.10.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-10.3 Sample Preparation. Specimens shall be ~~tested both before and after the preconditioning as specified in 6-1.2 and then~~ conditioned as specified in 6-1.3.
Substantiation: An enormous amount of thermal protective performance (TPP) testing is conducted on different three layer composites to permit listing different material systems to NFPA 1971. In all cases that I am aware of, the TPP rating for washed composite samples always yields a higher TPP rating than unwashed or pristine specimens. Testing of composite TPP in a pristine state will not affect the compliance of existing composites and will significantly reduce the test burden for manufacturers and material suppliers.
Committee Meeting Action: Accept

1971-88 Log #97 FAE-SPF **Final Action: Accept in Principle**
(6.12)

Submitter: Charles Dunn, Soutern Mills inc.
Recommendation: Add text to read as follows:
6.12.5 Report
6.12.5.1 The rear resistance of an individual specimen shall be the average of the five highest peak loads of resistance registered. The trap tear of each specimen shall be reported to the nearest 0.5 N (0.1 lbf) of force.
6.12.5.2 An average trap tear strength shall be calculated of warp and filling directions.
6.12.5.3 In the event that fabric or filament strands slip through the clamps of the testing device during testing, the data from that test shall be disregarded and not used in the calculation of the average trap tear strength. If slipping does occur it is recommended that higher force clamps be used for the test.
Substantiation: The current ASTM D 5733 trap tear test method, which is used in the NFPA 1971, does not disallow tear results that occur if the fabric slips in the jaws of the Instron tester. With the increased use of filament yarns in outer shell fabrics this is becoming a significant issue, which results in inconsistent and artificially high-test results. Frequently, when filament yarns are used with spun yarns in a rip stop constructed fabric; the filament yarns pull through the clamp jaws while the spun yarns break. The proposed change to the standard would eliminate this problem.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 1971-89 (Log #59). ASTM D5587 is the more appropriate reference standard and this addresses the issue of seam slippage.

1971-89 Log #59 FAE-SPF **Final Action: Accept**
(6.12.4, 7.12.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change reference to ASTM D5587, Standard Test Method for Tearing Strength of Fabrics by Trapezoid Procedure.
Add to list of standards in Section 7-1.2.3.
Substantiation: ASTM D5587 is a more appropriate test method for measuring range of turnout clothing materials.
Committee Meeting Action: Accept

1971-90 Log #58 FAE-SPF **Final Action: Accept**
(6.13.3.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-13.3.1 Specimens shall be ~~conditioned~~ tested after being subjected to the conditioning as specified in 6-1.3 and after conditioning as specified in 6-1.2 followed by conditioning as specified in 6-1.3.
Substantiation: Burst testing of knit materials should be conducted both before and after laundering for consistency with other test methods and use of knit materials in the protective ensemble.
Committee Meeting Action: Accept

1971-91 Log #57 FAE-SPF **Final Action: Accept**
(6.13.3.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-13.3.2 Samples for conditioning shall be I-m (1-yd) square of material for knit materials provided in roll form, and in 1-m (1-yd) length for knit materials provided in tubular form.
Substantiation: Knit materials can also be provided in tubular form.
Committee Meeting Action: Accept

1971-92 Log #49 FAE-SPF **Final Action: Accept**
(6.14.2.2.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: 6-14.2.2.1 Where two pieces of woven garment fabric are jointed, the woven fabric seam specimen shall be prepared as specified in 8.2.1.2 of ASTM D1683, Standard Test Method for Failure in Sewn Seams of Woven Fabrics, and shall use the same thread, scam type, and stitch type as used in the finished garment. Specimens shall measure 200 by 100 mm (8 x 4 in.) with the seam bisecting the long dimension of the specimen.
Substantiation: The specimen size is much larger than needed.
Committee Meeting Action: Accept

1971-93 Log #56 FAE-SPF **Final Action: Accept**
(6.18.3.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: 6-18.3.1 Samples for conditioning shall be complete footwear toe sections , including any removable insoles.
Substantiation: Footwear should be tested in the manner in which it is used, including any removable inserts.
Committee Meeting Action: Accept

1971-94 Log #54 FAE-SPF **Final Action: Accept in Principle**
(6.20.3.1 and 6.20.7.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add text to read as follows:
6-20.3.1 Sample for conditioning shall be whole gloves and boots. It shall be permitted to condition samples of gloves composites that meet the specimen requirements specified in 6-20.7.2.
6-20.7.2 (new) Specimens shall measure 150 mm square (6 in. square) and shall be stitched around the perimeter using the same thread used in the glove construction.
Substantiation: This procedure provides for more efficient testing without any compromise of the test procedures.
Committee Meeting Action: Accept in Principle
Revise text as follows.
8.20 Puncture Resistance Test One
8.20.1 Application. ~~This test method shall apply to protective gloves and footwear uppers.~~
8.20.1.1 (New) This test method shall apply to protective gloves and footwear uppers.
8.20.1.2 (New) Modifications to this test method for evaluation of gloves shall be as specified in 8.20.7.
8.20.1.3 (New) Modifications to this test method for evaluation of footwear uppers shall be as specified in 8.20.8.
8.20.3.1 Samples for conditioning shall be complete ~~gloves or~~ footwear upper sections and glove composite pouches as specified in 8.20.7.2.

8.20.7 Specific Requirements for Testing Gloves

8.20.7.1 Specimens shall ~~consist~~ be representative of ~~each~~ the glove body composite construction of the palm, palm side of the fingers, and back of the ~~glove~~ hand ~~used in the actual glove construction with the layers arranged in proper order~~. Where the specimen composites of the palm, palm side of the fingers, and back of the glove are identical, only one representative composite shall be required to be tested.

8.20.7.2 ~~Glove specimens shall also be tested after wet conditioning as specified in 6-1.8.~~ Specimens for conditioning shall be in the form of an 200 mm x 200 mm (8in. x 8in.) pouch. The pouch will be made of two glove body composite swatches. The two composite swatches will be 200 mm x 200 mm (8in. x 8in.) and shall be constructed to simulate the actual layers of the glove, arranged in proper order. Each of the two composite swatches shall be stitched on all four sides using the same thread as used in the glove construction. The two composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction. (This addresses log 54)

8.20.7.3 ~~Testing shall be performed as specified in 6-20.2 through 6-20.6.~~ Glove specimens shall also be tested after wet conditioning as specified in 8.1.8.

8.20.7.4 (New) After the specimens are conditioned as specified above in 8.20.3.2 and 8.20.7.2, the pouch and necessary stitching shall be cut to form 150 mm x 150 mm (6 in. x 6 in.) specimens for testing.

8.20.7.5 (New) Testing shall be performed as specified in 8.20.2 through 8.20.6.

Committee Statement: The Committee agreed with the submitter's intent however the Committee made additional revisions to the test method renumbering and reformatting as necessary. The Committee also felt that larger specimens are also appropriate for this test method.

1971-95 Log #53 FAE-SPF **Final Action: Accept**
(6.20.3.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-20.3.2 Specimens shall be conditioning as specified in 6-1.3.
Substantiation: Editorial correction.
Committee Meeting Action: Accept

1971-96 Log #55 FAE-SPF **Final Action: Accept**
(6.20.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-20.5 Report. the puncture force in N (lbf) shall be reported for each puncture on each specimen. The average puncture force in N (lbf) shall be reported for all specimens tested.
Substantiation: In the current language, it is not clear that each specimen is subjected to three separate punctures.
Committee Meeting Action: Accept

1971-97 Log #52 FAE-SPF **Final Action: Accept**
(6.21.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: 6-21.5 Report. The puncture force in N (lbf) shall be reported ~~necessary to~~ for each puncture ~~the sole reinforcement device~~ on each specimen shall be reported.
Substantiation: In the current language, it is not clear that each specimen is subjected to three separate punctures.
Committee Meeting Action: Accept

1971-98 Log #51 FAE-SPF **Final Action: Accept**
(6.22.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: 6-22.4 Procedure. Specimens shall be evaluated in accordance with ASTM F1790, Test Methods for Measuring cut Resistance of Materials Used in Protective Clothing, with the following modifications:
(a) Specimens shall be tested to a specific load with the measurement of cut distance.
(b) A total of three cuts shall be made on each specimen.
Substantiation: In the current language, it is not clear that each specimen should be subjected to three separate cuts.
Committee Meeting Action: Accept

1971-99 Log #50 FAE-SPF **Final Action: Accept**
(6.22.5.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: 6-22.5.1 The cut distance shall be reported to the nearest 1 mm (3/64 in.) for each cut on each specimen.
Substantiation: In the current language, it is not clear that each specimen is subjected to three separate cuts.
Committee Meeting Action: Accept

1971-100 Log #20 FAE-SPF **Final Action: Reject**
(6.26)

NOTE:This proposal appeared as Comment 1971-235 (Log #22) which was held from the F99 ROC on Proposal 1971-132
Submitter: Donald Aldridge, Lion Apparel, Inc.
Recommendation: Delete Section 6-26.2 and 6-26.4 and replace with the following:
6-26.2 Specimens.
6-26.2.1 Three specimens of outer shell material and collar lining material measuring at least 203 mm x 203 mm (8 in. x 8 in.) shall be tested separately for water absorption.
6-26.3.1 Specimens shall be tested after being subject to the procedure specified in 6-1.2.
6-26.4 Procedure.
6-26.4.1 Specimens shall be tested in accordance with Method 5504, "Water Resistance of Coated Cloth: Spray Absorption Method," of Federal Test Method Standard 191A, Textile Test Method, with the following modification. The amount of water to be used shall be 5,500 ml. This can be accomplished by pouring 11 - 500 ml containers of water into the funnel one after another or by keeping the funnel 1/2 to 2/3 full with a constant stream of water for 10 min. If you use the constant stream method, measure down from the top of the funnel 2 and 1/2 in. and place a mark on the funnel. The water level in the funnel must remain at this level for the entire 10 min. At the end of the 10 min time frame place a container over the funnel end to stop any additional water which is in the funnel from spraying onto the test sample.
6-26.4.2 For collar lining materials, the exposure surface shall be the surface of the fabric that is next to the skin when the collar is closed in the raised position.
Substantiation: The test in the document has little support due to the test variances found between labs. Although the replacement method has a great deal of variances between labs it has been used in the past and will have a greater level of acceptance. By increasing the water exposure from less than 1 min to 10 min the test will more replicate actual exposure in the field. If a 20 min exposure is desired then the amount of water can be doubled or the amount of time can be increased to 20 min. We use a 20 min spray test in our shower test already and it would be easy to support using a 20 min exposure on this test also. The reason to keep the funnel 1/2 to 2/3 full is to better replicate the amount of pressure on the water in the funnel when you allow the funnel to start almost full and run down to almost empty.
Backup Information for Section 6-26.
To obtain the correct amount of water for this proposed test the following test were run:
1. The amount of time it takes for 500 ml to pass through the funnel is 56 sec.
2. 11 (500 ml) containers were poured into the funnel one after the other as soon as the funnel would accept the next 500 ml. It took 10 min to pass 5,500 ml through the nozzle. This test was run twice and the results were the same.
3. A continuous flow of water was allowed to flow into a full funnel for 5 min and the water was caught in a container when it came out the spray nozzle. The water was then measured and 3,675 ml of water had passed through the nozzle in 5 min. If you double this amount you will get 7,350 ml in 10 min. A constant flow with a full funnel will allow 1/3 more water to pass through the spray nozzle in 10 min than when you pour 500 ml one after the other into the funnel.
4. If you keep the water level at 2 and 1/2 in. down from the top edge of the funnel (the funnel is between 1/2 and 2/3 full) and you allow the water to run continuously the time to get 500 ml through the nozzle is 55.5 sec. This data was obtained by using a stop watch and placing a container under the nozzle and when the 500 ml mark on the container was reached it was removed and the stop watch was stopped. Seven (7) different tests were done to confirm that the 2 1/2 in. measurement is correct.
The above test indicates that the #4 solution is about equal to the #1 solution and #2 solution.
Committee Meeting Action: Reject

Committee Statement: The Committee believes the current test method is appropriate and adequate, and that the proposed method would not be an improvement.

1971-101 Log #32 FAE-SPF **Final Action: Accept**
(6.26)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-26 Water Absorption Resistance Test.
6-26 Application. This test method shall apply to the protective garment outer shell and collar lining materials.
6-26.2 Specimens. Three specimens of outer shell material and collar lining material measuring at least 200 mm x 200 mm (8 in. x 8 in.) shall be tested separately for water absorption.
6-26.3 Sample Preparation.
6-26.3.1 Samples for conditioning shall be at least 1 m (1 yd) square of each material.

6-26.3.2 Specimens to be tested shall be tested after being subjected to the procedure specified in 6-.1.2.

6-26.4 Apparatus. The test apparatus shall be as specified in AATCC 42, Water Resistance: Impact Penetration Test, with the following modifications:

(a) A metal roller approximately 115 mm (4.5 in.) long and weighing 1 kg (2.25 lbs) shall be used.

(b) Metal embroidery hoops, measuring 150 to 180 mm (6 to 7 in.) in diameter shall be used for mounting the specimen.

6-26.5 Procedure.

6-26.5.1 The conditioned specimen shall be securely mounted in the metal embroidery hoops with sufficient tension to ensure a uniformly smooth surface.

6-26.5.2 The direction of the flow of water down the specimen shall coincide with the warpwise direction of the specimen as placed on the stand.

6-26.5.3 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 angle with the horizontal.

6-26.5.4 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.

6-26.5.5 The following operations shall then be executed as rapidly as possible:

(a) The specimen shall be removed from the hoops and placed between sheets of blotting paper on a flat horizontal surface. The metal roller shall be tolled quickly forward and back one time over the paper without application of any pressure other than the weight of the roller.

(b) A square 102 by 102 mm (4 in. x 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.

(c) The same 102 mm (4 in.) square shall be conditioned as specified in 6-1.2 until it has dried and reached moisture equilibrium with the surrounding standard atmosphere for textiles. Following this conditioning it shall be reweighed. This weight shall be designated the "dry weight".

6-26.5.6 The percent water absorption shall be calculated using the following equation:

Percent water absorption = [(Wet Weight - Dry Weight)/(Dry Weight)] x 100

6-26.6 Report. The percent water absorption for each specimen shall be reported. The average percent water absorption for all tested specimens shall be calculated and reported.

6-26.7 Interpretation. The average percent water absorption shall be used to determine pass/fail performance.

Substantiation: The cited test method will no longer be available as the government phases out federal test methods.

Committee Meeting Action: Accept

1971-102 Log #13 FAE-SPF **Final Action: Reject**
(6.26.4, Chapter 7)

NOTE:This proposal appeared as Comment 1971-240 (Log #153) which was held from the F99 ROC on Proposal 1971-132

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: Revise paragraph to read:

6-26.4 Specimens shall be tested in accordance with AATCC 42, Water Resistance: Impact Penetration Test.

Add new test method reference to Chapter 7.

Substantiation: The proposed test method (AATCC 70) results in generally a 3-fold increase in fabric weight due to the immersion process used for exposing specimens. This exposure process does not simulate real exposure any better than the formerly specified test method (FTMS 191A, 5504). Despite the change in the test method and the concurrent impact on materials, no change in the performance criterion has been recommended. The test method suggested in this comment reflects the AATCC method most similar to the incumbent method (FTMS 191A, 5504).

Committee Meeting Action: Reject

Committee Statement: The Committee believes the current test method is appropriate and adequate, and that the proposed method would not be an improvement. Also see Committee Action on 1971-101 (Log #32).

1971-103 Log #46 FAE-SPF **Final Action: Accept**
(6.28.4.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: Change item (2) to read, "Battery acid (37 percent by weight ~~w/w~~ sulfuric acid to water) ."

Substantiation: Provides greater clarity to concentration of chemical.

Committee Meeting Action: Accept

1971-104 Log #47 FAE-SPF **Final Action: Reject**
(6.28.4.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: Delete item "(3) Fire-resistant hydraulic fluid, phosphate ester base" from the list of chemicals.

Substantiation: The hydraulic fluid, while representative of a fireground chemical, represents a poor liquid challenge due to its high viscosity, high surface tension, and low degradation effects. The other chemicals provide an adequate assessment of moisture barrier resistance to liquids.

Committee Meeting Action: Reject

Committee Statement: Deleting hydraulic fluid would do away with a chemical group, and for that reason the Committee believes it should not be eliminated.

1971-105 Log #45 FAE-SPF **Final Action: Accept in Principle in Part**
(6.28.7.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: Change first sentence to read, "...and shall consist of a comosite constructed using a layer of outer shell material ~~7.5 oz natural Nomex~~ , the moisture barrier, a layer of ~~Q9~~ thermal barrier material, and another layer of outer shell material ~~7.5 oz natural Nomex.~~ "

Substantiation: Provides greater flexibility in creating test samples.

Committee Meeting Action: Accept in Principle in Part

Revise text as follows.

6.28.7.1 "…and shall consist of a composite constructed using a layer of 7.5 oz natural Nomex, the moisture barrier, a layer of 3.8 oz, ±0.3 oz aramid needle punched non woven, quilted to 3.4oz, ±0.2 oz aramid woven plain weave thermal barrier material, and another layer of 7.5 oz natural Nomex.

Committee Statement: The Committee is rejecting the concept of replacing specific materials with generic terms. The Committee believes specificity is important for consistency. The Committee is accepting the deletion of Q9 as the thermal barrier material, however, wishes to designate a specific thermal barrier.

1971-106 Log #42 FAE-SPF **Final Action: Accept in Principle**
(6.28.8.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Recommendation: Add new text to the end of paragraph to read as follows:

If same barrier material is used throughout the construction of the glove, then it shall be permitted to take only specimens from the seams.

Substantiation: Seams represent the weakest part of the glove liner for liquid challenges; adequate performance of seams indicates that the material will also perform adequately.

Committee Meeting Action: Accept in Principle

8.28 Liquid Penetration Resistance Test

8.28.1.1 This test shall apply to garment moisture barrier materials and moisture barrier seams, gloves moisture barriers and moisture barrier seams , and footwear.

8.28.1.3 Modifications to this test method for testing gloves moisture barriers and moisture barrier seams shall be as specified in 8.28.8.

8.28.8 Specific Requirements for Testing Glove ~~materials~~ Moisture Barriers and Moisture Barrier Seams

8.28.8.1 ~~Three specimens each shall be taken from the sample gloves at the palm, back, and seam areas.~~ Specimens shall be representative of the glove moisture barrier and moisture barrier seams.

8.28.8.2 ~~Samples for conditioning shall be whole gloves~~ . Samples for conditioning shall be in the form of an 200 mm x 200 mm (8 in. x 8 in.) pouch and shall consist of a composite constructed to simulate a glove body composite using the following layers and construction:

Layer 1: 3.0 – 3.5 osy cowsplit leather
Layer 2: Glove Moisture Barrier
Layer 3: 7 – 10 osy Modacrylic knit
Layer 4: 7 – 10 osy Moadacylic knit
Layer 5: Glove Moisture Barrier
Layer 6: 3.0 – 3.5 osy cowsplit leather

In cases where the thermal liner and barrier are combined, the Modacrylic knits may be omitted from the composite. Where the moisture barrier material is continuous throughout the glove body, the moisture barrier layers shall contain a seam. The seam shall run within 25mm (1 in.) of the center and shall extend across the entire width of the specimen. Layers 1, 2, and 3 shall be stitched together on all four sides. Layers 4, 5, and 6 shall also be stitched together on all four sides. The two resulting composite swatches shall then be stitched together, inner liner to inner liner, on three sides. All stitching shall be done with an inherently flame and heat resistant thread. All layers shall be positioned in proper order as would be the orientation of the layers in the actual glove.

8.28.8.3 ~~Testing shall be performed as specified in 6-28.2 through 6-28.6.~~ The glove moisture barrier layers shall be removed from the multi-layer composite samples after all preconditioning has been completed and shall become the glove barrier test specimen.

8.28.8.4 Specimens for testing shall be ~~permitted to be~~ the barrier layer only.

8.28.8.5 (New) Testing shall be performed as specified in 8.28.2 through 8.28.6.

8.28.8.6 (New) Where the moisture barrier material is continuous throughout the glove body, only the barrier seams will be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

Committee Statement: The Committee agreed with the submitter's intent however the Committee made additional revisions to the test method renumbering and reformatting as necessary.

1971-107 Log #43 FAE-SPF **Final Action: Accept**
(6.29.4)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new text to the end of paragraph to read as follows:
The normal outer surface of the material shall be exposed to the viral challenge as oriented in the clothing item.
Substantiation: Ensure that correct surface is exposed to the viral challenge.
Committee Meeting Action: Accept

1971-108 Log #18 FAE-SPF **Final Action: Reject**
(6.29.4.1)

NOTE:This proposal appeared as Comment 1971-256 (Log #201) which was held from the F99 ROC on Proposal 1971-132
Submitter: Frank P. Taylor, Lion Apparel Inc.
Recommendation: Revise the Liquid Penetration resistance testing for moisture barriers and moisture barrier seams, gloves and footwear, add goggles and faceshields and wherever applicable make it composite vs. components test as follows:
Delete from: " ~~shall be conducted in accordance with ASTM F 1671, Standard Test Method for Resistance of Materials used in Protective Clothing to Penetration by Bloodborne Pathogens using Phi X 174 Bacteriophage as a test system.~~ "
Add: " shall be conducted in accordance with appropriately modified ASTM F 1862, Standard Test Method for Resistance of Medical Face Masks to Penetration by Synthetic Blood (Horizontal Projection of fixed volume at Known Velocity). See article from the February 1999 issue of ASTM Standardization News for a description of ASTM F 1862. "
Substantiation: The current test method cannot test composites that represent the PPE (Structural Protective Clothing, footwear and gloves, add goggles and faceshields) as worn by emergency responders. ASTM F 1862 will allow for blood penetration testing to be conducted on conditioned material specimens oriented in the same way as worn in the field. The test method (ASTM F 1862) can be modified to project synthetic blood at a selected worst case velocity at worst case conditioned composites of protective clothing, gloves, footwear and headwear used by fire department emergency responders. This new test method appears to better replicate field exposures experienced by emergency responders than ASTM F 1671 which can only manage the moisture barrier components of FF PPE.
The current test method, ASTM F 1671, does not accommodate inline production quality control testing of barrier materials or sealed seams on a timely basis. A modified ASTM F 1862 appears to accommodate quality control testing on sealed seam samples in the plant as they are produced.
Note: Supporting material is available for review at NFPA Headquarters.
Committee Meeting Action: Reject
Committee Statement: After discussion, the Committee felt, and the submitter who was present agreed, that this was not an appropriate test method for this Standard.

1971-109 Log #44 FAE-SPF **Final Action: Accept in Principle in Part**
(6.29.7.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Change first sentence to read, "...and shall consist of a composite constructed using a layer of outer shell material ~~7.5 oz natural Nomex,~~ the moisture barrier, a layer of ~~Q9~~ thermal barrier material, and another layer of outer shell material ~~7.5 oz natural Nomex."~~
Substantiation: Provides greater flexibility in creating test samples.
Committee Meeting Action: Accept in Principle in Part
Committee Statement: See Committee Action on 1971-105 (Log #45).

1971-110 Log #41 FAE-SPF **Final Action: Accept in Principle**
(6.29.8.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new text to the end of paragraph to read as follows:
If same barrier material is used throughout the construction of the glove, then it shall be permitted to take only specimens from the seams.
Substantiation: Seams represent the weakest part of the glove liner for viral challenges; adequate performance of seams indicates that the material will also perform adequately.
Committee Meeting Action: Accept in Principle
8.29 Viral Penetration Resistance Test
8.29.1.1 This test shall apply to garment moisture barrier materials and moisture barrier seams, gloves moisture barriers , and footwear.
8.29.1.3 Modifications to this test method for testing gloves moisture barriers and moisture barrier seams shall be as specified in 8.29.8.
8.29.8 Specific Requirements for Testing Glove ~~materials~~ Moisture Barriers and Moisture Barrier Seams
8.29.8.1 ~~Three specimens each shall be taken from the sample gloves at the palm, back, and seam areas.~~ Specimens shall be representative of the glove moisture barrier and moisture barrier seams.
8.29.8.2 ~~Samples for conditioning shall be whole gloves~~ . Samples for conditioning shall be in the form of an 200mm x 200mm (8in. x 8in.) pouch and shall consist of a composite constructed to simulate a glove body composite using the following layers and construction:
Layer 1: 3.0 – 3.5 osy cowsplit leather
Layer 2: Glove Moisture Barrier
Layer 3: 7 – 10 osy Modacrylic knit
Layer 4: 7 – 10 osy Moadacylic knit
Layer 5: Glove Moisture Barrier
Layer 6: 3.0 – 3.5 osy cowsplit leather
In cases where the thermal liner and barrier are combined, the Modacrylic knits may be omitted from the composite. Where the moisture barrier material is continuous throughout the glove body, the moisture barrier layers shall contain a seam. The seam shall run within 25mm (1 in.) of the center and shall extend across the entire width of the specimen. Layers 1, 2, and 3 shall be stitched together on all four sides. Layers 4, 5, and 6 shall also be stitched together on all four sides. The two resulting composite swatches shall then be stitched together, inner liner to inner liner, on three sides. All stitching shall be done with an inherently flame and heat resistant thread. All layers shall be positioned in proper order as would be the orientation of the layers in the actual glove.
8.29.8.3 ~~Testing shall be as described in 6-29.2 through 6-29.6.~~ The glove moisture barrier layers shall be removed from the multi-layer composite samples after all preconditiong has been completed and shall become the glove barrier test specimen.
8.29.8.4 Specimens for testing shall be the barrier layer only.
8.29.8.5 (New) Testing shall be as described in 8.29.2 through 8.29.6.
8.28.8.6 (New) Where the moisture barrier material is continuous throughout the glove body, only the barrier seams will be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

Committee Statement: The Committee agreed with the submitter's intent however the Committee made additional revisions to the test method renumbering and reformatting as necessary.

1971-111 Log #40 FAE-SPF **Final Action: Accept**
(6.30.1.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-30.1.1 This test method shall apply to hardware items on protective garments, helmets, gloves, footwear, and partial eye/face protective devices that contain any metallic components.
Substantiation: It is not necessary to evaluate the corrosion resistance of non-metallic items.
Committee Meeting Action: Accept

1971-112 Log #39 FAE-SPF **Final Action: Accept**
(6.33.3.2 and 6.33.3.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-33.3.2 Specimens shall first be conditioned as specified in 6-1.5 and then conditioned as specified in 6-1.2 prior to testing."
Delete 6-33.3.3.
Substantiation: The proposed change reduces the number of test replicates, while preserving the more rigorous challenge.
Committee Meeting Action: Accept

1971-113 Log #38 FAE-SPF **Final Action: Accept**
(6.33.5.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
The test subject shall immerse the glove specimen to within 64 mm (2.5 in.) ~~25 mm (1 in.)~~ of the top of the body of the glove specimen for 5 minutes in 20°C, ± 3°C (68°F, ± 5°F) water treated with a surfactant to lower its surface tension to 34 dynes/cm, ± 5 dynes/cm. The test subject shall flex the glove specimen in a fist-clenching motion every ~~10~~ 30 seconds.
Substantiation: The proposed change will improve the efficiency of the testing; will not appreciably alter the severity of the test.
Committee Meeting Action: Accept

1971-114 Log #37 FAE-SPF **Final Action: Accept**
(6.34.2.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Delete paragraph.
Substantiation: ASTM F 1868 permits different sizes of sweating hot plates.
Committee Meeting Action: Accept

1971-115 Log #36 FAE-SPF **Final Action: Accept**
(6.42.7.1)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-42.7.1 For testing label legibility after laundering, specimens shall include individual labels sewn or heat sealed onto a 1 m (1 yd) square of ballast material or other fabric meeting the requirements of this standard no closer than 51 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.
Substantiation: The proposed change permits heat sealing of labels for those garments that may use heat scaled labels.
Committee Meeting Action: Accept

1971-116 Log #35 FAE-SPF **Final Action: Reject**
(6.46.3.3)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
6-46.3.3 The fluorescence shall be evaluated as specified in 6-46.4.2, 2 minutes, +/- 15 seconds after the rainfall exposure has been started.
Substantiation: Corrects omission in standard.
Committee Meeting Action: Reject
Committee Statement: Rainfall cannot degrade the fluorescent quality of a material. The fluorescent component is an inherent quality of a material. Further, it cannot be measured/qualified according to new requirements proposed by 1971-49 (Log #17) during rainfall. Also see Committee Action on 1971-49 (Log #17).

1971-117 Log #121 FAE-SPF **Final Action: Reject**
(6.48.4)

Submitter: Bill Grilliot, Morning Pride Mfg L.L.C
Recommendation: Add a provision for the test apparatus to have one of the arms bent 90° at the elbow (fore arm parallel to the ground) - remainder of apparatus stays the same.
Substantiation: Should test arm/wrist area in more than just current straight down arm orientation - the suggested 90° additional orientation would provide a more reliable indication of suitability of construction for fire service use.
Committee Meeting Action: Reject
Committee Statement: The Committee did not feel bending one elbow added anything to the test method, but that it could adversely provide additional variability to the test.

1971-118 Log #27 FAE-SPF **Final Action: Accept**
(6.48.5(6))

Submitter: Harry P. Winer, U.S. Navy
Recommendation: Revise text to read as follows:
The suited mannequin shall be exposed to the liquid spray for a total of ~~20~~ 8 minutes, ~~25~~ 2 minutes in each of the four mannequin orientations.
Substantiation: This text will standardize method between NFPA 1999 and 1971.
Committee Meeting Action: Accept

1971-119 Log #34 FAE-SPF **Final Action: Accept in Principle**
(6.48.9.2 and 6.48.10.2)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Add new text to the end of paragraph as follows:
Suspenders shall be permitted to be used in securing the the trousers to the mannequin.
Substantiation: Provide flexibility for using suspenders in dressing mannequin.
Committee Meeting Action: Accept in Principle
Add new text as follows.
6.48.9.2 Suspenders shall be permitted to be used in securing the trousers to the mannequin, if they are designed to be worn with suspenders.
Committee Statement: The committee reworded the submitter's text to preclude using suspenders if the garment was not designed to accept them.

1971-120 Log #33 FAE-SPF **Final Action: Accept**
(6.48.9.4 and 6.48.10.5)

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.
Recommendation: Revise text to read as follows:
Absorbent toweling or similar material shall be permitted to be placed underneath the mannequin in order to prevent water splashing up inside the trouser leg.
Substantiation: The specified technique is not always necessary.
Committee Meeting Action: Accept

1971-121 Log #94 FAE-SPF **Final Action: Reject**
(6.51)

Submitter: Kevin J. O'Connell, Louisville Fire & Rescue
Recommendation: Change all the appropriate wording in this test method to eliminate testing of dry samples, thereby leaving the test method with three iterations of wet sample testing.
Substantiation: Based on discussion and a review of test data submitted, the Garment Task Group determined that, although heat resistance in compression areas is important with dry garments, this test method reveals wet samples as, almost always, generating lower CCHR rating numbers. Therefore, with the associated proposed change in the pass/fail criteria, three iterations of wet sample testing should meet the goal of enhanced protection in compression areas in garments that are either wet or dry.
Please note there is an associated proposal for the pass/fail criteria 5.1.23.
Committee Meeting Action: Reject
Committee Statement: Wet testing is not always the worst-case, and the Committee believes it is important to continue to test in both wet and dry condition. Also see Committee Action on 1971-77 (Log #100).

1971-122 Log #98 FAE-SPF **Final Action: Reject**
(6.51)

Submitter: Tim Durby, Phoenix Fire Department
Recommendation: Add text to read as follows:
Develop and add a new compression test for knees only. This test should compress a knee layup into a puddle (1 to 2 in. deep) of hot water (approximately 200°F).
Substantiation: I believe one cause of knee burns is from hot water on the floor soaking into the knee pad and under compression transmits the heat to the skin. this is different than water (sweat) in the thermal liner heated and then heat transfer occurs, CCHR test addresses this.
Committee Meeting Action: Reject
Committee Statement: The submitter proposed a concept, but did not provide a performance requirement or test method. The Committee was unable to develop an appropriate test method. However, the CCHR performance requirement which affects knees was increased. Also see Committee Action on 1971-52 (Log #100).

1971-123 Log #117 FAE-SPF **Final Action: Reject**
(6.51.3)

Submitter: Frank P. Taylor, Lion Apparel Inc.
Recommendation: Revise test to read as follows:
6-51.3 Specimen Preparation is its entirety should be moved into Section 6-1 Sample Preparation Procedures and renumbered accordingly.
Substantiation: Placement of the CCHR test sample/test specimen preparation procedures should be formatted, renumbered, and located in Section 6-1 instead of in the Test Method Section.
Committee Meeting Action: Reject
Committee Statement: This proposal is suggesting to move sample preparation text to the preconditioning section of the document. The text is in the correct location in the current document as it is sample preparation specific to the CCHR test and not preconditioning.

1971-124 Log #118 FAE-SPF **Final Action: Accept in Principle in Part**
(6.51.3.4)

Submitter: Frank P. Taylor, Lion Apparel Inc.
Recommendation: Add new text as follows:
6-51.3.4 Moisture in the amount equal to a 30% gain in wet weight of Aralite shall be applied to all specimens of the innermost layer of a liner system for all thermal bench top tests [example CCHR, SET, TPP, RPP, etc.]. The innermost layer of the composite specimen shall be placed between the two sheets of blotting paper.
6-1.X For wet Full Scale Thermal Manikin Testing the Sample Liner System Preparation shall be further conditioned as follows prior to testing:
[1] Remove liner system from shell and turn inside out.
[2] Cotton terry towels [approx. 50" x 29"] shall be saturated in distilled water.
[3] Run the wetted towel through a wringer to get the correct amount of moisture left in the towel. [To be established: The correct amount of moisture is equal to what it takes to transfer a 30% wet weight gain to an element liner system having Aralite as the thermal liner in contact the the wetted towel during conditioning].
[4] Lay the wetted towel on a flat surface. Place the liner system element on the towel when it is rolled up [coat include wristlet].
[5] Roll up the wetted towel with the liner system element inside it and seal in a plastic bag.
[6] The inner most layer of the elements liner system, rolled up in a wetted towel, shall be conditioned in the air and liquid tight bag at room temperature for at least 24 hours, and shall not be removed from conditioning more than 10 minutes prior to testing.
[7] After removal from conditioning, the liner system element shall be

removed from the towel, and reassembled with the outer shell with all layers arranged in the same order and orientation as intended to be worn and placed [doffed] on the manikin.

Substantiation: The original intent of the Thermal Task Group's creation of the wetting procedure for the CCHR test was to subject all test specimens to an equal amount of replicated sweat moisture. Moisture that is equal to a 30% wet weight gain in the 'Aralite' quilted thermal liner manufactured and marketed by Southern Mills, Inc. The current procedure is only able to get 20 to 23% into Aralite.

Use the same wet pre-conditioning procedure for all bench top thermal test methods. [And] Establish a wetting procedure for full-scale thermal manikin tests.

Similar to stored energy moisture storage also occurs. Stored moisture in areas of the inner most layer of a set of gear have been measured on the 'Aralite' thermal liner in areas where the fire fighters skin was in direct contact with the face cloth and where the skin and face cloth were separate by a 100% cotton beefy T-shirt.

Direct skin contact: Aralite gained 31.5% wet weight from sweat in simulated fire fighting activities that averaged 25 minutes duration in a moderate climate.

T-shirt contact: Aralite gained 13% wet weight from swear-saturated cotton T-shirt.

The worst case wetting occurs with direct skin contact. Stored moisture appears to be exposure time related more than any other factor and 25 minutes of wear/exposure time appears reasonable.

Committee Meeting Action: Accept in Principle in Part

Add new text as follows.

6.51.3.4 For wet condition testing only, Moisture in the amount equal to a 30% gain in wet weight of Aralite shall be applied to the innermost layer of the composite specimen and conditioned as follows prior to testing:

(1) Blotting paper measuring 225 mm x 225 mm (9 in. x 9 in.) shall be saturated in distilled water.

(2) Two sheets of the saturated blotter paper shall be run together through a wringer that meets the requirements of 10.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar dynamic Absorption Test.*

(3) The innermost layer of the composite specimen shall be placed between the two sheets of blotting paper.

(4) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be placed into a 4-L (1 gal) size air and liquid tight bag and the bag shall be sealed closed.

(5) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be conditioned in the air and liquid tight bag at room temperature for at least 24 hours, and shall not be removed from conditioning more than 5 minutes prior to testing.

(6) After removal from conditioning, the innermost layer shall be removed from the blotting paper, and the composite specimen shall be reassembled with all layers arranged in the same order and orientation as intended to be worn.

Committee Statement: The Committee is accepting the proposed new wetting procedure for the CCHR test only, and is revising the text provided by the submitter to reflect this. The Committee is rejecting the request to add the wetting procedure to the TPP and RPP test methods as well as the wetting procedure for whole garments as there are no whole garment tests being added in this edition of the standard.

NFPA 1971
Standard on
Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting
2006 Edition

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

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

Chapter 1 Administration

1.1* Scope.

1.1.1 This standard shall specify the minimum design, performance, testing, and certification requirements for structural fire fighting protective ensembles and ensemble elements that include coats, trousers, coveralls, helmets, gloves, footwear, and interface components.

1.1.2 This standard shall specify the minimum design, performance, testing, and certification requirements for proximity fire fighting protective ensembles and ensemble elements that include coats, trousers, coveralls, helmets, gloves, footwear, and interface components.

1.1.3 This standard shall also specify additional ***optional*** requirements for structural fire fighting protective ensembles, proximity fire fighting protective ensembles, and elements of both ensembles that will provide limited protection from specified chemical, biological, and radiological terrorism agents.

1.1.4 This standard shall specify requirements for *new* structural fire fighting protective ensembles, new proximity fire fighting protective ensembles, or new elements for both ensembles.

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

1.1.6 This standard shall not specify the respiratory protection that is necessary for proper protection with both protective ensembles.

1.1.7 Certification of compliant structural fire fighting protective ensembles, compliant proximity fire fighting protective ensembles, and compliant elements of both ensembles to the requirements of this standard shall not preclude certification to additional appropriate standards where the ensemble or element meets all the applicable requirements of each standard.

1.1.8 This standard shall not be construed as addressing all of 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 determine the applicability of regulatory limitations prior to use.

1.1.9 This standard shall not be construed as addressing all of the safety concerns, if any, associated with the use of this standard by testing facilities. 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 determine the applicability of regulatory limitations prior to using this standard for any designing, manufacturing, and testing.

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

1.2* Purpose.

1.2.1* The purpose of this standard shall be to establish minimum levels of protection for fire fighting personnel assigned to fire department operations including but not limited to structural fire fighting, proximity fire fighting, rescue, emergency medical, and other emergency first responder functions.

1.2.1.1 To achieve this purpose, this standard shall establish minimum requirements for structural fire fighting protective ensembles and ensemble elements designed to provide fire fighting personnel limited protection from thermal, physical, environmental, and bloodborne pathogen hazards encountered during structural fire fighting operations.

1.2.1.2 To achieve this purpose, this standard shall establish minimum requirements for proximity fire fighting protective ensembles and ensemble elements designed to provide fire fighting personnel limited protection from thermal exposures where high levels of radiant heat as well as convective and conductive heat are released, and from physical, environmental, and bloodborne pathogen hazards encountered during proximity fire fighting operations.

1.2.1.3 The purpose of this standard shall also be to establish an ***optional*** minimum level of protection for structural fire fighting and proximity fire fighting protective ensembles to provide limited protection from specified chemical and biological vapor, liquid splash, and particulate agents that could be encountered by fire fighters as first responders to terrorism incidents.

1.2.2 The purpose of this standard shall also be to establish a minimum level of protection for structural and proximity fire fighting personnel from specified chemical and biological terrorism agents in vapor, liquid splash, and particulate environments during chemical and biological terrorism incidents as an *option* for compliant structural fire fighting ensembles, for compliant proximity fire fighting ensembles, and for compliant elements for both ensembles.

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 shall not be utilized as a detailed manufacturing or purchasing 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 structural fire fighting protective ensembles, new proximity fire fighting protective ensembles, and new elements of both ensembles for protection from thermal, physical, environmental, and bloodborne pathogen hazards encountered during structural fire fighting operations.

1.3.2 This standard shall apply to the design, manufacturing, testing, and certification of new structural fire fighting protective ensembles, new proximity fire fighting protective ensembles, and new elements of both ensembles for the additional ***optional*** protection from specified chemical, biological, and radiological terrorism agents.

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

1.3.4 This standard shall not apply to any protective ensembles, ensemble elements, or protective clothing for any other types of fire fighting operations.

1.3.5 This standard shall not apply to structural fire fighting protective ensembles manufactured according to previous editions of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting.*

1.3.6 This standard shall not apply to structural fire fighting protective clothing and equipment manufactured according to past editions of NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*; NFPA 1972, *Standard on Helmets for Structural Fire Fighting*; NFPA 1973, *Standard on Gloves for Structural Fire Fighting*; and NFPA 1974, *Standard on Protective Footwear for Structural Fire Fighting.*

1.3.7 This standard shall not apply to proximity fire fighting protective ensembles manufactured according to previous editions of NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting.*

1.3.8 This standard shall not apply to proximity fire fighting protective clothing and equipment manufactured according to past editions of NFPA 1976, *Standard on Protective Clothing for Proximity Fire Fighting.*

1.3.9* This standard shall not apply to any accessories that could be attached to the certified product, before or after purchase, but are not necessary for the certified product to meet the requirements of this standard.

1.3.10 This standard shall not apply to the use of structural fire fighting protective ensembles, proximity fire fighting protective ensembles, or elements of these ensembles since these requirements are specified in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*.

1.4 Units.

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

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

Chapter 2 (Old Chapter 7) Referenced Publications

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

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

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2002 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service*, 2002 edition.

2.3 Other Publications.

2.3.1 AATCC Publication. American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, NC 27709.

AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test*, 1989.

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

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

ANSI Z34.1, *Standard for Third-Party Certification Programs for Products, Processes, and Services*, 1993.

ANSI Z41, *Standard for Personal Protection— Protective Footwear*, 1991.

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

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

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

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ASTM F 739, *Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact,* 1999a.

ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 1990.

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

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

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

ASTM F 1359, *Standard Practice for Evaluating the Liquid-Tight Integrity of Chemical Protective Clothing*, 1991.

ASTM F 1671, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X-174 Bacteriophage as a Test System*, 1995.

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

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

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FIA 1209, *Whole Shoe Flex*, 1984.

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Method 5512, *Water Resistance of Coated Cloth; High Range, Hydrostatic Pressure Method*, 20 July 1978.

Method 5903.1, *Flame Resistance of Cloth; Vertical*, 28 December 1989.

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ISO Guide 25, *General Requirements for the Competence of Calibration and Testing Laboratories,* 1990.

ISO 9001, *Quality Systems — Model for Quality Assurance in Design, Development, Production, Installation, and Servicing,* 1994.

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

SAE J211, *Instrumentation for Impact Test*, 1988.

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

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2.3.11 U.S. Department of Defense. Standardization Document Order Desk, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

A-A-55634, *Commercial Item Description Zippers (Fasteners, Slide Interlocking)*, March 20, 1998.

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

2.3.12 U.S. Military Publication. U.S. Army Developmental Test Command (DTC), ATTN: CSTE-DTC-TT-S, Aberdeen Proving Ground, MD 21005-5055

Test Operations Procedure (TOP 10-2-022), *Man-In-Simulant Test (MIST) - Chemical Vapor Testing of Chemical/Biological Protective Suits*, September 2001

Stoll, A. M. and M. A. Chianta, "Method and Rating System for Evaluation of Thermal Protection," *Aerospace Medicine*, vol. 40, 1968, pp. 1232–1238.

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* (1-3.2) Approved. Acceptable to the authority having jurisdiction.

3.2.2* (1-3.4) 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 (1-3.64) 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.*(See also definition 3.3.77 (3.3.xx1), Product Label.)*

3.2.4* (1-3.67) Listed. Equipment, materials, or services included in a list published by an over the top of the head in a plane perpendicular to the midsagittal plane.

3.3 General Definitions.

3.3.1 (1-3.1) Arch. The bottom curve of the foot from the heel to the ball.

3.3.2 (1-3.5) Barrier Material. The component or layer of material that limits liquid transfer from the face of the component or layer to the other side.

3.3.3 (1-3.6) Basic Plane. The anatomical plane on a headform that includes the superior rim of the external auditory meatus, the upper edge of the external openings of the ear, and the inferior margin of the orbit, which is the lowest point of the floor of the eye socket.

3.3.4 (1-3.8) Biological Terrorism Agents. Liquid or particulate agents that can consist of biologically derived toxin or pathogen to inflict lethal or incapacitating casualties.

3.3.5* (1-3.9) Bitragion Coronal Arc. The arc between the right and left tragion as measured over the top of the head in a plane perpendicular to the midsagittal plane.

3.3.6* (1-3.10) Bitragion Inion Arc. The arc between tragion as measured over the inion. For helmet test purposes, the bitragion inion arc is identified as Datum Plane 10 in Figures 8.15.4.1(a) [6-15.4.1(a)] through (c).

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

3.3.8 (1-3.11) Body Fluids. Fluids produced by the body including, but not limited to, blood, semen, mucus, feces, urine, vaginal secretions, breast milk, amniotic fluid, cerebrospinal fluid, synovial fluid, and pericardial fluid.

3.3.9 Bootie. A sock-like extension of the garment leg, covering the entire foot.

3.3.10 (1-3.12) Brim. The part of the helmet shell extending around the entire circumference of the helmet.

3.3.11 (1-3.13) Brim Line. The horizontal plane intersecting the point of the front opening of the helmet at the midsagittal plane.

3.3.12 (1-3.14) Cargo Pockets. Pockets located on the protective garment exterior.

3.3.13 (1-3.15) 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 compliance with the requirements of this standard.

3.3.14 (1-3.16) Certification Organization. An independent, third-party organization that determines product compliance with the requirements of this standard with a labeling/ listing/follow-up program.

3.3.15 (1-3.17) Char. The formation of a brittle residue when material is exposed to thermal energy.

3.3.16 Chemical/Biological/Particulate Barrier Layer. The part of a composite that is intended to provide a barrier of protection against chemical and biological terrorism agents.

3.3.17 Chemical/Biological Terrorism Agents. The term used to refer to chemical terrorism agents, biological terrorism agents, and dual-use industrial chemicals.

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

3.3.19 Chemical Warfare (CW) Agents. Liquid, solid, and gas chemical agents (most are liquids) traditionally used during warfare or armed conflict to kill or incapacitate an enemy.

3.3.20 (1-3.18) Chin Strap. The adjustable strap, fitting under the chin, to help secure the helmet to the head.

3.3.21 (1-3.19) Coat. See definitions of *structural fire fighting protective coat* and *proximity fire fighting protective coat.*

3.3.22 (1-3.20) Collar. The portion of a coat or coverall that encircles the neck.

3.3.23 (1-3.21) Collar Lining. The part of the collar fabric composite that is next to the skin when the collar is closed in the raised position.

3.3.24 (1-3.22) Compliance/Compliant. Meeting or exceeding all applicable requirements of this standard.

3.3.25 (1-3.23) Component. Any material, part, or subassembly used in the construction of the protective ensemble or any element of the protective ensemble. (*See also definition 3.3.61 (1-3.63), Interface Components.*)

3.3.26 (1-3.24) Composite. The layer or combination of layers of the protective ensemble or any element of the protective ensemble that provides the required protection.

3.3.27 (1-3.25) Coronal Plane. The anatomical plane perpendicular to both the basic and midsagittal planes and containing the midpoint of a line connecting the superior rims of the right and left auditory meatuses.

3.3.28 (1-3.26) Coverall. See definitions of *structural fire fighting protective coverall* and *proximity fire fighting protective coverall.*

3.3.29 (1-3.27) Crown. The portion of the helmet that covers the head above the reference plane.

3.3.30 (1-3.28) Crown Straps. The part of the helmet suspension that passes over the head.

3.3.31 (1-3.29) Dielectric Test Plane. A helmet term for the plane that runs from the intersection of the test line and midsagittal plane in the front of the headform diagonally through the headform to the intersection of the reference plane and midsagittal plane in the rear of the headform.

3.3.32 (1-3.30) Drip. To run or fall in drops or blobs.

3.3.33 (1-3.31) Ear Covers. The integral part of the helmet designed to extend over and provide limited protection for the ears that does not provide significant thermal protection.

3.3.34 (1-3.32) Elements. See definition of *ensemble elements.*

3.3.35 (1-3.33) Energy Absorbing System. The material, suspension system, or combination thereof incorporated into the design of the helmet to attenuate impact energy.

3.3.36 (1-3.34) Ensemble. See definitions of *structural fire fighting protective ensemble* and *proximity fire fighting protective ensemble.*

3.3.37 Ensemble Elements. The compliant products that provide protection to the upper and lower torso, arms, legs, head, hands, and feet.

3.3.38* (1-3.35) Entry Fire Fighting. Extraordinarily specialized fire-fighting operations that can include the activities of rescue, fire suppression, and property conservation at incidents involving fires producing extreme levels of radiant, conductive, and convective heat

3.3.39 (1-3.37) Faceshield. The component of the helmet that provides limited protection to a portion of the wearer's face. Not intended as primary eye protection.

3.3.40 (1-3.38) Faceshield/Goggle. The helmet component that is a faceshield, or goggles, or both.

3.3.41 (1-3.39) Flame Resistance. The property of a material whereby the application of a flaming or nonflaming source of ignition and the subsequent removal of the ignition source results in the termination of combustion. Flame resistance can be an inherent property of the material, or it can be imparted by specific treatment.

3.3.42 (1-3.40) Fluorescence. A process by which radiant flux of certain wavelengths is absorbed and reradiated nonthermally in other, usually longer, wavelengths.

3.3.43 (1-3.41) Follow-up Program. The sampling, inspection, tests, or other measures conducted by the certification organization on a periodic basis to determine the continued compliance of products listed that are being produced by the manufacturer to the requirements of this standard.

3.3.44* (1-3.42) Footwear. See definitions of *structural fire fighting protective footwear* and *proximity fire fighting protective footwear.*

3.3.45 Footwear Cover. A secondary boot worn over the footwear ensemble element or bootie for the purpose of providing physical protection to meet the requirements of this standard.

3.3.46 (1-3.43) Functional. The ability of an element or component of an element to continue to be utilized for its intended purpose.

3.3.47 (1-3.44) Garment(s). See definitions of *structural fire fighting protective garments* and *proximity fire fighting protective garments.*

3.3.48 (1-3.45) Gauntlet. The circular, flared, or otherwise expanded part of the glove that extends beyond the opening of the glove body. (*See also definition 3.3.47 (1-3.49), Glove Wristlet.*)

3.3.49 (1-3.46) Glove. See definitions of *structural fire fighting protective gloves* and *proximity fire fighting protective gloves.*

3.3.50 (1-3.48) Glove Liner. The innermost component of the glove body composite that comes into contact with the wearer's skin.

3.3.51 (1-3.49) Glove Wristlet. The circular, close-fitting part of the glove, usually made of knitted material, that extends beyond the opening of the glove body. (*See also definitions 3.3.43 (1-3.45), Gauntlet and 3.3.129 (1-3.135), Wristlet.*)

3.3.52 (1-3.50) Goggles. The helmet component intended to help protect the wearer's eyes and a portion of the wearer's face, not intended as primary eye protection. (*See also definition 3.3.36 (1-3.38), Faceshield/Goggle.*)

3.3.53 (1-3.51) Grading. The process of proportioning components for construction of an element.

3.3.54 (1-3.52) Hardware. Nonfabric components of the protective clothing and equipment including, but not limited to, those made of metal or plastic.

3.3.55 (1-3.53) Hazardous Chemicals. Any solid, liquid, gas, or mixture thereof that can potentially cause harm to the human body through respiration, ingestion, skin absorption, injection, or contact.

3.3.56 (1-3.54) Hazardous Materials Emergencies. Incidents involving the release or potential release of hazardous chemicals into the environment that can cause loss of life, personnel injury, or damage to property and the environment.

3.3.57 (1-3.55) Headband. The portion of the helmet suspension that encircles the head.

3.3.58 (1-3.56) Headform. A device that simulates the configuration of the human head.

3.3.59 (1-3.57) Helmet. See definitions of *structural fire fighting protective helmet* and *proximity fire fighting protective helmet.*

3.3.60 (1-3.59) Hood. See definitions of *structural fire fighting protective hood* and *proximity fire fighting protective hood.*

3.3.61 (1-3.60) Inherent Flame Resistant. As applied to textiles, flame resistance that is derived from an essential characteristic of the fiber or polymer from which the textile is made.

3.3.62 (1-3.61) Insole. The inner part of the protective footwear upon which the foot rests and that conforms to the bottom of the foot.

3.3.63 (1-3.62) Interface Area. An area of the body where the protective garments, helmet, gloves, footwear, or SCBA facepiece meet (i.e., the protective coat/helmet/SCBA facepiece area, protective coat/protective trouser area, the protective coat/glove area, and the protective trouser/footwear area).

3.3.64 (1-3.63) Interface Components. Elements of the protective ensemble that are designed to provide limited protection to interface areas.

3.3.65 (1-3.65) Ladder Shank. See definition 3.3.102 (1-3.107), Shank.

3.3.66 (1-3.66) Liquid Borne Pathogen. An infectious bacteria or virus carried in human, animal, or clinical body fluids, organs, or tissues.

3.3.67 (1-3.68) Lower Torso. The area of body below the waist including the legs but excluding the ankles and feet.

3.3.68 (1-3.69) Major A Seams. See definition 3.3.100 (1-3.104), Seams.

3.3.69 (1-3.70) Major B Seams. See definition 3.3.100 (1-3.104), Seams.

3.3.70 (1-3.71) Manufacturer. The entity that assumes the liability and provides the warranty for the compliant product.

3.3.71 (1-3.72) Melt. A response to heat by a material resulting in evidence of flowing or dripping.

3.3.72 (1-3.73) 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.

3.3.73 (1-3.74) Minor Seams. See definition 3.3.100 (1-3.104), Seams.

3.3.74 (1-3.75) Model. The collective term used to identify a group of individual elements of the same basic design and components from a single manufacturer produced by the same manufacturing and quality assurance procedures that are covered by the same certification.

3.3.75 (1-3.76) Model Weight. The basic weight of the helmet plus accessories for the specific model identified.

3.3.76 (1-3.77) Moisture Barrier. The portion of the composite designed to prevent the transfer of liquids.

3.3.77 (1-3.78) Nape Device. The device located below the bitragion inion arc used to aid in helmet retention.

3.3.78 Outer Garment. A secondary garment worn over the ensemble garment element for the purpose of providing the chemical / biological / particulate protection.

3.3.79 Outer Glove. A secondary glove worn over the glove ensemble element for the purpose of providing chemical / biological / particulate protection.

3.3.80 (1.3.79) Outer Shell. The outermost layer of the garment composite with the exception of trim, hardware, reinforcing material, and wristlet material.

3.3.81 Particulates. Solid matter that is dispersed in air as a mixture. For the purpose of this standard, particulates do not include aerosol, or suspended liquid droplets in air. Aerosols are considered liquids.

3.3.82 Percent Inward Leakage. The ratio of vapor concentration inside the ensemble versus the vapor concentration outside the ensemble expressed as a percentage.

3.3.83 (1-3.80) Product. The compliant protective ensemble or the compliant elements of the protective ensemble.

3.3.84 (1-3.81) Product Label. A label or marking affixed to each compliant element of a protective ensemble by the manufacturer. Such labels contain compliance statements, certification statements, general information, care, maintenance, or similar data. The product label is not the certification organization's label, symbol, or identifying mark;

however, the certification organization's label, symbol, or identifying mark can be attached to or be part of the product label. (*See also definition 3.2.3 (1-3.64), Labeled.*)

3.3.85 (1-3.82) Protective Clothing. See definitions of *structural fire fighting protective ensemble* and *proximity fire fighting protective ensemble.*

3.3.86 (1-3.83) Protective Coat. See definitions of *structural fire fighting protective coat* and *proximity fire fighting protective coat.*

3.3.87 (1-3.84) Protective Coverall. See definitions of *structural fire fighting protective coverall* and *proximity fire fighting protective coverall..*

3.3.88* (1-3.85) Protective Ensemble. See definitions of *structural fire fighting protective ensemble* and *proximity fire fighting protective ensemble.*

3.3.89 Protective Ensemble with Chemical/Biological/ Radiological (CBR) Terrorism Agent Protection. See definitions of *structural fire fighting protective ensemble* and *proximity fire fighting protective ensemble.*

3.3.90 (1-3.86) Protective Footwear. See definitions of *structural fire fighting protective footwear* and *proximity fire fighting protective footwear.*

3.3.91 (1-3.87) Protective Garment. See definitions of *structural fire fighting protective garments* and *proximity fire fighting protective garments.*

3.3.92 (1-3.88) Protective Gloves. See definitions of *structural fire fighting protective glove* and *proximity fire fighting protective gove..*

3.3.93 (1-3.89) Protective Helmet. See definitions of *structural fire fighting protective helmet* and *proximity fire fighting protective helmet.*

3.3.94 (1-3.90) Protective Hood. See definitions of *structural fire fighting protective hood* and *proximity fire fighting protective hood.*

3.3.95 (1-3.91) Protective Trousers. See definitions of *structural fire fighting protective trousers* and *proximity fire fighting protective trousers.*

3.3.96 (1-3.92) Protective Wristlet. See definition 3.3.129 (1-3.135), Wristlet.

3.3.97* (1-3.93) Proximity Fire Fighting. Specialized fire-fighting operations that can include the activities of rescue, fire suppression, and property conservation at incidents involving fires producing high levels of radiant heat as well as conductive and convective heat. Specialized thermal protection is necessary for persons involved in such operations due to the scope of these operations and the close distance to the fire at which these operations are conducted, although direct entry into flame is NOT made.

3.3.98 Proximity Fire-Fighting Protective Clothing. See definition 3.3.101, Proximity Fire-Fighting Protective Ensemble.

3.3.99 Proximity Fire-Fighting Protective Coat. The element of the protective ensemble that provides protection to upper torso and arms, excluding the hands and head.

3.3.100 Proximity Fire-Fighting Protective Coverall. The element of the protective ensemble that provides protection to the torso, arms, and legs, excluding the head, hands, and feet.

3.3.101 Proximity Fire-Fighting Protective Ensemble. Multiple elements of compliant protective clothing and equipment that when worn together provide protection from some, but not all, risks of emergency incident operations.

3.3.102 Proximity Fire-Fighting Ensemble with *Optional* Chemical/Biological/ Radiological Terrorism Agent Protection. A compliant proximity fire-fighting protective ensemble that is also certified as an entire ensemble to meet the optional requirements for protection from specific chemical, biological, and radiological particulate terrorism agents.

3.3.103* Proximity Fire-Fighting Protective Footwear. The element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.104 Proximity Fire-Fighting Protective Garment. The coat, trouser, or coverall elements of the protective ensemble.

3.3.105 Proximity Fire-Fighting Protective Glove. The element of the protective ensemble that provides protection to the hand and wrist.

3.3.106 Proximity Fire-Fighting Protective Helmet. The element of the protective ensemble that provides protection to the head.

3.3.107 Proximity Fire-Fighting Protective Hood. The interface element of the protective ensemble that provides limited protection to the coat/helmet/SCBA facepiece interface area.

3.3.108 Proximity Fire-Fighting Protective Shroud. The component of the helmet that provides limited protection to the helmet/coat facepiece interface area.

3.3.109 Proximity Fire Fighting Protective Trousers. The element of the protective ensemble that provides protection to the lower torso and legs, excluding the ankles and feet.

3.3.110 (1-3.94) Puncture-Resistant Device. The reinforcement to the bottom of protective footwear that is located between the sole with heel and the insole that is designed to provide puncture resistance.

3.3.111 (1-3.95) Radiological Agents. Radiation associated with X-rays, alpha, beta, and gamma emissions from radioactive isotopes or other materials in excess of normal background radiation levels.

3.3.112 (1-3.96) Recall System. The action by which a manufacturer identifies an element, provides notice to the users, withdraws an element from the marketplace and distribution sites, and returns the element to the manufacturer or other acceptable location for corrective action.

3.3.113 (1-3.97) Reference Plane. The plane that is 27.5 mm (1 5/64 in.) above and parallel to the basic plane on an ISO J headform *(see Figure 6.16.4.1 [6-16.4.1]).*

3.3.114 (1-3.98) Retention System. The complete assembly by which the helmet is retained in position on the head.

3.3.115 (1-3.99) Retroreflection. The reflection of light in which the reflected rays are preferentially returned in the direction close to the opposite of the direction of the incident rays, with this property being maintained over wide variations of the direction of the incident rays.

3.3.116 (1-3.100) Retroreflective Markings. A material that reflects and returns a relatively high proportion of light in a direction close to the direction from which it came.

3.3.117 (1-3.101) Sample. Protective ensemble elements taken from a manufacturer's current production lot. (*See also definition 3.3.104 (1-3.110), Specimen.*)

3.3.118 (1-3.102) Seam. Any permanent attachment of two or more materials in a line formed by joining the separate material pieces.

3.3.119 (1-3.103) Seam Assembly. The structure obtained where fabrics are joined by means of a seam.

3.3.120 (1-3.104) Seams.

3.3.120.1 (1-3.104.1) Major A Seams. Outermost layer seam assemblies where rupture could reduce the protection of the garment by exposing the inner layers such as the moisture barrier, the thermal barrier, the wearer's station/work uniform, other clothing, or skin.

3.3.120.2 (1-3.104.2) Major B Seams. Moisture barrier or thermal barrier seam assemblies where rupture could reduce the protection of the garment by exposing the next layer of the garment, the wearer's station/work uniform, other clothing, or skin.

3.3.120.3 (1-3.104.3) Minor Seams. Seam assemblies that are not classified as Major A or Major B seams.

3.3.121 (1-3.105) Separation. A material response evidenced by splitting or delamination.

3.3.122 (1-3.107) Shank. The reinforcement to the area of protective footwear designed to provide additional support for the instep when standing on a ladder rung. Also called Ladder Shank.

3.3.123 (1-3.108) Shell. The outermost layer of the protective ensemble element composite. (*See also definition 3.3.75 (1-3.79), Outer Shell.*)

3.3.124 (1-3.110) Specimen. The item that undergoes testing and is known as the sample in some cases.

3.3.125 (1-3.111) Structural Fire Fighting. The activities of rescue, fire suppression, and property conservation in buildings, enclosed structures, vehicles, marine vessels, or like properties that are involved in a fire or emergency situation.

3.3.126 (1-3.119) Structural Fire-Fighting Protective Clothing. See definition of *Structural Fire Fighting Protective Ensemble.*

3.3.127 (1-3.112) Structural Fire-Fighting Protective Coat. The element of the protective ensemble designed to provide minimum protection to upper torso and arms, excluding the hands and head.

3.3.128 (1-3.113) Structural Fire-Fighting Protective Coverall. The element of the protective ensemble configured as a single-piece garment and designed to provide minimum protection to the torso, arms, and legs, excluding the head, hands, and feet.

3.3.129* (1-3.114) Structural Fire-Fighting Protective Ensemble. Multiple elements of compliant protective clothing and equipment that when worn together provide protection from some risks, but not all risks, of emergency incident operations.

3.3.130 Structural Fire-Fighting Ensemble with *Optional* Chemical/Biological/ Radiological Terrorism Agent Protection. A compliant structural fire-fighting protective ensemble that is also certified as an entire ensemble to meet the optional requirements for protection from specific chemical, biological, and radiological particulate terrorism agents.

3.3.131 (1-3.115) Structural Fire-Fighting Protective Footwear. The element of the protective ensemble designed to provide minimum protection to the foot, ankle, and lower leg.

3.3.132 (1-3.116) Structural Fire-Fighting Protective Garments. The coat, trouser, or coverall elements of the protective ensemble

3.3.133 (1-3.117) Structural Fire-Fighting Protective Glove. The element of the protective ensemble that provides protection to the hand and wrist.

3.3.134 (1-3.118) Structural Fire-Fighting Protective Helmet. The element of the protective ensemble that provides protection to the head.

3.3.135 Structural Fire-Fighting Protective Hood. The interface element of the protective ensemble that provides limited protection to the coat/helmet/SCBA facepiece interface area.

3.3.136 (1-3.120) Structural Fire-Fighting Protective Trousers. The element of the protective ensemble that provides protection to the lower torso and legs, excluding the ankles and feet.

3.3.137 (1-3.121) Suspension. The energy-attenuating system of the helmet made up of the headband and crown straps.

3.3.138 (1-3.122) Sweatband. That part of a helmet headband, either integral or attached, that comes in contact with the wearer's forehead.

3.3.139 (1-3.123) Textile Fabric. A planar structure consisting of yarns or fibers.

3.3.140 (1-3.124) Thermal Barrier. The portion of protective ensemble element composites that is designed to provide thermal protection.

3.3.141 (1-3.125) Toecap. The reinforcement to the toe area of footwear designed to protect the toes from impact and compression.

3.3.142 (1-3.126) Top. The intersection between the midsagittal plane and the coronal plane extended to the helmet surface.

3.3.143 (1-3.127) Top Line. The top edge of the protective footwear that includes the tongue, gusset, quarter, collar, and shaft.

3.3.144 Toxic Industrial Chemicals. Highly toxic chemicals that have been identified as substances that could be used to inflict casualties, generally on a civilian population, during a terrorist attack. Can be liquid, solid, or gas agents.

3.3.145 (1-3.128) Trim. Retroreflective and fluorescent materials attached to the outermost surface of the protective ensemble element for visibility enhancement. Retroreflective materials enhance nighttime visibility, and fluorescent materials enhance daytime visibility.

3.3.146 (1-3.129) Trousers. See definitions of *structural fire fighting protective trousers* and *proximity fire fighting protective trousers.*

3.3.147* (1-3.130) Upper. The part of the protective footwear including, but not limited to, the toe, vamp, quarter, shaft, collar, and throat, but excluding the sole with heel, puncture-resistant device, and insole.

3.3.148 (1-3.131) Upper Torso. The area of body above the waist and extending to the shoulder, including the arms and wrists, but excluding the hands.

3.3.149 (1-3.132) Wear Surface. The bottom of the footwear sole, including the heel.

3.3.150 (1-3.134) Winter Liner. An optional component layer that provides added insulation against cold.

3.3.151 (1-3.135) Wristlet. An interface component element of the protective ensemble that is the circular, close-fitting extension of the coat sleeve, usually made of knitted material, designed to provide limited protection to the protective coat/glove interface area.

Chapter 4 (Old Chapter 2) Certification

4.1 General.

4.1.1 The process of certification for product as being compliant with NFPA 1971 shall meet the requirements of Section 4.1, General; Section 4.2, Certification Program; Section 4.3, Inspection and Testing; Section 4.4, Recertification; 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 product that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

4.1.2.1 The certification organization shall only permit the certification of complete protective ensembles, that include protective garments, protective helmet, protective gloves, protective footwear, and protective hood where the hood is not part of the protective garments, to the optional requirements for protection against chemical, biological, and radiological terrorism agents.

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

4.1.2.3 The respiratory protection shall be a specific model self-contained breathing apparatus (SCBA) that is certified as compliant with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services*, and also certified as CBRN SCBA by the National Institute for Occupational Safety and Health (NIOSH), as part of the ensemble.

4.1.3 All certification shall be performed by a certification organization that meets at least the requirements specified in Section 4.2, Certification Program, and that is accredited for personal protective equipment in accordance with ISO 65, *General requirements for bodies operating product certification systems.* The accreditation shall be issued by an accreditation body operating in accordance with ISO 17011, *General requirements for accreditation bodies accrediting conformity assessment bodies.*

4.1.4* Manufacturers shall not claim compliance with portions or segments of the requirements of this standard and shall not use the NFPA name or the name or identification of this standard, NFPA 1971, in any statements about their respective products unless the products are certified as compliant to this standard.

4.1.5 All compliant products shall be labeled and listed.

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

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

4.1.8 The certification organization shall not issue any new certifications to the 2000 editions of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, and NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, on or after the NFPA effective date for the 2006 edition which is XX February 2006.

4.1.9 The certification organization shall not permit any manufacturer to continue to label any products that are certified as compliant with the 2000 editions of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, and NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, on or after 1 September 2006.

4.1.10 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2000 editions of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, and NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, from all products that are under the control of the manufacturer on 1 September 2006, and the certification organization shall verify this action is taken.

4.2 Certification Program.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2.9.4 For products, components, and materials where prior testing, judgment, and experience of the certification organization have shown results to be, in jeopardy of not complying with this standard, the certification organization shall conduct more frequent testing of sample 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 reports of situations in which a compliant product is subsequently found to be hazardous.

4.2.11 The certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions. 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 compliant products, the certification organization shall conduct both inspection and testing as specified in this section.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.4 Recertification.

4.4.1 All products that are labeled as being compliant with this standard shall undergo recertification on an annual basis.

4.4.1.1 This recertification shall include inspection and evaluation to the design requirements and testing to the performance requirements as required by this standard on all manufacturers' compliant product models.

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

4.4.1.3 For the purpose of this standard, models shall include each unique pattern, style, or design of the compliant products.

4.4.2 Samples of manufacturer's models and components for recertification shall be acquired from the manufacturer or component supplier during random and unannounced visits as part of the follow-up program specified in 4.2.9.

4.4.2.1 For recertification, the certification organization shall acquire at least one complete compliant product.

4.4.2.2 The certification organization shall also acquire a sufficient quantity of components to be tested for recertification as required by 4.4.3.

4.4.3 Compliant products and components shall be inspected, evaluated, and tested as specified in 4.4.3.1 and 4.4.3.2. Inspection, evaluation, and testing performed as part of the follow-up program shall be permitted to be used for recertification to avoid duplication.

4.4.3.1 One sample of each compliant product shall be inspected and evaluated to the design requirements specified in Chapter 6.

4.4.3.2 One sample of each compliant product and component shall be tested for overall performance as specified in Chapter 7.

4.4.4 The manufacturer shall maintain all design, inspection, performance, and test data from the certification organization produced during the recertification of manufacturers' models and components. The manufacturer shall provide such data, upon request, to the purchaser or to the authority having jurisdiction.

4.5 Manufacturers' Quality Assurance Program.

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

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

4.5.3 The manufacturer shall be registered to ISO 9001, *Quality management systems – requirements.*

4.5.3.1 Registration to the requirements of ISO 9001 shall be conducted by a registrar that is accredited for personal protective equipment in accordance with ISO 62, *General requirements for bodies operating assessment and certification / registration of quality systems.* The registrar shall affix the accreditation mark on the ISO registration certificate.

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

4.5.4* Any entity that meets the definition of manufacturer specified in Section 3.3, General Definitions, and therefore is considered the "manufacturer" but does not manufacture or assemble the compliant product, shall meet the requirements specified in this Section 4.5.

4.5.5 Where the manufacturer uses sub-contractors or component manufacturers in construction or assembly of the compliant product, the locations and names of all manufacturing facilities, all sub-contractor facilities, and all component manufacturer facilities shall be documented and the documentation shall be provided to the manufacturer's ISO registrar, and to the certification organization.

4.5.5.1 Component manufacturers shall be considered as sub-contractors.

4.5.5.2 Subcontractors shall include but not be limited to a person or persons, or a company, firm, corporation, partnership, or other organization having an agreement with or under contract with the compliant product manufacturer to supply or assemble components of the compliant product, or to assemble portions of the compliant product.

4.5.5.3 The assembly portion of the manufacturing process shall include but not be limited to the sewing, gluing, laminating, tacking, or other means of attaching whereby materials or component parts are joined together to form a portion, a component, or a complete compliant product.

4.5.6 All sub-contractors, where different from the manufacturer, shall also be registered to the requirements of ISO 9001, *Quality management systems – requirements*, for manufacturing, unless the provisions specified in 4.5.6.1 and 4.5.6.2 apply.

4.5.6.1 The manufacturer shall be permitted to include subcontractors in the manufacturer's ISO 9001 registration in lieu of requiring the sub-contractor to have their own ISO registration.

4.5.6.2 Where the manufacturer applies their ISO registration to sub-contractors, this action shall require the inclusion of the subcontractors' addresses and functions on the manufacturer's ISO 9001 registration certificate, and the manufacturer shall provide the certification organization with copies of the ISO 9001 registrar's reports showing acceptable inclusion of these locations for the functions they perform for the manufacturer.

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 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 which results in exposing life, limb, or property to an imminently dangerous or dangerous condition.

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

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

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

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

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

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

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

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

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

(2) Notification of parties authorized and responsible for issuing a product recall when, in the opinion of the certification organization, such a recall is necessary to protect the users.

(3) Removing the mark of certification from the product.

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

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

4.6.13 Where a change to an NFPA standard(s) is felt to be necessary, the certification organization shall also provide a copy of the report and corrective actions indicated to the NFPA, and shall also submit either a Public Proposal for a proposed change to the next revision of the applicable standard, or a proposed Temporary Interim Amendment (TIA) to the current edition of the applicable standard.

4.7 Manufacturers' Investigation of Complaints and Returns.

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

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

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

4.8 Manufacturers' Safety Alert and Product Recall Systems.

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

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

(1) The establishment of a coordinator and responsibilities by the manufacturer for the handling of safety alerts and product recalls

(2) A method of notifying all dealers, distributors, purchasers, users, and the NFPA about the safety alert or product recall that can be initiated within a 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 product that is recalled and for documenting the effectiveness of the product recall

(5) A plan for either repairing, or replacing, or compensating purchasers for returned product

Chapter 5 (Old Chapter 3) Labeling and Information

5.1 (3-1) Product Label Requirements for Both Ensembles.

5.1.1* (3-1.1) Each element of both protective ensembles shall have at least one product label permanently and conspicuously located inside each element when the element is properly assembled with all layers and components in place.

5.1.2 (3-1.2) Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label. However, all label pieces comprising the product label shall be located adjacent to each other.

5.1.3* (3-1.3) The certification organization's label, symbol, or identifying mark shall be permanently attached to the product label or shall be part of the product label. All letters shall be at least 2.5 mm (3/32 in.) high. The label, symbol, or identifying mark shall be at least 6 mm (1/4 in.) in height and shall be placed in a conspicuous location.

5.1.4 (3-1.4) All worded portions of the required product label shall be printed at least in English.

5.1.5 (3-1.5) Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

5.1.6 (3-1.6) The compliance statements specified in Section 5.2 for structural fire fighting protective ensemble elements, for Section 5.3 for proximity fire fighting protective ensemble elements, shall be printed legibly on the product label.

5.1.7 (3-1.7) The following information shall also be printed legibly on the each product label with all letters at least 1.5 mm (1/16 in.) in height:

(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) Principle material(s) of construction

(9) Cleaning precautions

5.2 Additional Product Label Requirements for Structural Fire Fighting Ensemble Elements Only.

5.2.1 (3-1.6) The following compliance statement shall be printed legibly on the product label for each structural fire fighting protective ensemble element, unless the requirements in 5.2.1.1 prevail. The appropriate term for the element type — garment, helmet, glove, footwear, hood — shall be inserted in the compliance statement text where indicated. All product label letters and figures shall be at least 2.5 mm ($^{3}/_{32}$ in.) in height.

"THIS (insert appropriate element term here) **MEETS THE STRUCTURAL FIRE FIGHTING** (insert appropriate element term here) **REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLES FOR STRUCTURAL FIRE FIGHTING AND PROXIMITY FIRE FIGHTING**

2006 EDITION.

DO NOT REMOVE THIS LABEL."

5.2.1.1 Where an entire ensemble is also certified as compliant the optional requirements for protection against chemical, biological, and radiological terrorism agents, each element of the entire ensemble shall have at least the additional following compliance statement on the product label in place of the compliance statement specified in 5.2.1. The appropriate term for the element type — garment, helmet, glove, footwear, hood — shall be inserted in the compliance statement text where indicated. All product label letters and figures shall be at least 2.5 mm (3/32 in.) in height.

"THIS STRUCTURAL FIRE FIGHTING PROTECTIVE (insert appropriate element term here) **MEETS THE** (insert appropriate element term here) **REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLES FOR STRUCTURAL FIRE FIGHTING AND PROXIMITY FIRE FIGHTING, 2006 EDITION, AND THE OPTIONAL REQUIREMENTS FOR CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL PROTECTION, WHEN WORN TOGETHER WITH THE OTHER SPECIFIED PARTS OF THE ENSEMBLE."**

DO NOT REMOVE THIS LABEL."

5.2.1.2 The garment element of the ensemble meeting the optional requirements for protection against chemical, biological, and radiological terrorism agents shall list those items of the certified ensemble by manufacturer name and model number on the product label.

5.2.2 (3-1.8) Where other protective item(s) or detachable components must be used with structural fire fighting protective ensemble elements in order for an element to be compliant with this standard, at least the following statement and information shall also be printed legibly on the product label. All letters shall be at least 2.5 mm (3/32 in.) high. The appropriate term for the element type — garment, helmet, glove, footwear, hood — shall be inserted in the statement text where indicated. Following this statement, the additional protective items or detachable components shall be listed by type, identification, and how properly assembled.

"FOR COMPLIANCE WITH THE STRUCTURAL FIRE FIGHTING (insert appropriate element term here) **REQUIREMENTS OF NFPA 1971, THE FOLLOWING PROTECTIVE ITEMS MUST BE WORN IN CONJUNCTION WITH THIS** (insert appropriate element term here)**:"**

(List additional items or detachable components here.)

5.2.3 (3-1.9) For helmets only, the helmet manufacturer shall place a unique manufacturer's part number, the symbol of the certification organization, and the words "NFPA 1971, 2006 Edition" permanently on each replaceable performance critical part of the goggle lens or faceshield.

5.2.4 (3-1.10) For hoods only, where the hood is designed to interface with a specific SCBA facepiece(s), the hood manufacturer shall add an item (10) to the items specified in 5.1.7 (3-1.7.)

5.2.4.1 (3-1.10.1) The hood manufacturers shall designate the specific SCBA facepiece(s), model(s) and size(s) in item (10).

5.2.4.2 (3-1.10.2) Where the hood is designed to be used with a specific SCBA facepiece(s), the hood manufacturer shall add to the hood product label the following statement:

"THIS HOOD IS DESIGNED TO BE USED ONLY WITH [insert SCBA facepieces(s), model(s), and size(s) here]. **FOR COMPLIANCE WITH NFPA 1971, THIS HOOD CAN ONLY BE USED WITH THE ABOVE NOTED FACEPIECE(S)."**

5.3 Additional Product Label Requirements for Proximity Fire Fighting Ensemble Elements Only.

5.3.1 (3-1.6) The following compliance statement shall be printed legibly on the product label for each proximity fire fighting protective ensemble element. The appropriate term for the element type — garment, helmet, glove, footwear, hood — shall be inserted in the compliance statement text where indicated. All product label letters and figures shall be at least 2.5 mm (3/32 in.) in height.

"THIS (insert appropriate element term here) **MEETS THE PROXIMITY** (insert appropriate element term here) **REQUIREMENTS OF NFPA 1971, STANDARD ON PROTECTIVE ENSEMBLES FOR STRUCTURAL FIRE FIGHTING AND PROXIMITY FIRE FIGHTING, 2006 EDITION.**

DO NOT REMOVE THIS LABEL."

5.3.2 (3-1.8) Where other protective item(s) or detachable components must be used with proximity fire fighting protective ensemble elements in order for an element to be compliant with this standard, at least the following statement and information shall also be printed legibly on the product label. All letters shall be at least 2.5 mm ($^3/_{32}$ in.) high. The appropriate term for the element type — garment, helmet, glove, footwear, hood — shall be inserted in the statement text where indicated. Following this statement, the additional protective items or detachable components shall be listed by type, identification, and how properly assembled.

"FOR COMPLIANCE WITH THE PROXIMITY (insert appropriate element term here) **REQUIREMENTS OF NFPA 1971, THE FOLLOWING PROTECTIVE ITEMS MUST BE WORN IN CONJUNCTION WITH THIS** (insert appropriate element term here)**:"**

(List additional items or detachable components here.)

5.3.3 (3-1.9) For helmets only, the helmet manufacturer shall place a unique manufacturer's part number, the symbol of the certification organization, and the words "NFPA 1971, 2006 Edition" permanently on each replaceable performance critical part of the goggle lens or faceshield.

5.3.4 For the helmet shroud only, the manufacturer shall add the following statement to the shroud product label the following statement:

"THIS SHROUD IS DESIGNED TO BE USED WITH (insert helmet manufacturer's name, specific helmet model here)**. FOR COMPLIANCE WITH 2006 EDITION OF NFPA 1971, THIS SHROUD CAN ONLY BE USED WITH THE ABOVE NOTED HELMET(S)**.

DO NOT REMOVE THIS LABEL"

5.3.5 (3-1.10) For hoods only, where the hood is designed to interface with a specific SCBA facepiece(s), the hood manufacturer shall add an item (10) to the items specified in 5.1.7 (3-1.7.)

5.3.5.1 (3-1.10.1) The hood manufacturers shall designate the specific SCBA facepiece(s), model(s) and size(s) in item (10).

5.3.5.2 (3-1.10.2) Where the hood is designed to be used with a specific SCBA facepiece(s), the hood manufacturer shall add to the hood product label the following statement:

"THIS HOOD IS DESIGNED TO BE USED ONLY WITH [insert SCBA facepieces(s), model(s), and size(s) here]**. FOR COMPLIANCE WITH THE 2006 EDITION OF NFPA 1971, THIS HOOD CAN ONLY BE USED WITH THE ABOVE NOTED FACEPIECE(S)."**

5.4 (3-2) User Information Requirements for Both Ensembles.

5.4.1 (3-2.1) The manufacturer shall provide at least the user information that is specified in 5.4.4 (3-2.4) with each structural and proximity fire fighting elements.

5.4.2 (3-2.2) 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.

5.4.3 (3-2.3) 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 manufacturer shall provide notice that the user information is to be removed only by the end user.

5.4.4* (3-2.4) The manufacturer shall provide at least the following instructions and information with each element:

(1) Pre-use information
   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
   a. Sizing/adjustment
   b. Recommended storage practices
(3) Inspection frequency and details
(4) Don/doff
   a. Donning and doffing procedures
   b. Sizing and adjustment procedures
   c. Interface issues
(5) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and 29 *CFR* 1910.132, General Requirements of Subpart I, *Personal Protective Equipment*
(6)* Maintenance and cleaning
   a. Cleaning instructions and precautions with a statement advising users not to use an element that is not thoroughly cleaned and dried
   b. Inspection details
   c. Maintenance criteria and methods of repair where applicable
   d. Decontamination procedures for both chemical and biological contamination
(7) Retirement and disposal criteria and considerations

5.4.5 (3-2.5) For footwear only, the manufacturer shall establish and provide, upon request, a size conversion chart for each model or style footwear element based on toe length, arch length, and foot width as measured on a Brannock Scientific Foot Measuring Device.

5.5 Technical Data Package Requirements for Both Ensembles.

5.5.1 General.

5.5.1.1* Upon the request of the authority having jurisdiction, the manufacturer shall furnish a technical data package with each structural fire fighting and proximity fire fighting protective ensemble, and each ensemble element.

5.5.1.2* The technical data package shall contain all documentation required by this standard and the data showing compliance with this standard.

5.5.1.3 In the technical data package, the manufacturer shall describe the protective ensemble or ensemble elements in terms of manufacturer trade name, model number, manufacturer replaceable components and component parts, and available options such as accessories, testing devices, and sizes.

5.5.1.4 In the technical data package, the manufacturer shall describe the available sizes protective ensemble or ensemble element. For those ensembles or elements where indivdual custom sizing is provided, descriptions of sizes shall include the range or key dimensions of the ensemble or element.

5.5.2 Material and Component Descriptions.

5.5.2.1 Where specific elements, component parts or accessories are required for certifying the protective ensemble or element as compliant with this standard, the manufacturer shall list these elements or component parts in the technical data package.

5.5.2.2 The manufacturer shall provide, in the technical data package, the list and descriptions of the following ensemble or element materials and component parts, where applicable:

(1) Garment material(s)
(2) Helmet material(s)
(3) Glove material(s)
(4) Footwear material(s)
(5) Material seam types, stitch types and thread or sealing material(s)
(6) Zipper/closure type and materials of construction

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

5.5.2.4 Where the ensemble is certified to the optional requirements for protection against chemical, biological, and radiological terrorism agents, the manufacturer shall describe, in the technical data package, the type of interfaces between the following ensemble elements and equipment items, and the respective methods used for providing integrity in different garment openings:

(1) Garment–Helmet
(2) Garment–Glove
(3) Garment–Footwear
(4) Garment–Hood
(5) Garment–SCBA
(6) Garment closures
(7) Upper Garment–Lower Garment

Chapter 6 (Old Chapter 4) Design Requirements

6.1* (4-1) Protective Garment Element Design Requirements for Both Ensembles.

6.1.1 (4-1.1) Garment elements shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3 (2-3), Inspection and Testing.

6.1.1.1 (4-1.16.1) For coveralls, the portion of the coverall that corresponds to the coat shall meet all garment requirements and all requirements specified for coat elements of this section.

6.1.1.2 (4-1.16.2) For coveralls, the portion of the coverall that corresponds to the trouser shall meet all garment requirements and all requirements specified for trouser elements of this section.

6.1.2* (4-1.2) Garments shall consist of a composite of an outer shell, moisture barrier, and thermal barrier. This composite shall be permitted to be configured as a single layer or multiple layers.

6.1.3* (4-1.3) Garments shall have a means of securing the moisture barrier and thermal barrier to the outer shell in such a manner to permit the visual inspection of both the interior and exterior surfaces of each barrier.

6.1.4 (4-1.4) Garment moisture barriers and thermal barriers, or materials meeting the performance requirements of these components, shall extend at least to the neckline seam of coats, at least to the waistline seam of trousers, and shall extend at least to within 75 mm (3 in.) of the bottom outer shell hems of both coats and trousers.

6.1.4.1 For coats, the moisture barriers and thermal barriers, or materials meeting the performance requirements of these components, 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.

6.1.4.2 For trousers, moisture barriers and thermal barriers, or materials meeting the performance requirements of these components, shall be attached to the trouser legs.

6.1.4.3 Any mechanism used to attach the liner system 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.

6.1.5 (4-1.5) Garments and their closure systems, including the coat front and the trouser fly, shall be constructed in a manner that provides continuous moisture and thermal protection.

6.1.5.1 Such closure systems shall be secured with positive locking fasteners including, but not limited to, hooks and dees or zippers.

6.1.5.2 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.

6.1.5.3 (4-1.6) Snaps shall be Style 2 and shall comply with the design and construction requirements of MIL-F-10884F. The construction of the snap shall be permitted to vary from the MIL-F-10884F drawings with regard to the attachment means and use of logos on the caps.

6.1.5.4 (4-1.8) Zippers shall meet the physical performance requirements of A-A-55634, *Commercial Item Description, Zippers (Fasteners, Slide, Interlocking)*. Coat/coverall front closures zippers, trouser fly zippers, and sleeve and leg zippers shall be size 9 or larger when measured in accordance with A-A-55634, *Commercial Item Description, Zippers (Fasteners, Slide, Interlocking)*.

6.1.5.5 (4-1.9) Hooks and dees shall be nonferrous. Hooks shall be inward facing and shall have at least three attachment points. Dees shall have at least two attachment points.

6.1.6 (4-1.10) All garment hardware finishes shall be free of rough spots, burrs, or sharp edges.

6.1.7 (5-1.10) All sewing thread utilized in the construction of garments and the DRDs shall be made of an inherently flame-resistant fiber.

6.1.8* (4-1.11) Garment cargo pockets, where provided, shall have a means to drain water and shall have a means of fastening in the closed position.

6.1.9 (4-1.14.1) Coats shall be designed to provide protection to the upper torso, neck, arms, and wrists, excluding the hands and head.

6.1.9.1 (New) Each coat element shall have a drag rescue device (DRD) installed in the upper torso portion of the element.

6.1.9.1.1 The DRD shall be located inside the outer shell to shield the device.

6.1.9.1.2 An access point to the DRD handle shall be located on the exterior surface of the outer shell of the coat.

6.1.9.1.3 The access point to the DRD handle shall permit easy access for deployment, shall be designed to prevent accidental deployment of the DRD handle, and shall permit for visual inspection of the DRD within the coat.

6.1.9.1.4 The DRD shall be designed to allow deployment and operation of the DRD while the incapacitated fire fighter is wearing an SCBA. The operation of the DRD shall not cause the SCBA to be removed from the fire fighter.

6.1.9.1.5 The DRD shall be designed so that when deployed, the DRD secures the fire fighter by the upper torso or shoulders so that the DRD pulls directly on the body, and shall not be designed to pull only the garment.

6.1.9.2* (4-1.14.2) Each coat sleeve shall have a protective wristlet permanently attached to the coat sleeve.

6.1.9.2.1 The wristler shall be designed so that it will not permit a gap in thermal protection.

6.1.9.2.2 The wristlet shall meet the requirements specified in Section 6.6 (4-6), Protective Wristlet Interface Component Design Requirements for Both Ensembles, and Section 7.6 (5-6), Protective Wristlet Interface Component Performance Requirements for Both Ensembles.

6.1.9.3 (4-1.14.3) Coats shall have a composite collar at least 75 mm (3 in.) in height at any point when measured from the top of the collar down.

6.1.9.3.1 The collar shall incorporate a closure system.

6.1.9.3.2 The collar and closure system shall consist of an outer shell, a moisture barrier, and a thermal barrier, or of a composite that meets all applicable performance requirements specified in Section 7.1 (5-1), Protective Garment Performance Requirements for Both Ensembles.

6.1.9.4 (4-1.14.4) Coat hardware shall not penetrate through the outer shell, moisture barrier, and thermal barrier to contact the wearer's body when the coat is worn with the closures fastened, unless the hardware is completely covered by external closure flaps.

6.1.10* (4-1.15.1) Trousers shall be designed to provide protection to the lower torso and legs, excluding the ankles and feet.

6.1.10.1 (4-1.15.2) Trouser hardware shall not penetrate through the outer shell, moisture barrier, and thermal barrier to come into contact with the wearer's body when the trouser is worn with the closures fastened, unless the hardware is located on or above the waistline or hardware is completely covered by external closure flaps.

6.1.11* (4-1.14.6) In order to label a coat, trouser, or coverall as compliant with this standard, the manufacturer shall provide coats, trousers, or coveralls in the size ranges specified in Table 6.1.11.

Table 6.1.11 (4-1.14.6) Available Coat/Trouser Size Ranges

	Men	Women	Increment
Chest	865 mm - 1525 mm (34 in. - 60 in.)	710 mm - 1270 mm (28 in. - 50 in.)	50 mm (2 in.)
Sleeve	820 mm - 965 mm (32 in. - 38 in.)	710 mm - 865 mm (28 in. - 34 in.)	25 mm (1 in.)
Waist	760 mm - 1525 mm (30 in. - 60 in.)	710 mm - 1270 mm (28 in. - 50 in.)	50 mm (2 in.)
Inseam	660 mm - 915 mm (26 in. - 36 in.)	610 mm - 865 mm (24 in. - 34 in.)	50 mm (2 in.)

6.1.11.1 The sizing increments for the ranges specified in Table 6.1.10 (4-1.14.6) for men's and women's chest sizes shall be in increments no greater than 50 mm (2 in.), sleeve lengths shall be in increments no greater than 25 mm (1 in.), men's and women's waist sizes shall be in increments no greater than 50 mm (2 in.), and inseam lengths shall be in increments no greater than 50 mm (2 in.).

6.1.11.2 (4-1.14.7) Men's and women's sizing shall be accomplished by men's and women's individual patterns.

6.2 Additional Design Requirements for Structural Fire Fighting Garment Elements Only

6.2.1 (4-1.1) Structural fire fighting protective garment elements shall also have at least the applicable design requirements specified in this section in addition to the design requirements specified in Section 6.1, Protective Garment Element Design Requirements for Both Ensembles, where inspected by the certification organization as specified in Section 4.3 (2-3), Inspection and Testing.

6.2.2* (4-1.12) Garments shall have fluorescent and retroreflective trim permanently attached to the outer shells of garments to meet visibility requirements.

6.2.2.1 Trim shall be at least 50 mm (2 in.) wide and shall have both retroreflective and fluorescent surfaces.

6.2.2.2 The retroreflective surface of trim shall be at least 16 mm (5/8 in.) wide.

6.2.2.3 Fluorescent and retroreflective areas of trim shall appear to be continuous for the length of the trim, with gaps of not more than 3 mm (1/8 in.).

6.2.2.4 (4-1.12.1) Trim used to meet the minimum trim pattern requirements shall have a minimum fluorescent surface of 50 mm^2/linear mm (2 $in.^2$/linear in.) of trim.

6.2.2.5 (4-1.12.2) Trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figure 6.2.2 (4-1.14.5) and Figure 6.2.3 (4-1.15.3) shall be permitted to not meet the minimum fluorescent surface of 50 mm^2/linear mm (2 $in.^2$/linear in.) of trim, and shall be permitted to be obscured by components including but not limited to pockets, storm flaps, and reinforcing patches as long as the minimum trim pattern is not obscured.

6.2.3* (4-1.14.5) Coat trim configuration shall be in accordance with Figure 6.2.3 (4-1.14.5). No vertical stripes of trim shall be permitted on the front of the coat.

FIGURE 6.2.3 (4-1.14.5) Minimum required Structural Fire Fighting Coat trim patterns. [Existing Figure 4-1.14.5, 2000 ed., (no change)]

6.2.3.1 The coat minimum trim pattern shall have one circumferential band of trim or a staggered 360-degree visibility pattern meeting or exceeding the surface area of a continuous circumferential band around the bottom of the coat. The front of the coat shall have at least one band of horizontal trim at the chest level.

6.2.3.2 The lower edge of the circumferential band on the lower part of the coat shall be within 25 mm (1 in.) of the coat hem's highest point.

6.2.3.3 Where a staggered pattern is used in the lower circumferential trim band, the lower edge of the upper trim piece shall not be higher than the upper edge of the lower trim piece.

6.2.3.4 The back of the coat shall also have a minimum of either two vertical stripes of trim, perpendicular to the bottom band and with one strip located on both the left and right sides of the back of the coat, or a minimum of one horizontal band of trim at the chest/shoulder blade level.

6.2.3.5 The minimum trim configuration for each sleeve shall be one circumferential band, or a staggered 360-degree visibility pattern meeting or exceeding the surface area of a continuous circumferential band, between the wrist and elbow level. Where trim on the coat intersects a zipper or where the trim intersects the innermost seam of each sleeve, a maximum gap in the trim of 25 mm (1 in.) shall be permitted.

6.2.4* (4-1.15.3) Trouser trim configuration shall be in accordance with Figure 6.2.4 (4-1.15.3).

FIGURE 6.2.4 (4-1.15.3) Minimum required Structural Fire Fighting Trouser trim patterns. [Existing Figure 4-1.15.3, 2000 ed., (no change)]

6.2.4.1 The minimum trim pattern for the trousers shall consist of two circumferential bands of trim with one band around each leg between the bottom hem and knee areas.

6.2.4.2 Where trim on the trouser element intersects a zipper or where the trim intersects the innermost seam of each trouser leg, a maximum gap in the trim of 25 mm (1 in.) shall be permitted.

6.3 Additional Design Requirements for Proximity Fire Fighting Garment Elements Only

6.3.1 (4-1.1) Proximity fire fighting protective garment elements shall also have at least the applicable design requirements specified in this section in addition to the design requirements specified in Section 6.1, Protective Garment Element Design Requirements for Both Ensembles, where inspected by the certification organization as specified in Section 4.3 (2-3), Inspection and Testing.

6.3.2 (1976: 4-1.12) Garments shall not have materials that do not meet the radiant reflective requirements specified in **7.3.X** (1976: 5-1.1) affixed to the outer shell radiant reflective surfaces of the garments unless such materials are covered in 6.3.2 (1976: 4-1.13).

6.3.3 (1976: 4-1.13) Reinforcing materials that do not meet the radiant reflective requirements specified in **7.3.X** (1976: 5-1.1) shall be permitted to be affixed only to the garment outer shell radiant reflect surfaces as reinforcement of the sleeve cuffs and trouser leg cuffs where the following requirements are met:

(1) The reinforcing materials above shall meet the flame resistant requirements specified in **7.X.X** (1976: 5-1.8).

(2) The reinforcing materials above shall meet the heat resistance requirements specified in **7.X.X** (1976: 5-1.10).

(3) Reinforcement areas shall not cover the radiant reflective surfaces of the garment by more than 25 mm (1 in.) when measured from the edge of the cuff back along the sleeve or leg.

6.3.4 (1976: 4-1.14.3) Coats shall have a composite collar at least 100 mm (4 in.) in height at any point and shall have a closure system.

6.3.4.1 The collar and closure system shall consist of an outer shell, moisture barrier, thermal barrier, and collar lining, or of materials that meet all applicable performance requirements as specified in Section 7.1, Protective Garment Element Performance Requirements for Both Ensembles (1976: 5-1).

6.3.4.2 The collar lining material shall not be reflective material.

6.4* (4-2) Protective Helmet Element Design Requirements for Both Ensembles.

6.4.1 (4-2.1) Helmet elements shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3 (2-3), Inspection and Testing.

6.4.2 (4-2.3) There shall be no openings penetrating the helmet shell other than those provided by the manufacturer for mounting energy absorbing systems, retention systems, and accessories.

6.4.3 (4-2.5) The helmet retention system shall include a chin strap and a nape device. The chin strap shall have a minimum width of 19 mm (3/4 in.).

6.4.4 (5-2.12) All sewing thread used in the construction of helmets shall be made of inherently flame-resistant fiber.

6.4.5 (4-2.7) The helmet faceshield or the faceshield / goggle component, when deployed, shall provide at least the following field of vision:

(1) A dihedral angle of at least 85 degrees

(2) An upper dihedral angle of at least 10 degrees

(3) An lower dihedral angle of at least 40 degrees

6.4.5.1 The field of vision shall be measured from the center of the eye.

6.4.5.2 The faceshield or the faceshield / goggle component shall be positioned in accordance with the helmet eye/face-positioning indexes on an Alderson 50th-percentile male headform specified in Figure 8.17.4.1.1 (6-17.4.1.1).

6.4.5.3 The helmet positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane of the ISO J headform with the helmet is firmly positioned on the headform.

6.4.6 (4-2.4) The helmet faceshield or the faceshield/goggle component in the stowed position shall provide peripheral vision clearance of at least 94 degrees to each side.

6.4.6.1 The faceshield or the faceshield/goggle component shall be in the stowed position.

6.4.6.2 The peripheral vision clearance shall be measured from the center of the eye with the helmet positioned according to the helmet positioning index on the Alderson 50th-percentile male headform specified in Figure 8.17.4.1.1 (6-17.4.1.1).

6.4.6.3 The helmet positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane on the Alderson 50th-percentile male headform specified in Figure 8.17.4.1.1 (6-17.4.1.1) with the helmet is firmly positioned on the headform.

6.4.7 (4-2.9) Where helmets are provided with an SCBA facepiece that is attached or integrated with the helmet, the helmet with the SCBA facepiece installed shall meet all applicable design and performance requirements of this standard.

6.5 Additional Design Requirements for Structural Fire Fighting Helmets Only.

6.5.1 (4-2.1) Structural fire fighting protective helmet elements shall also have at least the applicable design requirements specified in this section in addition to the design requirements specified in Section 6.4, Protective Helmet Element Design Requirements for Both Ensembles, where inspected by the certification organization as specified in Section 4.3 (2-3), Inspection and Testing.

6.5.2 (4-2.2) Helmets shall consist of at least all of the following assembled components: a shell, energy absorbing system, retention system, fuorescent and retroreflective trim, ear covers, and either a faceshield, or goggles, or both

6.5.2.1* (4-2.7) The helmet faceshield or faceshield / goggle component shall be attached to the helmet other than as permitted by 6.5.2.2.

6.5.2.2 (4-2.2.1) Where goggles are selected in accordance with 6.5.2, the goggles shall be permitted to be unattached, not assembled, to the helmet.

6.5.3 (4-2.6) Helmet elements shall have fluorescent and retroreflective trim on the shell exterior.

6.5.3.1 (4-2.6.1) A minimum of 2580 mm^2 (4 $in.^2$) of the retroreflective and fluorescent trim shall be visible above the reference plane when the helmet, with the faceshield/goggle component in the stowed position, is viewed at the:

(1) left intersection of the coronal and reference planes at a distance of 2.4 m (8 ft)

(2) right intersection of the coronal and reference planes at a distance of 2.4 m (8 ft)

(3) rear intersection of the midsagittal and reference planes at a distance of 2.4 m (8 ft)

6.5.3.2 (4-2.6.2) A minimum of 2580 mm^2 (4 $in.^2$) of the retroreflective and fluorescent trim shall be visible when the helmet, with the faceshield/goggle component in the stowed position, is viewed at the intersection of the midsagittal plane and the coronal plane at a distance of 2.4 m (8 ft).

6.5.3.3 (4-2.6.3) The entire surface of the trim shall be permitted to be both fluorescent and retroreflective.

6.5.4 (4-2.8) Helmet ear covers or the portion of the helmet providing the coverage of the ears, when deployed, shall provide at least the following coverage: :

(1) 92.5 mm (3 3/4 in.) measured 50 mm (2 in.) forward of the coronal plane

(2) 117.5 mm (4 3/4 in.) measured 25 mm (1 in.) forward of the coronal plane

(3) 127.5 mm (5 7/64 in.) measured at the coronal plane

(4) 127.5 mm (5 7/64 in.) measured at the midsagittal plane at the rear of the headform

6.5.4.1 The helmet, with the ear covers or the portion of the helmet providing the ear coverage deployed, shall be donned in the proper wearing position as specified by the helmet manufacturer, on an ISO J headform according to its helmet-positioning index.

6.5.4.2 The helmet positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane of the ISO J headform with the helmet is firmly positioned on the headform.

6.5.4.3 In this position, the ear coverage shall be measured downward from the reference plane to the lower edge of the ear coverage at the specified points to determine the coverage specified in 6.5.4.

6.5.4.4 Where the helmet incorporates a ratchet style headband, an opening in the covering surrounding the ratchet knob shall be permitted. The opening shall not extend more than 13 mm (1/2 in.) in any direction around the perimeter of the adjustment device.

6.6 Additional Design Requirements for Proximity Fire Fighting Helmets Only.

6.6.1 (4-2.1) Proximity fire fighting protective helmet elements shall also have at least the applicable design requirements specified in this section in addition to the design requirements specified in Section 6.4, Protective Helmet Element Design Requirements for Both Ensembles, where inspected by the certification organization as specified in Section 4.3 (2-3), Inspection and Testing.

6.6.2 (1976: 4-2.2) Helmets shall consist of at least the following assembled components: a shell, an energy absorbing system, a retention system, a faceshield, and a shroud.

6.6.3* [1976: 4-2.5] Helmet faceshields shall be attached to the helmet.

6.6.4 (1976: 4-2.2.1) Helmets shall be permitted to have an outer cover to provide the radiant reflective protection for the exterior of the helmet shell, including the upper surface of the brim, and the brim edge.

6.6.3.1 (1976: 4-2.2.2) The helmet outer cover shall be permitted to be removable.

6.6.3.2 (1976: 4-2.8) The helmet, and helmet outer cover where provided, shall be permitted to have fluorescent and retroreflective trim on the helmet exterior and on the helmet outer cover.

6.6.3.3 (1976: 4-2.9) Identification markings or material including, but not limited to, trim, lettering, patches, name or number stencils, emblems, and paint shall be permitted *only* on the helmet outer cover, provided such materials are located above the corresponding helmet test line.

6.6.3.4 The corresponding helmet with the outer cover and markings attached shall meet the requirements specified in 7.6.xx (1976: 5-2.23).

6.6.4 (1976: 4-2.7) The helmet shroud component shall consist of an outer shell, moisture barrier, and thermal liner. This composite shall be permitted to be configured as a single layer or multiple layers, however all of the layers shall be permanently attached together around the edges.

6.6.4.1 The shroud shall be attached to the helmet and shall be designed to cover and provide continuous radiant reflective protection for the head, face, and neck areas that do not receive primary protection from the helmet, faceshield, or the SCBA facepiece.

6.6.4.2 (1976: 4-2.7.2) Shrouds shall provide at least the following coverage:

(1) 230 mm (9 1/8 in.) on each side measured downward from the reference plane at the coronal plane

(2) 330 mm (13 in.) in the back measured downward from the reference plane at the rear mid-sagittal plane

(3) 295 mm (11 5/8 in.) in the front measured downward from the reference plane at the front midsagittal plane, including the gap of material where the face opening is located

6.6.4.2.1 The helmet with shroud in place shall be donned, in the proper wearing position as specified by the helmet manufacturer, on an ISO J headform according to its helmet-positioning index.

6.6.4.2.2 The helmet positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane of the ISO J headform with the helmet is firmly positioned on the headform.

6.6.4.2.3 In this position, the shroud shall be shall be measured downward from the reference plane to the lower edge of the shroud at the specified points to determine the coverage specified in 6.6.4.2.

6.6.4.3 (1976: 4-2.7.1) The shroud shall be permitted to be a part of a helmet outer cover, where provided.

6.6.4.4 (1976: 4-2.7.2) The shroud shall be designed to interface with a specific helmet.

6.6.4.5 (1976: 4-2.7.6) The helmet shroud, when deployed, shall provide peripheral vision clearance of at least 85 degrees to each side of the midsagittal plane, an angle of at least 7 degrees above the reference plane, and an angle of at least 40 degrees under the basic plane.

6.6.4.5.1 The helmet with the shroud attached shall be seated according to its helmet positioning index on the Alderson 50th-percentile male headform illustrated in Figure 8.20.4.1.1 (1976: 6-20.4.1.1).

6.6.4.5.2 The helmet positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane of the ISO J headform with the helmet is firmly positioned on the headform.

6.6.4.6 (1976: 4-2.7.7) Shrouds shall not overlap or obscure vision areas as defined in 6.4.5 (1976: 4-2.5) and 6.4.6 (1976: 4-2.6).

6.7 (4-3) Protective Glove Element Design Requirements for Both Ensembles.

6.7.1 (4-3.1) Glove elements shall have at least the applicable design requirements specified in this section when inspected by the certification organization as specified in Section 4.3 (2-3).

6.7.2 (4-3.2) Gloves shall consist of a composite meeting the performance requirements of Section 7.7 (5-3), Protective Glove Element Performance Requirements for Both Ensembles.

6.7.2.1 The composite shall be permitted to be configured as a continuous or joined single layer or as continuous or joined multiple layers.

6.7.2.2 Where a glove is made up of multiple layers, all layers of the glove shall be individually graded per size.

6.7.3 (5-3.8) All sewing thread utilized in the construction of gloves shall be made of an inherently flame-resistant fiber.

6.7.4 (4-3.5.1) For selection of proper glove size, the dimensions for hand circumference and the hand length shall be measured as shown in Figure 6.7.4 (4-3.5.1):

FIGURE 6.7.4 [4-3.5.1] **Method of measuring hand dimensions for selection of proper glove.** [Existing Figure 4-3.5.1, 2000 ed., (no change)]

6.7.4.1 (4-3.5.1.1) Hand circumference shall be measured by placing a measuring tape on a table or other flat surface with the numerals facing downward.

6.7.4.1.1 The subject shall place the right hand, palm down and fingers together, in the middle of the tape so that the tape can pass straight across the metacarpal knuckles.

6.7.4.1.2 The circumference shall be measured to the nearest 3.18 mm (1/8 in.) as shown in Figure 6.7.4 [4-3.5.1].

6.7.4.2 (4-3.5.1.2) Finger circumference shall be measured at the proximal interphalangeal joint (first knuckle).

6.7.4.3 Finger length shall be measured from the tip of the finger to the base of the finger crease on the palm side.

6.7.4.4 (4-3.5.1.3) Hand length shall be measured by placing the subject's hand, palm down, on a piece of paper with the fingers together and the hand and arm in a straight line.

6.7.4.4.1 The thumb shall be fully abducted, extended away from the palm as far as possible.

6.7.4.4.2 The paper shall be marked at the tip of the third, or middle, finger. A pencil mark shall be placed in the notch at the base of the thumb where the thumb joins the wrist.

6.7.4.3.3 The straight line distance between the two points shall be measured to the nearest 3 mm (1/8 in.) as shown in Figure 6.7.4 (4-3.5.1).

6.7.5 (4-3.5.2) In order to label or otherwise represent a glove as compliant with the requirements of this standard, the manufacturer shall provide gloves in the following sizes: Extra, Extra Small (XXS), Extra Small (XS), Small (S), Medium (M), Large (L), Extra Large (XL), and Extra, Extra Large (XXL).

6.7.5.1 The glove sizes from XS through XL indicated on the label shall be determined by the hand dimensions given in Tables 6.7.6 [4-3.5.3] (a) through (e).

6.7.5.2 The sizes for XXS shall be smaller than the sizing indicated in Table 6.7.6(a) and Size XXL shall be larger than sizes indicated in Table 6.7.6(e).

6.7.6* (4-3.5.3) The glove size indicated on the label shall be determined by the hand dimensions given in Tables 6.7.6 [4-3.5.3] (a) through (e).

Table 6.7.6(a) [4-3.5.3(a)] Sizing for Small (XS) Glove

			mm	in.
Range for hand length:			16.25–17.25	6.40–6.79
Range for hand circumference:			16.25–20.25	6.40–7.97
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**in.**	**cm**	**in.**
Digit1 circumference	6.17	2.43	5.60–6.74	2.20–2.65
Digit 2 circumference	6.06	2.39	5.50–6.63	2.17–2.61
Digit 3 circumference	6.08	2.39	5.53–6.63	2.18–2.61
Digit 4 circumference	5.69	2.24	5.12–6.26	2.02–2.46
Digit 5 circumference	5.00	1.97	4.48–5.52	1.76–2.17
Digit 1 length	4.94	1.94	4.36–5.52	1.72–2.17
Digit 2 length	6.44	2.54	5.75–7.12	2.26–2.80
Digit 3 length	7.29	2.87	6.71–7.87	2.64–3.10
Digit 4 length	6.78	2.67	6.13–7.42	2.41–2.92
Digit 5 length	5.09	2.00	4.52–5.66	1.78–2.23
Hand circumference	18.25	7.19	16.34–20.16	6.43–7.94
Hand length	16.75	6.59	16.27–17.23	6.41–6.78

Table 6.7.6(b) [4-3.5.3(b)] Sizing for Small (S) Glove

			mm	in.
Range for hand length:			17.25–18.25	6.79–7.19
Range for hand circumference:			17.25–21.25	6.79–8.37
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**in.**	**cm**	**in.**
Digit 1 circumference	6.40	2.52	5.82–6.97	2.29–2.74
Digit 2 circumference	6.29	2.48	5.73–6.85	2.26–2.70
Digit 3 circumference	6.31	2.48	5.76–6.87	2.27–2.70
Digit 4 circumference	5.92	2.33	5.35–6.49	2.11–2.56
Digit 5 circumference	5.22	2.06	4.70–5.74	1.85–2.26
Digit 1 length	5.31	2.09	4.74–5.89	1.87–2.32
Digit 2 length	6.89	2.71	6.21–7.57	2.44–2.98
Digit 3 length	7.71	3.04	7.13–8.30	2.81–3.27
Digit 4 length	7.19	2.83	6.55–7.03	2.58–3.08
Digit 5 length	5.44	2.14	4.87–6.01	1.92–2.37
Hand circumference	19.25	7.58	17.34–21.16	6.83–8.33
Hand length	17.75	6.99	17.27–18.23	6.80–7.18

Table 6.7.6(c) [4-3.5.3(c)] Sizing for Medium (M) Glove

			mm	in.
Range for hand length:			18.25–19.25	7.19–7.58
Range for hand circumference:			18.25–22.25	7.19–8.76
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**in.**	**cm**	**in.**
Digit 1 circumference	7.01	2.76	6.36–7.65	2.50–3.01
Digit 2 circumference	6.82	2.69	6.31–7.32	2.48–2.88
Digit 3 circumference	6.83	2.69	6.26–7.40	2.46–2.91
Digit 4 circumference	6.34	2.50	5.78–6.90	2.28–2.72
Digit 5 circumference	5.63	2.22	5.09–6.17	2.00–2.43
Digit 1 length	5.63	2.22	5.00–6.26	1.97–2.46
Digit 2 length	7.11	2.80	6.50–7.72	2.56–3.04
Digit 3 length	8.07	3.18	7.55–8.58	2.97–3.38
Digit 4 length	7.61	3.00	7.14–8.08	2.81–3.18
Digit 5 length	5.78	2.28	5.16–6.41	2.03–2.52
Hand circumference	20.25	7.97	18.34–22.16	7.22–8.72
Hand length	18.75	7.38	18.27–19.23	7.19–7.57

Table 6.7.6(d) [4-3.5.3(d)] Sizing for Large (L) Glove

			mm	in.
Range for hand length:			19.25–20.25	7.587.97
Range for hand circumference:			19.25–23.25	7.589.15
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**in.**	**cm**	**in.**
Digit 1 circumference	7.26	2.86	6.62–7.91	2.61–3.11
Digit 2 circumference	7.03	2.77	6.53–7.54	2.57–2.97
Digit 3 circumference	7.10	2.80	6.53–7.66	2.57–3.02
Digit 4 circumference	6.60	2.60	6.04–7.16	2.38–2.82
Digit 5 circumference	5.85	2.30	5.31–6.39	2.09–2.52
Digit 1 length	5.87	2.31	5.24–6.50	2.06–2.56
Digit 2 length	7.49	2.95	6.88–8.10	2.71–3.19
Digit 3 length	8.54	3.36	8.03–9.06	3.16–3.57
Digit 4 length	8.03	3.16	7.56–8.50	2.98–3.35
Digit 5 length	6.13	2.41	5.51–6.75	2.17–2.66
Hand circumference	21.25	8.37	19.34–23.16	7.61–9.12
Hand length	19.75	7.78	19.27–20.23	7.59–7.96

Table 6.7.6(e) [4-3.5.3(e)] Sizing for Extra-Large (XL) Glove

			mm	in.
Range for hand length:			20.25–21.25	7.97–8.37
Range for hand circumference:			20.25–24.25	7.97–9.55
	Mid-Size Value		**Range to Be Accommodated**	
	cm	**in.**	**cm**	**in.**
Digit 1 circumference	7.52	2.96	6.87–8.16	2.70–3.21
Digit 2 circumference	7.25	2.85	6.74–7.76	2.65–3.06
Digit 3 circumference	7.36	2.90	6.79–7.93	2.67–3.12
Digit 4 circumference	6.86	2.70	6.30–7.42	2.48–2.92
Digit 5 circumference	6.06	2.39	5.52–6.60	2.17–2.60
Digit 1 length	6.11	2.41	5.48–6.75	2.16–2.66
Digit 2 length	7.86	3.09	7.26–8.47	2.86–3.33
Digit 3 length	9.02	3.55	8.51–9.54	3.35–3.76
Digit 4 length	8.44	3.32	7.97–8 .91	3.14–3.51
Digit 5 length	6.48	2.55	5.85–7 .10	2.30–2.80
Hand circumference	22.25	8.76	20.34–2 4.16	8.01–9.51
Hand length	20.75	8.17	20.27–2 1.23	7.98–8.36

6.8 Additional Design Requirements for Structural Fire Fighting Protective Gloves Only.

6.8.1 (4-3.1) Structural fire fighting protective glove elements shall also have at least the applicable design requirements specified in this section in addition to the design requirements specified in Section 6.7, Protective Glove Element Design Requirements for Both Ensembles, where inspected by the certification organization as specified in Section 4.3 (2-3).

6.8.2 (4-3.4) Gloves shall be permitted to be provided with either a gauntlet or a glove wristlet.

6.8.3 (4-3.3) The glove body where a gauntlet or glove wristlet is not provided, or the glove body including the gauntlet or glove wristlet where provided shall extend circumferentially not less than 50 mm (2 in.) beyond the wrist crease where measured from the tip of the middle finger.

6.8.3.1 The location of the wrist crease shall be determined as shown in Figure 6.8.3.1 (4-3.3).

FIGURE 6.8.3.1 [4-3.3] **Anatomical landmarks at base of hand.**
[Existing Figure 4-3.3, 2000 ed., (no change)]

6.9 Additional Design Requirements for Proximity Fire Fighting Protective Gloves Only.

6.9.1 (4-3.1) Proximity fire fighting protective glove elements shall also have at least the applicable design requirements specified in this section in addition to the design requirements specified in Section 6.7, Protective Glove Element Design Requirements for Both Ensembles, where inspected by the certification organization as specified in Section 4.3 (2-3).

6.9.2 (1976: 4-3.3) The glove body shall extend circumferentially not less than 50 mm (2 in.) beyond the wrist crease where measured from the tip of the middle finger.

6.9.2.1 (1976: 4-3.3) The location of the wrist crease shall be determined as shown in Figure 6.8.3.1 (1976: 4-3.3).

6.9.3 (1976: 4-3.4) Gloves shall be permitted to be provided with either a gauntlet or a glove wristlet.

6.9.3.1 Where gloves are provided with a gauntlet or a glove wristlet, the sample glove body and the gauntlet or glove wristlet shall extend circumferentially at least 75 mm (3 in.) beyond the wrist crease.

6.9.3.2 Where gloves are not provided with a gauntlet or a glove wristlet, the sample glove body shall extend circumferentially at least 75 mm (3 in.) beyond the wrist crease, an increase of 25 mm (1 in.) to the requirement specified in 6.9.2 (4-3.3).

6.9.4 (1976: 4-3.5) Gloves shall not be permitted to have any hardware.

6.9.5 (1976: 4-3.6) The outer shell of the back and portions of the sides of the glove body including the back of the digits shall be a radiant reflective material.

6.9.5.1 (1976: 4-3.6.1) Glove fingers, thumb, and the back shall have radiant reflective protection of 210 degrees, +20°/-0°. The radiant reflective material shall provide coverage from 0 degrees to 105 degrees, +10°/-0° and then from 255 degrees, +10°/-0° to 360 degrees as specified in Figure 6.9.5.1 (1976: 4-3.6.1).

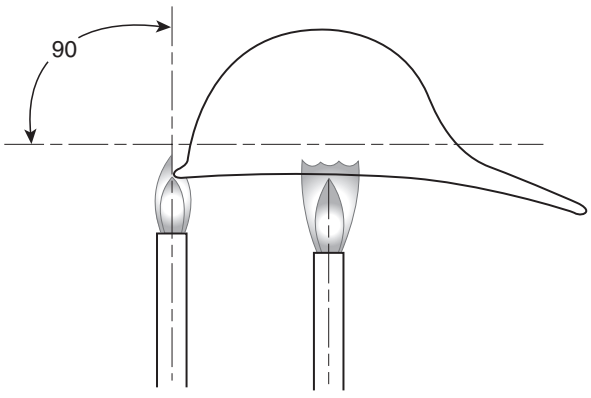

Figure 6.9.5.1 (1976: 4-3.6.1) **Glove radiant reflective protection areas.** [Pickup Figure 4-3.6.1, NFPA 1976, 2000 ed.,]

6.9.5.2 (1976: 4-3.6.2) The radiant reflective material shall provide coverage for the finger/thumb tip of at least 195 degrees, +10°/-0° as specified in Figure 6.9.4.1 (1976: 4-3.6.1).

6.9.5.3 (1976: 4-3.6.2) The portion of the finger, thumb, and palm surfaces that are not covered by the radiant reflective protection shall be the gripping surface of the glove.

6.10 (4-4) Protective Footwear Design Requirements for Both Ensembles.

6.10.1 (4-4.1) Footwear elements shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3 (2-3).

6.10.2 (4-4.2) Footwear shall consist of at least the following assembled components: a sole with a heel, an upper with lining, a puncture resistant insole, a ladder shank, and an impact- and compression-resistant toecap.

6.10.3 (4-4.3) Footwear height shall be a minimum of 250 mm (10 in.).

6.10.3.1 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 highest point of the footwear excluding pull-on loops.

6.10.3.2 Removable insole inserts shall be removed prior to measurement.

6.10.4 (4-4.4) The footwear heel breast shall not be less than 13 mm (1/2 in.) nor more than 25 mm (1 in).

6.10.4.1 The heel breasting angle shall not be less than 90 degrees nor more than 135 degrees.

6.10.4.2 The heel edges shall not be less than, or extend more than, 13 mm (1/2 in.) laterally from the upper at any point.

6.10.4.3 The width of the footwear heel shall be equal to or greater than the width of the sole at the intersection of the heel breast and the sole bottom, excluding any calendar roll where present.

6.10.5 (4-4.5) The puncture resistant insole component shall cover the maximum area of the insole.

6.10.6 (4-4.6) Metal parts shall not penetrate from the outside into the lining or insole at any point.

6.10.7 (4-4.7) 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.

6.10.8 (5-4.9) All sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber.

6.10.9 (4-4.8.1) In order to label or otherwise represent footwear as compliant with the requirements of this standard, the manufacturer shall have footwear available in all of the following sizes:

(1) Men's 5–13, including half sizes and a minimum of three widths

(2) Women's 5–10, including half sizes and a minimum of three widths

6.10.9.1 (4-4.8.2) 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.

6.10.9.2 (4-4.8.3) Full and half sizes, in each of the three required widths, shall be accomplished by individual and unique men's and women's lasts to provide proper fit.

6.11 Additional Design Requirements for Structural Fire Fighting Protective Footwear Only. (Reserve)

6.12 Additional Design Requirements for Proximity Fire Fighting Protective Footwear Only. (Reserve)

6.13 (4.5) Protective Hood Interface Component Design Requirements for Both Ensembles. (Reserve)

6.14 Additional Design Requirements for Structural Fire Fighting Protective Hood Interface Components Only.

6.14.1 (4-5.1) A sample hood shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3 (2-3).

6.14.2 (4-5.2) The hood shall be designed to cover and provide the limited protection, as specified within this section, to the head, face, and neck areas that do not receive primary protection from the helmet or the SCBA facepiece.

6.13.3 (5-5.7) All sewing thread utilized in the construction of hoods shall be made of an inherently flame-resistant fiber

6.14.4 (4-5.3) The hood shall be donned properly, in accordance with the manufacturer's instructions for wearing, on the ISO size J headform specified in Figure 8.16.4.1 (6-16.4.1). In this position, the hood shall provide a minimum coverage on each side measured downward from the reference plane at the coronal plane of 230 mm (9 in.), shall provide a minimum coverage in the back measured downward from the reference plane at the rear midsagittal plane of 330 mm (13 in.), and shall provide a minimum coverage in the front measured downward from the reference plane at the front midsagittal plane, excluding the face opening, of 300 mm (11 13/16 in.).

6.14.5 (4.5.4) The hood shall be designed with a face opening. Other than where the hood face opening is designed to interface with a specific SCBA facepiece or where the hood face opening is designed to be adjustable, the hood face opening shall measure 145 mm, +0/–25 mm (5 5/8 in., +0/–1 in.) in any direction when the hood is laid out in a relaxed condition on a flat surface, smoothed out, and with the face opening up.

6.14.5.1 (4-5.4.1) Where the hood face opening is designed to interface with a specific SCBA facepiece, the hood face opening shall overlap the outer edge of the specific SCBA facepiece-to-face seal perimeter by not less than 13 mm (1/2 in.).

6.14.5.2 (4-5.4.2) Where the hood face opening is provided with manual adjustment, the hood face opening shall be adjustable to achieve a face opening of 145 mm (5 5/8 in.).

6.15 Additional Design Requirements for Proximity Fire Fighting Protective Hood Interface Components Only. (Reserve)

6.16 (4.6) Protective Wristlets Interface Component Design Requirements for Both Ensembles.

6.16.1 (4-6.1) Wristlets shall have at least the applicable design requirements specified in this section where inspected by the certification organization as specified in Section 4.3 (2-3).

6.16.2 (4-6.2) Wristlets shall be designed to cover and provide limited protection to the wrist areas.

6.16.3 (4-6.3) Wristlets shall be permanently attached to the protective coat sleeve in a manner that will not permit a gap in the thermal protection.

6.16.4 (5-6.6) All sewing thread utilized in the construction of wristlets shall be made of an inherently flame-resistant fiber.

6.17 Additional Design Requirements for Structural Fire Fighting Protective Wristlet Interface Components Only. (Reserve)

6.18 Additional Design Requirements for Proximity Fire Fighting Protective Wristlet Interface Component Only. (Reserve)

6.19 (Reserve)

6.20 *Optional* Design Requirements for Protection from Chemical, Biological, and Radiological (CBR) Terrorism Agents.

6.20.1 Protective Ensemble CBR Design Requirements for Both Ensembles.

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

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

6.20.1.3 Ensembles elements shall include protective garments, protective helmet, protective gloves, protective footwear, protective garment, and protective hood when the protective hood is not already part of the protective garment.

6.20.1.4 All self-contained breathing apparatus specified by the ensemble manufacturer for inclusion in the ensemble shall be certified to NFPA 1981, *Standard on Open-Circuit, Self-Contained Breathing Apparatus for the Fire and Emergency Services*, and by certified as CBRN SCBA by the National Institute for Occupational Safety and Health (NIOSH).

6.20.1.5 Ensembles shall be permitted to be designed as either encapsulating or non-encapsulating.

6.20.1.5.1 The entire surface area of the wearer shall be protected by a continuous chemical/biological/particulate barrier layer.

6.20.1.5.2 The ensemble shall be permitted to use different chemical/biological/particulate barrier layers in the construction of each element.

6.20.1.5.3 The self-contained breathing apparatus specified by the ensemble manufacturer shall be permitted to complete the chemical/biological/particulate barrier layer around the wearer.

6.20.1.6 Ensembles shall be designed to accommodate the respirators specified by the manufacturer for the specific ensemble.

6.20.2 Additional CBR Design Requirements for Structural Fire Fighting Protective Ensembles Only. (Reserve)

6.20.3 Additional CBR Design Requirements for Proximity Fire Fighting Protective Ensembles Only. (Reserve)

6.20.4 Protective Garment Element CBR Design Requirements for Both Ensembles.

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

6.20.4.2 Garments shall be designed and configured to protect at least the wearer's upper and lower torso, arms, and legs.

6.20.4.2.1 Garments shall be permitted to include integrated hoods to protect the wearer's head in conjunction with the self-contained breathing apparatus specified by the ensemble manufacturer.

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

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

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

6.20.5 Additional CBR Design Requirements for Structural Fire Fighting Protective Garment Elements Only. (Reserve)

6.20.6 Additional CBR Design Requirements for Proximity Fire Fighting Protective Garment Elements Only. (Reserve)

6.20.7 Protective Helmet Element CBR Design Requirements for Both Ensembles.

6.20.7.1 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.

6.20.7.2 Where the chemical/biological/particulate barrier layer is provided in the protective hood and provides an interface with the SCBA specified by the ensemble manufacturer, the helmet shall not be required to incorporate a chemical/biological/particulate barrier layer.

6.20.8 Additional CBR Design Requirements for Structural Fire Fighting Protective Helmet Elements Only. (Reserve)

6.20.9 Additional CBR Design Requirements for Proximity Fire Fighting Protective Helmet Elements Only. (Reserve)

6.20.10 Protective Glove Element CBR Design Requirements for Both Ensembles.

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

6.20.10.2 Gloves shall be designed and configured to cover at least the wearer's hands and wrists from the end of the fingertips to at least 25 mm (1 in.) past the wearer's wrist crease.

6.20.10.3 Where outer gloves are worn to provide a chemical/biological/particulate barrier layer, the manufacturer shall provide gloves in not less than five separate and distinct sizes.

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

6.20.11 Additional CBR Design Requirements for Structural Fire Fighting Protective Glove Elements Only. (Reserve)

6.20.12 Additional CBR Design Requirements for Proximity Fire Fighting Protective Glove Elements Only. (Reserve)

6.20.13 Protective Footwear Element CBR Design Requirements for Both Ensembles.

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

6.20.13.2 Footwear shall be designed and configured to cover the wearer's feet from the bottom of the wearer's feet to a height of least 200 mm (8 in.) from the bottom of the wearer's feet.

6.20.13.3 Where booties are used as part of the ensemble, the manufacturer shall specify types of outer footwear that provide the physical and other performance requirements for footwear as specified in Sections 6.9 and 7.9 {standard footwear design and performance requirements).

6.20.13.4 Where outer footwear covers are used as part of the ensemble, the manufacturer shall specify types of outer footwear that provide the physical and other performance requirements for footwear as specified in Sections 6.9 and 7.9 {standard footwear design and performance requirements).

6.20.13.5 Where outer footwear covers are used as part of the ensemble, the manufacturer shall provide footwear covers in not less than five separate and distinct sizes.

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

6.20.14 Additional CBR Design Requirements for Structural Fire Fighting Protective Footwear Elements Only. (Reserve)

6.20.15 Additional CBR Design Requirements for Proximity Fire Fighting Protective Footwear Elements Only. (Reserve)

6.20.16 Protective Hood Interface Component CBR Design Requirements for Both Ensembles.

6.20.16.1 Hood interface components 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.

6.20.16.2 Hood interface components shall be designed and configured to protect the weaerer's head, neck, and face areas, excluding the portion of the face covered by the facepiece of the self-contained breathing apparatus specified by the ensemble manufacturer.

6.20.16.3 Hood interface component shall be permitted to be integrated with the protective garment.

6.20.17 Additional CBR Design Requirements for Structural Fire Fighting Protective Hood Interface Components Only. (Reserve)

6.20.18 Additional CBR Design Requirements for Proximity Fire Fighting Protective Hood Interface Components Only. (Reserve)

Chapter 7 (Old Chapter 5) Performance Requirements

7.1* (5-1) Protective Garment Performance Requirements for Both Ensembles.

7.1.1 (5-1.1) Garment composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for thermal insulation as specified in Section 8.10 (6-10), Thermal Protective Performance (TPP) Test, and shall have an average TPP of not less than 35.0.

7.1.2 (5-1.2) Garment composite shall be tested for overall liquid penetration resistance as specified in Section 8.48 (6-48), Whole Garment Liquid Penetration Test, and shall allow no liquid penetration.

7.1.3 (5-1.4) Garment outer shells, moisture barriers, thermal barriers, collar linings, winter liners where provided, drag rescue devices (DRDs), trim, lettering, and other materials used in garment construction including, but not limited to, padding, reinforcement, interfacing, binding, hanger loops, emblems, and patches shall be individually tested for resistance to flame as specified in Section 8.2 (6-2), Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.) average, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

7.1.3.1 (5-1.4.1) Labels shall meet the performance requirements specified in 7.1.3 only where placed on the exterior of the garment.

7.1.3.2 (5-1.4.2) Zippers and seam-sealing materials shall meet the performance requirements specified in 7.1.3 (5-1.4) only where located on the exterior of the garment or located where they will directly contact the wearer's body.

7.1.3.3 (5-1.4.3) Elastic and hook and pile fasteners shall meet the performance requirements specified in 7.1.3 (5-1.4) only where located where they will directly contact the wearer's body.

7.1.3.4 (5-1.4.4) Small specimens such as hanger loops and emblems or patches that are not large enough to meet the specimen size requirements in 8.2.2.1 (6-2.2.1) shall be tested for resistance to flame as specified in Section 8.2 (6-2), Flame Resistance Test 1, and shall not be totally consumed, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

7.1.4 (5-1.5) Garment outer shells, moisture barriers, thermal barriers, winter liners where provided, and collar linings shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10.0 percent in any direction.

7.1.5 (5-1.6) Garment outer shells, moisture barriers, thermal barriers, collar linings, winter liners where provided, DRDs, trim, lettering, and other materials used in garment construction, including, but not limited to, padding, reinforcement, labels, interfacing, binding, hanger loops, emblems or patches, but excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body, shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

7.1.6 (5-1.23) The garment composite from the shoulder areas and the knee areas shall be tested for resistance to heat transfer as specified in Section 8.51 (6-51), Conductive and Compressive Heat Resistance (CCHR) Test, and shall have a minimum CCHR rating of 25 for the shoulder areas and for the knee areas.

7.1.7 Garment composites consisting of the outer shell, moisture barrier, and thermal barrier shall be tested for heat momentum as specified in 8.61, Heat Momentum Test, and shall have an average time to burn of not less than 12 seconds.

7.1.8 Garment composites consisting of the outer shell, moisture barrier, and thermal barrier shall be tested for stored thermal energy as specified in 8.60, Stored Energy Test, and shall have an average time to burn of not less than 60 seconds.

7.1.9 (5-1.7) Garment moisture barrier seams shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not drip or ignite.

7.1.10 (5-1.8) Garment outer shells and collar linings shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not char.

7.1.11 (5-1.9) All garment hardware, excluding hook and pile fasteners, where placed so that they will not directly contact the wearer's body, shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not ignite and shall remain functional.

7.1.12 (5-1.10) All sewing thread utilized in the construction of garments and the DRDs shall be tested for resistance to melting as specified in Section 8.11 (6-11), Thread Melting Test, and shall not melt below 260°C (500°F).

7.1.13 (5-1.11) Garment outer shells and collar linings shall be individually tested for resistance to tearing as specified in Section 8.12 (6-12), Tear Resistance Test, and shall have a tear strength of not less than 100 N (22 lbf).

7.1.14 (5-1.12) Garment moisture barriers, thermal barriers, and winter liners, where provided, shall be tested for resistance to tearing as specified in Section 8.12 (6-12), Tear Resistance Test, and shall have a tear strength of not less than 22 N (5 lbf).

7.1.15 (5-1.13) All garment seam assemblies shall be tested for strength as specified in Section 8.14 (6-14), Seam-Breaking Strength Test.

7.1.15.1 (5-1.13.1) Woven garment seam assemblies and specimens of seam assemblies that contain at least one woven material shall demonstrate a sewn seam strength equal to or greater than 667 N (150 lbf) force for Major A seams, 334 N (75 lbf) force for Major B seams, and 180 N (40 lbf) force for Minor seams when tested using the method specified in 8.14.2.2.1 (6-14.2.2.1).

7.1.15.2 (5-1.13.2) Seam breaking strength shall be considered acceptable where the fabric strength is less than the required seam strength specified in 7.1.15.1 (5-1.13.1), providing the fabric fails without failure of the seam below the applicable forces specified in 7.1.15.1 (5-1.13.1).

7.1.15.3 (5-1.13.3) All knit or stretch woven garment seam assemblies shall demonstrate a sewn seam strength equal to or greater than 180 N (40 lbf) when tested using the method specified in 8.14.2.2.2 (6-14.2.2.2).

7.1.15.4 (5-1.13.4) All combination woven and knit or stretch knit seam specimens shall meet the requirements specified in 7.1.15.1 (5-1.13.1).

7.1.16 (5-1.14) Garment moisture barriers shall be tested for resistance to water penetration as specified in Section 8.27 (6-27), Water Penetration Resistance Test, and shall have a minimum water penetration resistance of 172 kPa (25 psi).

7.1.17* (5-1.15) Garment moisture barrier materials and seams shall be tested for resistance to liquid penetration as specified in Section 8.28 (6-28), Liquid Penetration Resistance Test, and shall show no penetration of the test liquids for at least 1 hour.

7.1.18 (5-1.16) Garment moisture barriers and moisture barrier seams shall be tested for resistance to liquid or blood-borne pathogens as specified in Section 8.29 (6-29), Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.1.19 (5-1.17) Garment outer shells, moisture barriers, thermal barriers, winter liners where provided, and collar linings shall be individually tested for resistance to shrinkage as specified in Section 8.25 (6-25), Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

7.1.20 (5-1.18) Garment outer shells and collar linings shall be individually tested for resistance to water absorption as specified in Section 8.26 (6-26), Water Absorption Resistance Test, and shall not have more than 30 percent water absorption.

7.1.21 (5-1.19) Garment outer shells and collar linings shall be individually tested for strength after washing as specified in Section 8.50 (6-50), Breaking Strength Test, and shall have a breaking strength of not less than 623 N (140 lbf).

7.1.22 (5-1.20) All garment metal hardware and specimens of all garment hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 8.30 (6-30), Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show no more than light surface-type corrosion or oxidation and shall remain functional. Ferrous metals shall show no corrosion of the base metal and shall remain functional.

7.1.23 (5-1.12) Labels shall be tested for durability and legibility as specified in Section 8.42 (6-42), Label Durability and Legibility Test 1, and shall remain in place and shall be legible.

7.1.24 DRD materials and seams shall be tested for material strength as specified in Section 8.58, DRD Materials Strength Test, and shall have a minimum tensile strength of 13.5 kN (3034 lbs).

7.1.25 Garments with the DRD installed shall be tested for functionality as specified in 8.59, DRD Function Test, and shall allow for the mannequin to be dragged for a minimum of 2.5 m (5 ft).

7.1.26 Garment moisture barrier materials shall be tested for resistance to light degradation as specified in Section 8.62, Light Degradation Resistance Test, and shall have a minimum water penetration resistance of 13.8 kPa (2 psi).

7.1.27 Hook and loop fastener tapes shall be tested for flame resistance as specified in Section 8.6, Hook and Loop Flame Resistance Test, and shall have a char length of not more than 150 mm (6 in.), shall have an afterflame of not more than 15 seconds, and shall not have drips that burn for more than 3 seconds after falling.

7.1.28 Hook and loop fastener tapes shall be tested for shear strength as specified in Section 8.64, Shear Strength Test, and shall have a sheer not less than 44.8 kPa (6.5 psi).

7.1.29 Hook and loop fastener tapes shall be tested for peel strength as specified in Section 8.65, Peel Strength Test, and shall have a peel strength not less than 0.05 N/mm (0.3 lbf/in.) width.

7.2 Additional Performance Requirements for Structural Fire Fighting Garments Only.

7.2.1 Structural fire fighting protective garment elements shall also meet the performance requirements specified in this section in addition to the perofrmance requirements specified in Section 7.1, Protective Garment Performance Requirements for Both Ensembles.

7.2.2 (5-1.3) Garment composite consisting of the outer shell, moisture barrier, and thermal barrier shall be tested for evaporative heat transfer as specified in Section 8.34 (1976: 6-34), Total Heat Loss Test, and shall have a total heat loss of not less than 170 W/m^2.

7.2.3 (5-1.22) Garment trim shall be tested for retroreflectivity and fluorescence as specified in Section 8.46 (6-46), Retroreflectivity and Fluorescence Test, and shall have a Coefficient of Retroreflection (R_a) of not less than 100 $cd/lux/m^2$ ($cd/fc/ft^2$), and the chromaticity for the specified colors shall lbe within one of the areas defined in Table 7.1.22, Color, and the Cap Y luminance factor shall exceed the corresponding minimum.

Table 7.1.22 Color

Color	Chromaticity Coordinates		Minimum Luminance Factor (Cap Y)
Fluorescent Yellow-Green	0.387	0.610	70
	0.356	0.494	
	0.398	0.452	
	0.460	0.540	
Fluorescent Orange-Red	0.610	0.390	40
	0.535	0.375	
	0.570	0.340	
	0.655	0.344	
Fluorescent Red	0.655	0.344	25
	0.570	0.340	
	0.595	0.315	
	0.690	0.310	

7.3 Additional Performance Requirements for Proximity Fire Fighting Garments Only.

7.3.1 Proximity fire fighting protective garment elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.1, Protective Garment Design Requirements for Both Ensembles.

7.3.2 Garment outer shells shall be tested for radiant reflective capability as specified in 8.5.2 (1976: 6-10), Radiant Heat Resistance Test 2, and shall have a radiant reflective value of not less than 20 seconds.

7.3.3 Garment outer shells shall be tested for resistance to delamination as specified in Section 8.54 (1976: 6-31), Wet Flex, and shall show no signs of cracking on the face or delamination if the base fabric is a laminate.

7.3.4 Garment outer shells shall be tested for adhesion durability as specified in Section 8.55 (1976: 6-32), Adhesion After Wet Flex-Tape Method, and shall show no evidence of separation of the coating or laminate from the base cloth.

7.3.5 Garment outer shells shall be tested for flex durability as specified in Section 8.56 (1976: 6-33), Flex at Low Temperature, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.3.6 Garment outer shells shall be tested for blocking durability as specified in Section 8.57 (1976: 6-34), Resistance to High-Temperature Blocking, and shall show no blocking.

7.4 (5-2) Protective Helmet Performance Requirements for Both Ensembles.

7.4.1 (5-2.1) Helmets shall be tested for resistance to impact as specified in Section 8.15 (6-15), Top Impact Resistance Test (Force), and shall have no sample transmit a force of more than 3780 N (850 lbf).

7.4.2 (5-2.2) Helmets shall be tested for resistance to impact as specified in Section 8.16 (6-16), Impact Resistance Test (Acceleration), and shall have no sample exceed the maximum acceleration specified in Table 7.4.2 (5-2.2). Any acceleration above 200 Gn shall not exceed a duration of 3 milliseconds, and an acceleration above 150 Gn shall not exceed a duration of 6 milliseconds.

Table 7.4.2 (5-2.2) Impact Acceleration

Impact Location	Maximum Acceleration	m • sec/sec	(ft • sec/sec)
Top	150 × Gn*	1471.5	(4830)
Front	300 × Gn	2943.0	(9660)
Sides	300 × Gn	2943.0	(9660)
Back[1]	300 × Gn	2943.0	(9660)

7.4.3 (5-2.3) Helmets shall be tested for resistance to penetration as specified in Section 8.19 (6-19), Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration test striker and the headform.

7.4.4 (5-2.4) Helmets shall be tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test. The following results shall be considered unacceptable:

(1) Parts of the complete helmet assembly that do not contact the headform before this test come in contact with the headform as a result of this test

(2) Shell distortion in the back extend more than 40 mm (1 5/8 in.) below the original position of the helmet

(3) Distortion of the front and sides of the shell extend more than 30 mm (1 3/16 in.) below the original position of the helmet

(4) Separation, melting, or dripping of the retention system, energy absorption system, or ear covers

(5) Dysfunctional chin strap closure device

(6) Ignition of any part of the helmet assembly

(7) Ignition or melting of the product labels

(8) Part of the faceshield/goggle component that was not below the brim line prior to the test be below the brim line after the test

(9) Dripping of the faceshield/goggle component

7.4.5 (5-2.5) Helmets shall be tested for resistance to flame as specified in Section 8.3 (6-3), Flame Resistance Test 2, Procedures A and C, and shall not show any visible afterflame or glow 5.0 seconds after removal from the test flame in each test.

7.4.6 (5-2.6) Helmets shall be tested for resistance to electricity as specified in both Procedure A and Procedure B of Section 8.31 (6-31), Electrical Insulation Test 1, and shall not have leakage current exceeding 3.0 mA in each test.

7.4.7 (5-2.7) Helmets shall be tested for retention ability as specified in Section 8.35 (6-35), Retention System Test, without any break occurring and without any resulting slip or stretch of more than 20 mm (13/16 in.).

7.4.8 (5-2.8) Helmet suspension systems shall be tested for retention ability as specified in Section 8.36 (6-36), Suspension System Retention Test, and shall not separate from the helmet.

7.4.9 (5-2.9) Helmets shall be tested for shell retention ability as specified in Section 8.44 (6-44), Shell Retention Test, and shall not have the helmet shell separate from the helmet suspension and retention systems.

7.4.10 (5-2.10) All materials utilized in the construction of helmet ear covers and chin straps shall be individually tested for resistance to flame as specified in Section 8.2 (6-2), Flame Resistance Test 1, and shall not have a char length greater than 100 mm (4 in.), shall not show any visible afterflame 2.0 seconds after removal from the test flame, and shall not melt or drip.

7.4.11 (5-2.11) All materials utilized in the construction of helmet ear covers and chin straps shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction, and shall not melt, separate, or ignite. Helmet chin strap material shall meet the thermal shrinkage requirement for the length dimension only.

7.4.12 (5-2.12) All sewing thread used in the construction of helmets shall be tested for melting resistance as specified in Section 8.11 (6-11), Thread Melting Test, and shall not melt below 260°C (500°F).

7.4.13 (5-2.13) All helmet metal hardware and specimens of all helmet hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 8.30 (6-30), Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show no more than light surface-type corrosion or oxidation and shall remain functional. Ferrous metals shall show no corrosion of the base metal and shall remain functional.

7.4.14 (5-2.14) Labels shall be tested for durability and legibility as specified in Section 8.43 (6-43), Label Durability and Legibility Test 2, shall remain in place, and shall be legible.

7.4.15 (5-2.15) Helmet trim shall be tested for retroreflectivity and fluorescence as specified in Section 8.46 (6-46), Retroreflectivity and Fluorescence Test, shall have a Coefficient of Retroreflection (*Ra*) of not less than 100 cd/lux/m^2 (cd/ft candle/ft^2), and shall be designated as fluorescent.

7.5 Additional Performance Requirements for Structural Fire Fighting Helmet Only.

7.5.1 Structural fire fighting protective helmets shall also meet the performance requirements specified in this section in addition to the perofrmance requirements specified in Section 7.4, Protective Helmet Performance Requirements for Both Ensembles.

7.5.2 (5-2.16) Faceshield/goggle components shall be tested for resistance to impact as specified in Section 8.17 (6-17), Faceshield/Goggle Component Lens Impact Resistance Test, Tests One and Two. Faceshield/goggle components shall have no contact with an eye of the headform nor shall any parts of fragments be ejected from the component that could contact the eye of the headform.

7.5.3 (5-2.17) Faceshield/goggle components shall be tested for flame resistance as specified in Section 8.3 (6-3), Flame Resistance Test 2, Procedure B, and shall not show any visible afterflame 5.0 seconds after removal of the test flame.

7.5.4 (5-2.18) All fabrics utilized in construction of faceshield/goggle components shall be tested for flame resistance as specified in Section 8.2 (6-2), Flame Resistance Test 1. All fabrics shall not have a char length of more than 100 mm (4 in.) average and shall not have an afterflame of more than 5.0 seconds average after removal of the test flame.

7.5.5 (5-2.19) Faceshield/goggle component lenses shall be tested for resistance to scratching as specified in Section 8.23 (6-23), Faceshield/Goggle Component Lens Scratch Resistance Test, and shall not exhibit a delta haze of greater than 25 percent.

7.5.6 (5-2.20) Faceshield/goggle component lenses shall be tested for transmittance of light as specified in Section 8.45 (6-45), Luminous (Visible) Transmittance Test. Clear lenses shall transmit a minimum of 85 percent of the incident visible radiation. Colored lenses shall transmit a minimum of 43 percent of the incident visible radiation.

7.5.7 (5-2.21) Where provided, the faceshield/goggle component attachment hardware shall be tested for flame resistance as specified in Section 8.3 (6.3), Flame Resistance Test 2, Procedure D, and shall not show any visible afterflame 5.0 seconds after removal of the test flame.

7.5.8 Helmet ear covers shall be tested for thermal insulation as specified in Section 8.10, Thermal Protective Performance (TPP) Test, and shall have an average TPP rating of at least 20.0.

7.6 Additional Performance Requirements for Proximity Fire Fighting Helmet Only.

7.6.1 Proximity fire fighting protective helmets shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.4, Protective Helmet Performance Requirements for Both Ensembles.

7.6.2 [1976: 5-2.23] Helmets shall be tested for radiant reflective value as specified in Section 8.53 (1976: 6-11), Radiant Heat Resistance Test 3, and shall not have a temperature rise of more than 25°C (45°F).

7.6.3 [1976: 5-2.1] Helmet shrouds shall be tested for radiant reflective capability as specified in Section 8.52 (1976: 6-10), Radiant Reflective Test 2, and shall have a radiant reflective value of not less than 20 seconds.

7.6.4 [1976: 5-2.2] Helmet shrouds with the a laminate base fabric shall be tested for resistance to delamination as specified in Section 8.54 (1976: 6-31), Wet Flex Test, and shall show no signs of cracking on the face or delamination.

7.6.5 [1976: 5-2.3] Helmet shrouds shall be tested for adhesion durability as specified in Section 8.55 (1976: 6-32), Adhesion After Wet Flex Tape Test, and shall show no evidence of separation of the coating or laminate from the base cloth.

7.6.6 [1976: 5-2.4] Helmet shrouds shall be tested for flex durability as specified in Section 8.56 (1976: 6-33), Flex at Low Temperature Test, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.6.7 [1976: 5-2.5] Helmet shrouds shall be tested for blocking durability as specified in Section 8.57 (1976: 6-34), Resistance to High-Temperature Blocking Test, and shall show no blocking.

7.6.8 [1976: 5-2.6] Helmet shroud composites outer shell, moisture barrier, and thermal barrier shall be tested for thermal insulation as specified in Section 8.13 [1976: 6-13], Thermal Protective Performance (TPP) Test, and shall have an average thermal protective performance (TPP) of not less than 35.0.

7.6.9 Helmet shroud moisture barrier materials and seams shall be tested for resistance to water penetration as specified in Section 8.28, Water Penetration Test, and shall have a minimum water penetration resistance of 1.76 kg/cm^2 (25 psi) when tested as specified in 8.28.4.1.

7.6.10 Helmet shroud moisture barrier materials and seams shall be tested for resistance to liquids penetration as specified in Section 8.29, Liquid Penetration Resistance Test, and shall show penetration of the test liquids for at least 1 hour.

7.6.11 Helmet shroud moisture barrier materials and seams shall be tested for resistance to liquid borne or blood borne pathogens as specified in Section 8.30, Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.6.12 [1976: 5-2.7] Helmet shrouds shall be individually tested for resistance to tearing as specified in Section 8.15 (1976: 6-15), Tear Resistance Test, and shall have a tear strength of not less than 98 N (22 lbf).

7.6.13 Helmet faceshields shall be tested for resistance to impact as specified in Section 8.20 (1976: 6-20), Faceshield Component Impact Resistance, Tests 1 and 2, and shall have no contact with an eye of the headform; nor shall any parts of fragments be ejected from the component that could contact the eye of the headform.

7.6.14 [1976: 5-2.25] Helmet faceshields shall be tested for flame resistance as specified in Section 8.3 [1976: 6-3], Flame Resistance Test 2, Procedure B, and shall not show any visible afterflame 5 seconds after removal of the test flame.

7.6.15 [1976: 5-2.26] Helmet faceshield component lenses shall be tested for transmittance of light as specified in Section 8.50 [1976: 6-50], Luminous (Visible) Transmittance Test, and shall transmit not less than 30 percent of the incident visible radiation.

7.6.16 [1976: 5-2.27] Helmet faceshields shall be tested for radiant reflective capability as specified in Section 8.52 [1976: 6-10], Radiant Reflective Test 2, and shall have a radiant reflective value of not less than 30 seconds.

7.6.17 [1976: 5-2.1] Helmet outer covers, where provided, shall be tested for radiant reflective capability as specified in Section 8.52 (1976: 6-10), Radiant Heat Resistance Test 2, and shall have a radiant reflective value of not less than 20 seconds.

7.6.18 [1976: 5-2.2] Helmet outer covers, where provided, shall be tested for resistance to delamination as specified in Section 8.54 (1976: 6-31), Wet Flex Test, and shall show no signs of cracking on the face or delamination if the base fabric is a laminate.

7.6.19 [1976: 5-2.3] Helmet outer covers, where provided, shall be tested for adhesion durability as specified in Section 8.55 (1976: 6-32), Adhesion After Wet Flex Tape Test, and shall show no evidence of separation of the coating or laminate from the base cloth.

7.6.20 [1976: 5-2.4] Helmet outer covers, where provided, shall be tested for flex durability as specified in Section 8.56 (1976: 6-33), Flex at Low Temperature Test, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.6.21 [1976: 5-2.5] Helmet outer covers, where provided, shall be tested for blocking durability as specified in Section 8.57 (1976: 6-34), Resistance to High-Temperature Blocking Test, and shall show no blocking.

7.6.22 [1976: 5-2.8] Helmet outer covers, where provided, shall be tested for resistance to tearing as specified in Section 6-15, Tear Resistance Test, and shall have a tear strength of not less than 22 N (5 lbf).

7.7 (5-3) Protective Glove Performance Requirements for Both Ensembles.

7.7.1 (5-3.1) The glove body composite shall be tested for thermal insulation as specified in Section 8.10 (6-10), Thermal Protective Performance (TPP) Test, and shall have an average TPP rating of at least 35.0.

7.7.2 (5-3.2) Where gauntlets or glove wristlets are provided, the glove gauntlet or glove wristlet composite shall be tested for thermal insulation as specified in Section 8.10 (6-10), Thermal Protective Performance (TPP) Test, and shall have an average TPP rating of at least 20.0.

7.7.3 (5-3.3) Gloves shall be tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite, shall not shrink more than 8 percent in length or width, shall be donnable, and shall be flexible.

7.7.4 (5-3.4) The innermost separable layer of the glove body composite that is designed to come into contact with the wearer's skin shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

7.7.5 (5-3.5) The glove body composite shall be tested for thermal insulation as specified in Section 8.7 (6-7), Conductive Heat Resistance Test 1, and shall have a second-degree burn time of not less than 10.0 seconds and shall have a pain time of not less than 6.0 seconds.

7.7.6 (5-3.6) The glove body composite shall be tested for resistance to flame as specified in Section 8.4 (6-4), Flame Resistance Test 3, and shall not have an average char length of more than 100 mm (4 in.), shall not have an average afterflame of more than 2.0 seconds, shall not melt or drip, and shall not have the amount of consumed materials exceed 5 percent.

7.7.6.1 Where glove gauntlets are provided and the gauntlet composite is different than the glove body composite, the glove gauntlet composite shall meet the requirements specified in 7.7.6.

7.7.6.2 (5-3.7) Where glove wristlets are provided, the wristlet composite shall meet the requirements specified in 7.7.6.

7.7.7 (5-3.8) All sewing thread utilized in the construction of gloves shall be tested for melting resistance as specified in Section 8.11 (6-11), Thread Melting Test, and shall not melt below 260°C (500°F).

7.7.8* (5-3.9) The glove body composite and seams shall be tested for resistance to liquid or blood-borne pathogens as specified in Section 8.29 (6-29), Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.7.9* (5-3.10) Glove body composite and seams shall be tested for resistance to liquid penetration as specified in Section 8.28 (6-28), Liquid Penetration Resistance Test, and shall allow no penetration of test liquids for at least 1 hour.

7.7.10 (5-3.11) The glove body composite shall be tested for resistance to cut as specified in Section 8.22 (6-22), Cut Resistance Test, and shall have a distance of blade travel of more than 25 mm (1 in.).

7.7.11 (5-3.12) The glove gauntlet or glove wristlet composite, if different from the glove body composite, shall be tested for resistance to cut as specified in Section 8.22 (6-22), Cut Resistance Test, and shall have a a distance of blade travel of more than 25 mm (1 in.).

7.7.12 (5-3.13) The glove body composite shall be tested for resistance to puncture as specified in Section 8.20 (6-20), Puncture Resistance Test 1, and shall not be punctured under an average applied force of 4.0 kg (8.8 lb).

7.7.13* (5-3.14) Gloves shall be tested for hand function as specified in Section 8.38 (6-38), Glove Hand Function Tests, and shall have an average percent of barehand control not exceeding 250 percent.

7.7.14 (5-3.15) Knit glove wristlet material(s) shall be tested for material strength as specified in Section 8.13 (6-13), Burst Strength Test, and shall have a burst strength of not less than 225 N (50 lbf).

7.7.15 (5-3.16) Knit glove wristlets and glove gauntlet seams shall be tested for seam strength as specified in Section 8.14 (6-14), Seam-Breaking Strength Test, and shall have a burst strength of not less than 182 N (41 lbf).

7.7.16* (5-3.18) Gloves shall be tested for resistance to leakage as specified in Section 8.33 (6-33), Overall Liquid Integrity Test 1, and shall show no leakage.

7.7.17* (5-3.19) Gloves shall be tested for ease of donning as specified in Section 8.37 (6-37), Glove Donning Test, and shall have the donning time not exceed 15 seconds, shall have no detachment of the inner liner or moisture barrier, and shall allow full insertion of all digits.

7.7.18 Gloves shall be tested for retention of the glove liner as specified in Section 8.63, Liner Retention Test, and shall have no detachment of the inner liner or moisture barrier.

7.7.19 (5-3.21) Labels shall be tested for durability and legibility as specified in Section 8.42 (6-42), Label Durability and Legibility Test 1, shall remain in place, and shall be legible.

7.8 Additional Performance Requirements for Structural Fire Fighting Gloves Only.

7.8.1 Structural fire fighting protective gloves shall also meet the performance requirements specified in this section in addition to the perofrmance requirements specified in Section 7.7, Protective Glove Performance Requirements for Both Ensembles.

7.8.2 (5-3.17) Gloves shall be tested for grip as specified in Section 8.39 (6-39), Grip Test, and shall have a weight-pulling capacity not less than 90 percent of the bare-handed control value.

7.8.3 (5-3.20) All glove metal hardware and all glove hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 8.30 (6-30), Corrosion Resistance Test. Metals inherently resistant to corrosion including, but not limited to, stainless steel, brass, copper, aluminum, and zinc shall show no more than light surface-type corrosion or oxidation, ferrous metals shall show no corrosion of the base metal, and hardware shall remain functional.

7.9 Additional Performance Requirements for Proximity Fire Fighting Gloves Only.

7.9.1 Proximity fire fighting protective gloves shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.7, Protective Glove Performance Requirements for Both Ensembles.

7.9.2 [1976: 5-3.1] The back of the hand of the glove, including the gauntlet where provided, shall be tested for radiant reflective capability as specified in Section 8.52 [1976: 6-10], Radiant Heat Resistance Test 2, and shall have a radiant reflective value of not less than 20 seconds.

7.9.3 [1976: 5-3.2] The back of the hand of the glove, including the gauntlet where provided, shall be tested for resistance to delamination as specified in Section 8.54 [1976: 6-31], Wet Flex Test, and shall show no signs of cracking on the face or delamination if the base fabric is a laminate.

7.9.4 [1976: 5-3.3] The back of the hand of the glove, including the gauntlet where provided, shall be tested for adhesion durability as specified in Section 8.55 [1976: 6-32], Adhesion After Wet Flex Tape Test, and shall show no evidence of separation of the coating or laminate from the base cloth.

7.9.5 [1976: 5-3.4] The back of the hand of the glove, including the gauntlet where provided, shall be tested for flex durability as specified in Section 8.56 [1976: 6-33], Flex at Low Temperature, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.9.6 [1976: 5-3.5] The back of the hand of the glove, including the gauntlet where provided, shall be tested for blocking durability as specified in Section 8.57 [1976: 6-34], Resistance to High-Temperature Blocking Test, and shall show no blocking.

7.9.7 [1976: 5-3.22] Gloves shall be tested for grip as specified in Section 8.39 (6-39), Grip Test, and shall have a weight-pulling capacity not less than 80 percent of the bare-handed control value.

7.10 (5.4) Protective Footwear Performance Requirements for Both Ensemles.

7.10.1 (5-4.2) Footwear shall be tested for thermal insulation as specified in Section 8.9 (6-9), Radiant Heat Resistance Test 1, and the temperature of the upper lining surface in contact with the skin shall not exceed 44°C (111°F).

7.10.2 (5-4.3) Footwear shall be tested for thermal insulation as specified in Section 8.7 (6-7), Conductive Heat Resistance Test 1, and the temperature of the upper lining surface in contact with skin shall have a second-degree burn time of not less than 10.0 seconds and shall have a pain time of not less than 6.0 seconds.

7.10.3 (5-4.4) Footwear shall be tested for thermal insulation as specified in Section 8.8 (6-8), Conductive Heat Resistance Test 2, and the temperature of the insole surface in contact with the foot shall not exceed 44°C (111°F).

7.10.4 (5-4.5) Footwear, with components in place, shall be tested for resistance to flame as specified in Section 8.5 (6-5), Flame Resistance Test Four, and shall not have an afterflame of more than 2.0 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.10.5 (5-4.9) All sewing thread utilized in the construction of footwear shall be tested for melt resistance as specified in Section 8.11 (6-11), Thread Melting Test and shall not melt below 260°C (500°F).

7.10.6 (5-4.6) The footwear upper material composite, upper seams, and vamp seams shall be tested for resistance to liquid penetration as specified in Section 8.28 (6-28), Liquid Penetration Resistance Test, and shall allow no penetration of the test liquids for at least 1 hour.

7.10.7 (5-4.7) The footwear upper material composite, upper seams, and vamp seams shall be tested for resistance to liquid or blood-borne pathogens as specified in Section 8.29 (6-29), Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.10.8 (5-4.8) Footwear shall be tested for resistance to puncture as specified in Section 8.20 (6-20), Puncture Resistance Test 1, and shall not puncture the footwear upper under an average applied force of 6 kg (13 lb).

7.10.9 (5-4.10) Footwear shall be tested for resistance to puncture as specified in Section 8.21 (6-21), Puncture Resistance Test 2, and shall not allow puncture through the sole area and the heel area at a force load of less than 1212 N (272 lbf).

7.10.10 (5-4.11) Footwear uppers shall be tested for resistance to cut as specified in Section 8.22 (6-22), Cut Resistance Test, and shall have a cut distance resistance of more than 25 mm (1 in.).

7.10.11* (5-4.12) Footwear shall be tested for resistance to slipping as specified in Section 8.41 (6-41), Slip Resistance Test, and the soles shall have a static coefficient of 0.75 or greater in a dry condition.

7.10.12 (5-4.13) Footwear shall be tested for resistance to abrasion as specified in Section 8.24 (6-24), Abrasion Resistance Test, and the sole with heel shall have an abrasion index of not less than 100.

7.10.13* (5-4.14) Footwear shall be tested for resistance to electricity as specified in Section 8.32 (6-32), Electrical Insulation Test 2, and shall have no leakage in excess of 5.0 mA.

7.10.14 (5-4.15) Footwear toes shall be tested for resistance to impact and compression as specified in Section 8.18 (6-18), Impact and Compression Tests, and shall have an impact requirement of 102 J (75 ft-lb) and shall have a compression requirement of 11,121 N (2500 lbf) with a minimum clearance of at least 13 mm (1/2 in.).

7.10.15 (5-4.16) Footwear ladder shanks shall be tested for resistance to bending as specified in Section 8.40 (6-40), Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (1/4 in.).

7.10.16 (5-4.17) Footwear stud posts and eyelets shall be tested for attachment strength as specified in Section 8.49 (6-49), Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 294 N (66 lbf).

7.10.17 (5-4.18) All footwear metal hardware and specimens of all footwear hardware that include metal parts including but not limited to toecap, ladder shank, puncture-resistant device, and components shall be individually tested for resistance to corrosion as specified in Section 8.30 (6-30), 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 all hardware remain functional.

7.10.19 (5-4.19) Labels shall be tested for durability and legibility as specified in Section 8.42 (6-42), Label Durability and Legibility Test 1, and shall remain in place and shall be legible to the unaided eye.

7.11 Additional Performance Requirements for Structural Fire Fighting Footwear Only.

7.11.1 Structural fire fighting protective footwear shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.10, Protective Footwear Performance Requirements for Both Ensembles.

7.11.2 (5-4.1) Footwear shall be tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not have any part of the footwear melt, separate, or ignite, shall show no water penetration, and shall have all components remain functional.

7.12 Additional Performance Requirements for Proximity Fire Fighting Footwear Only.

7.12.1 Proximity fire fighting protective footwear shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.10, Protective Footwear Performance Requirements for Both Ensembles.

7.12.2 [1976: 5-4.21] Footwear shall be tested for radiant reflective capability as specified in Section 8.52, (1976: 6-10), Radiant Heat Resistance Test 2, and shall have a radiant reflective value of not less than 20 seconds.

7.12.3 [1976: 5-4.1] Footwear shall be tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not have any part of the footwear melt, separate, or ignite; shall not shrink more than 5 percent in any dimension; and shall have all components remain functional.

7.12.4 [1976: 5-4.3] Footwear shall be tested for thermal insulation as specified in Section 8.7 (6-7), Conductive Heat Resistance Test 1, and the temperature of the upper lining surface in contact with skin shall not reach 44°C (111°F) in 10 minutes or less.

7.12.5 [1976: 5-4.7] Footwear shall be tested for resistance to water as specified in Section 8.71 (1976: 6-39), Overall Liquid Integrity Test 2, and shall show no water penetration.

7.13 (5-5) Protective Hood Interface Component Performance Requirements for Both Ensembles. (Reserve)

7.14 Additional Performance Requirements for Structural Fire Fighting Protective Hood Interface Components Only

7.14.1 (5-5.1) Structural fire fighting hood face openings that are not manually adjustable or that are not designed for interface with a specific SCBA facepiece shall be tested for shape retention as specified in Section 8.47 (6-47), Hood Opening Size Retention Test, and shall retain at least 80 percent of the original face opening size but shall not exceed 145 mm ($5^5/_8$ in.).

7.14.1.1 (5-5.1.1) Where hood face openings are designed to interface with a specific SCBA facepiece, specimens of such hood face openings shall be tested for shape retention as specified in Section 8.47 (6-47), Hood Opening Size Retention Test, and shall overlap the outer edge of the specific SCBA facepiece-to-face seal perimeter by not less than 13 mm (1/2 in.).

7.14.1.2 (5-5.1.2) Where hood face openings are designed to be manually adjustable, such hood face openings shall meet the design requirement specified in 6.5.4.2 (4-5.4.2).

7.14.2 (5-5.2) Hoods shall be tested for thermal insulation as specified in Section 8.10 (6-10), Thermal Protective Performance (TPP) Test, and shall have a TPP of not less than 20.0.

7.14.3 (5-5.3) Hood material(s), including labels but excluding hook and pile fasteners and elastic when not placed in direct contact with the body, shall be individually tested for resistance to flame as specified in Section 8.2 (6-2), Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.) average, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

7.14.4 (5-5.4) Hood material(s), excluding labels, hook and pile fasteners and elastic shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

7.14.5 (5-5.5) Hood material(s), including labels but excluding hook and pile fasteners and elastic when these items are placed where they will not directly contact the wearer's body, shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

7.14.6 (5-5.6) Hood material(s), including labels but excluding hook and pile fasteners and elastic when these items are placed where they will not directly contact the wearer's body, shall be individually tested for resistance to shrinkage as specified in Section 8.25 (6-25), Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

7.14.7 (5-5.7) All sewing thread utilized in the construction of hoods shall be tested for melting resistance as specified in Section 8.11 (6-11), Thread Melting Test, and shall not melt below 260°C (500°F).

7.14.8 (5-5.8) Knit hood material(s) shall be tested for material strength as specified in Section 8.13 (6-13), Burst Strength Test, and shall have a burst strength of not less than 225 N (51 lbf).

7.14.9 (5-5.9) Knit hood seams shall be tested for seam strength as specified in Section 8.14 (6-14), Seam-Breaking Strength Test, and shall have a burst strength of not less than 181 N (41 lbf).

7.14.10 (5-5.10) Labels shall be tested for durability and legibility as specified in Section 8.42 (6-42), Label Durability and Legibility Test 1, and shall remain attached to the hood and shall be legible to the unaided eye.

7.15 Additional Performance Requirements for Proximity Fire Fighting Protective Hood Interface Components Only.

7.15.1 Proximity fire fighting protective hood interface components shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.13, Protective Hood Interface Component Performance Requirements for Both Ensembles.

7.16 (5-6) Protective Wristlet Interface Component Performance Requirements for Both Ensembles.

7.16.1 (5-6.1) Wristlets shall be tested for thermal insulation as specified in Section 8.10 (6-10), Thermal Protective Performance (TPP) Test, and shall have a TPP of not less than 20.0.

7.16.2 (5-6.2) Wristlet material(s) shall be individually tested for resistance to flame as specified in Section 8.2 (6-2), Flame Resistance Test 1, and shall not have a char length of more than 100 mm (4 in.) average, shall not have an afterflame of more than 2.0 seconds average, and shall not melt or drip.

7.16.3 (5-6.3) Wristlet material(s) shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

7.16.4 (5-6.4) Wristlet material(s) shall be individually tested for resistance to heat as specified in Section 8.6 (6-6), Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

7.16.5 (5-6.5) Wristlet material(s) shall be individually tested for resistance to shrinkage as specified in Section 8.25 (6-25), Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

7.16.6 (5-6.6) All sewing thread utilized in the construction of wristlets shall be tested for melting resistance as specified in Section 8.11 (6-11), Thread Melting Test, and shall not melt at or below 260°C (500°F).

7.16.7 (5-6.7) Knit wristlet material(s) shall be tested for material strength as specified in Section 8.13 (6-13), Burst Strength Test, and shall have a burst strength of not less than 225 N (51 lbf).

7.16.8 (5-6.8) Knit wristlet seams shall be tested for seam strength as specified in Section 8.14 (6-14), Seam-Breaking Strength Test, and shall have a breaking strength of not less than 181 N (41 lbf).

7.17 Additional Performance Requirements for Structural Fire Fighting Protective Wristlet Interface Components Only.

7.17.1 Structural fire fighting protective hood interface components shall also meet the performance requirements specified in this section in addition to the perofrmance requirements specified in Section 7.16, Protective Wristlet Interface Component Performance Requirements for Both Ensembles.

7.18 Additional Performance Requirements for Proximity Fire Fighting Protective Wristlet Interface Components Only.

7.18.1 Proximity fire fighting protective wristlet interface components shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.16, Protective Wristlet Interface Component Performance Requirements for Both Ensembles.

7.19 (Reserved)

7.20 *Optional* Performance Requirements for Protection from Chemical, Biological, and Radiological (CBR) Terrorism Agents.

7.20.1 Protective Ensemble CBR Performance Requirements for Both Ensembles.

7.20.1.1 The entire ensemble shall be tested as specified in Section 8.A, Overall Ensemble Inward Leakage Test, and shall show no inward leakage greater than 1.0 percent.

7.20.1.2 The entire ensemble shall be tested as specified in Section 8.48, Whole Garment Liquid Penetration Test, and shall show no liquid penetration.

7.20.1.3 Where an ensemble element's chemical/biological/particulate barrier layer and the barrier layer seams are also the moisture barrier and moisture barrier seams for that element, the element's chemical/biological/particulate layer and the barrier layer seams shall meet all the performance requirements for the moisture barrier and the moisture barrier seams in {update list as number changes occur}

7.20.1.4 Each ensemble element's chemical/biological/particulate barrier layer and the barrier layer seams shall be tested for permeation resistance as specified in Section 8.B, Chemical Permeation Resistance Test, and shall meet the following performance criteria:

(1) For permeation testing of the chemical warfare agent Distilled Mustard (HD), the average cumulative permeation in 1 hour shall not exceed 4.0 g/cm^2.

(2) For permeation testing of the chemical warfare agent Sarin (GB), the average cumulative permeation in 1 hour shall not exceed 1.25 g/cm^2.

(3) For permeation testing of liquid and gaseous toxic industrial chemicals, the average breakthrough time shall not be less than 60 minutes.

7.20.1.5 Each ensemble element's chemical/biological/particulate barrier shall be tested for bursting strength as specified in Section 8.13, Burst Strength Test, and shall have a bursting strength of not less than 156 N (35 lb_f).

7.20.1.6 Each ensemble element's chemical/biological barrier layer shall be tested for puncture propagation tear resistance as specified in Section 8.C, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 31 N (7 lb_f).

7.20.1.7 Each ensemble element's chemical/biological/particulate barrier layer shall be tested for cold weather performance as specified in Section 8.D, Cold Temperature Performance Test 1, and shall have a bending moment of not greater than 0.057 N/m (½ in.-lb_f) at an angular deflection of 60 degrees at -25°C (-13°F).

7.20.1.8 Where an ensemble element's chemical/biological/particulate barrier layer is positioned as an inner layer of the element, the seams of the chemical/biological/particulate barrier layer shall be tested for seam strength as specified in Section 8.14, Seam Breaking Strength Test, and shall have a breaking strength of not less than 180 N (40 lb_f).

7.20.1.9 Where an ensemble element's chemical/biological/particulate barrier layer is positioned as an external layer of the element, the seams of the chemical/biological/particulate barrier layer shall be tested for seam strength as specified in Section 8.14, Seam-Breaking Strength Test, and shall have a breaking strength of not less than 334 N (75 lb_f).

7.20.2 Additional CBR Performance Requirements for Structural Fire Fighting Protective Ensembles Only. (Reserved)

7.20.3 Additional CBR Performance Requirements for Proximity Fire Fighting Protective Ensembles Only. (Reserved)

7.20.4 Protective Garment Element CBR Performance Requirements for Both Ensembles. (Reserved)

7.20.5 Additional CBR Performance Requirements for Structural Fire Fighting Protective Garment Elements Only. (Reserved)

7.20.6 Additional CBR Performance Requirements for Proximity Fire Fighting Protective Garment Elements Only. (Reserved)

7.20.7 Protective Helmet Element CBR Performance Requirements for Both Ensembles. (Reserved)

7.20.8 Additional CBR Performance Requirements for Structural Fire Fighting Protective Helmet Elements Only. (Reserved)

7.20.9 Additional CBR Performance Requirements for Proximity Fire Fighting Protective Helmet Elements Only. (Reserved)

7.20.10 Protective Glove Element CBR Performance Requirements for Both Ensembles.

7.20.10.1 Where the glove element's chemical/biological/particulate barrier layer is the most external layer of the element, the chemical/biological/particulate barrier layer shall be tested for cut resistance as specified in Section 8.22, Cut Resistance Test, and shall have a blade travel distance of not less than 25 mm (1 in.).

7.20.10.2 Where the glove element's chemical/biological/particulate barrier layer is the most external layer of the ensemble element for hand protection, the chemical/biological/particulate barrier layer shall be tested for puncture resistance as specified in Section 8.20, Puncture Resistance Test, and shall not be punctured under an average applied force of 22 N (5 lb_f).

7.20.11 Additional CBR Performance Requirements for Structural Fire Fighting Protective Glove Elements Only. (Reserved)

7.20.12 Additional CBR Performance Requirements for Proximity Fire Fighting Protective Glove Elements Only. (Reserved)

7.20.13 Protective Footwear Element CBR Performance Requirements for Both Ensembles.

7.20.13.1 Where the footwear element's chemical/biological/particulate barrier layer is the most external layer of the element, the chemical/biological/particulate barrier layer from the upper portion of the footwear element shall be tested for cut resistance as specified in Section 8.22, Cut Resistance Test, and shall have a blade travel distance of not less than 25 mm (1 in.).

7.20.13.2 Where the footwear element's chemical/biological/particulate barrier layer is the most external layer of the element, the chemical/biological/particulate barrier layer from the upper portion of the footwear element shall be tested for puncture resistance as specified in Section 8.20, Puncture Resistance Test 1, and shall not be punctured under an average applied force of 36 N (8 lb_f).

7.20.13.3 Where the footwear element's chemical/biological/particulate barrier layer is the most external layer of the element, the chemical/biological/particulate barrier layer from the wear surface of the footwear element shall be tested for puncture resistance as specified in Section 8.20, Puncture Resistance Test 1, and shall not be punctured under an average applied force of 200 N (45 lb_f).

7.20.13.4 Where the footwear element's chemical/biological/particulate barrier layer is the most external layer of the element, the chemical/biological/particulate barrier layer from the wear surface of the footwear element shall be tested for abrasion resistance as specified in Section 8.D, Abrasion Resistance Test 2, and shall not show wearer through of the film portion of the barrier layer in less than 3,000 cycles.

7.20.14 Additional CBR Performance Requirements for Structural Fire Fighting Protective Footwear Elements Only. (Reserved)

7.20.15 Additional CBR Performance Requirements for Proximity Fire Fighting Protective Footwear Elements Only. (Reserved)

7.20.16 Protective Hood Interface Component CBR Performance Requirements for Both Ensembles. (Reserved)

7.20.17 Additional CBR Performance Requirements for Structural Fire Fighting Protective Hood Interface Components Only. (Reserved)

7.20.18 Additional CBR Performance Requirements for Proximity Fire Fighting Protective Hood Interface Components Only. (Reserved)

Chapter 8 (Old Chapter 6) Test Methods

8.1 (6-1) Sample Preparation Procedures.

8.1.1 (6-1.1) Application.

8.1.1.1 (6-1.1.1) 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 (6-1.1.2) 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 (6-1.2) Washing and Drying Procedure for Garments, Gloves, Hoods, and Wristlets. Specimens shall be subjected to five 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 1.82-kg, ±0.1 kg (4.0-lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

8.1.3 (6-1.3) Room Temperature Conditioning Procedure for Garments, Trim, Helmets, Gloves, Footwear, and Faceshield/Goggle Components.

8.1.3.1 (6-1.3.1) Garment, glove, and footwear specimens shall be conditioned at a temperature of 21ºC, ±3°C (70°F, ±5°F) and a relative humidity of 65 percent, ±5 percent until equilibrium is reached, as determined in accordance with Section 4 of Federal Test Method Standard 191A, *Textile Test Methods*, or for at least 24 hours, whichever is shorter. Specimens shall be tested within 5 minutes after removal from conditioning.

8.1.3.2 (6-1.3.2) Helmet and faceshield/goggle component specimens shall be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and a relative humidity of 25 percent to 50 percent. Specimens shall be tested within 5 minutes after removal from conditioning.

8.1.4 (6-1.4) Low Temperature Environmental Conditioning Procedure for Helmets. Sample specimens shall be conditioned by exposing them to a temperature of -32°C, ±1°C (-25°F, ±2°F) for at least 4 hours. The impact/penetration test shall be completed within 15 seconds, ±5 seconds after removal from the cold temperature environment, or the specimens shall be reconditioned before testing.

8.1.5 (6-1.5) Convective Heat Conditioning Procedure for Helmets, Gloves, Footwear, Moisture Barriers, Moisture Barrier Seams, Labels, and Trim. Samples shall be conditioned by exposing them to the procedures specified in 8.6.4 (6-6.4) and in 8.6.5.2 (6-6.5.2) through 8.6.5.4 (6-6.5.4), with the following modifications.

(a) The oven temperature in 8.6.4.3 (6-6.4.3) shall be stabilized at 140°C, +6°/-/-0°C (285°F, +10°/-/-0°F) for helmets, footwear, moisture barriers, moisture barrier seams, labels, and trim, and the test exposure time shall be 10 minutes, +15/--0 seconds.

(b) The oven temperature in 8.6.4.3 (6-6.4.3) shall be stabilized at 177°C, +6°/--0°C (350°F, +10°/-/-0°F) for gloves only, the exposure time shall be 10 minutes, +15/-0 seconds, and the procedures specified in 8.6.13.5 shall be followed.

(c) The test exposure time shall begin when the test thermocouple reading has stabilized at the required test exposure temperature.

(d) The requirements of 8.6.5.5 (6-6.5.5) and 8.6.5.6 (6-6.5.6) shall be disregarded.

(e) For helmet specimens, the required testing shall be performed within 15 seconds, ±5 seconds, or the specimen shall be discarded and a new specimen shall be conditioned and tested as specified in this section.

(f) For gloves, trim, moisture barriers, and moisture barrier seam specimens, the required testing shall be performed no sooner than 24 hours after removal from conditioning.

(g) For faceshield/goggle components, these components, attached to the helmet, shall be conditioned by placing them on a room temperature, solid, nonmetallic headform conforming to the dimensions in Figure 8.6.12.3 (6-6.12.3) and by exposing them to a temperature of 108°C, +2°/-/-0°C, (225°F, +3°/--0°F) for 20 minutes, +15/--0 seconds. The impact test shall be completed within 15 seconds, ±5 seconds, after removal from the environmental chamber, or the faceshield/goggle components shall be reconditioned and tested as above.

(h) The oven temperature in 8.6.4.3 shall be stabilized at 177ºC, +6º/-0ºC (350ºF, +10º/-0ºF) for glove moisture barriers, and the test exposure time shall be 10 minutes, +15/-0 seconds. The glove moisture barrier sample pouch shall be filled with 4 mm sized Pyrex glass beads. The beads shall be room temperature. The opening of the pouch shall be folded over and clamped together, the specimen shall be suspended by the clamp in the oven so that the entire specimen is not less than 50 mm (2 in.) from any oven surface and not less than 150 mm (6 in.) from any other specimen, and airflow is parallel to the plane of the material. Not more than three specimens shall be placed in the test oven at one time. The specimens shall be suspended such that each specimen is the same distance from the air flow source, so that no sample is blocking the airflow to other samples.

8.1.6 (6-1.6) Radiant and Convective Heat Environmental Conditioning Procedure for Helmets.

8.1.6.1 (6-1.6.1) Sample helmets shall be conditioned by exposing the area to be impacted/ penetrated to a radiant heat source. The top, sides, front, and back test areas to be impacted/penetrated shall be as specified in Figure 8.1.6.1 (6-1.6.1).

8.1.6.2 (6-1.6.2) The area to be impacted/ penetrated shall be exposed to an irradiance of 1.0 W/cm^2, ±0.1 W/cm^2 for a length of time determined by exposure of a radiant heat transducer. The heat source shall be removed and the helmet shall be tested. The helmet shall be impacted/penetrated in 15 seconds, ±5 seconds after removal from the conditioning environment or the helmet shall be cooled to room temperature and reconditioned before testing.

8.1.6.3 (6-1.6.3) The radiometer shall have a spectral response flat within ±3 percent over a range of at least 1.0 mm to 10.1 mm (0.00004 in. to 0.0004 in.) and an overall accuracy of at least ±5 percent of the reading.

FIGURE 8.1.6.1 (6-1.6.1) Helmet test areas and landmarks.
[Existing Figure 6-1.6.1, 2000 ed., (no change)]

8.1.6.4 (6-1.8.4) The radiant panel shall have an effective radiating surface of 150 mm, ±6 mm (6 in., ±0.25 in.) square. The spectral radiant emittance curve of the radiant panel shall be that of a black body at a temperature of 1000°K, ±200°K (1340°F, ±360°F).

8.1.6.5 (6-1.8.5) The radiant heat transducer shown in Figure 8.1.6.5 **(6-1.6.5)** shall be constructed from sheet copper, ASTM B 152, *Specification for Copper Sheet, Strip Plate, and Rolled Bar*, Type 110 ETP, half hard, 0.64 mm, ±0.05 mm (0.025 in., ±0.002 in.) thick and 50 mm, ±0.5 mm (2 in., ± 1/64 in.) square. A constantan wire 0.81 mm, ±0.05 mm (0.032 in., ±0.002 in.) in diameter and an iron wire of the same diameter shall be silver soldered 15 mm, ±1 mm from the edges of the copper sheet on the same side, as shown in Figure 8.1.6.5

(6-1.6.5). The side of the copper sheet opposite that with the wires attached shall be painted flat black. The resulting transducer is a Type J thermocouple that shall be used in conjunction with appropriate instrumentation to monitor the heat exposure to which the helmet is to be subjected.

FIGURE 8.1.6.5 (6-1.6.5) Radiant heat transducer. [Existing Figure 6-1.6.5, 2000 ed., (no change)]

8.1.6.6 (6-1.6.6) Sample helmets shall be mounted in the position to be conditioned. The point of impact or penetration on the helmet shell shall be determined in accordance with the specific test to be performed. The helmet shall be removed temporarily, and a radiometer shall be located at that point perpendicular to and facing away from the helmet surface.

8.1.6.7 (6-1.6.7) The radiant panel shall be introduced in front of the radiometer with its effective radiating surface parallel to the plane tangent to the helmet surface at the center of the impact/penetration site on the helmet. The radiant panel shall be adjusted to obtain a stable uniform irradiance of 1.0 W/cm^2, ±0.1 W/cm^2 over a minimum 75-mm (3-in.) diameter circle located on the above plane and centered at the center of impact or penetration. Stability shall be achieved when the irradiance changes by less than 10 percent during a 3-minute period.

8.1.6.8* (6-1.6.8) The radiometer shall be replaced with the radiant heat transducer. The center of the transducer shall be positioned with its center coincident with the center of the impact/penetration site on the helmet and parallel to the plane tangent to the helmet surface at that point. The flat black surface of the transducer shall face the radiant panel. The time required for the transducer to reach a temperature of 260°C (500°F) shall be recorded. That time shall be 2.5 minutes, ±15.0 seconds. A closed, insulated chamber shall be required to achieve this exposure time.

8.1.6.9 (6-1.6.9) The chamber and helmet shall be stabilized at 25°C, ±5°C (77°F, ±9°F). The helmet shall be positioned in the chamber in the same position specified in (6-1.6.6). The helmet shall be subjected to the exposure conditions specified in 8.1.6.1 (6-1.6.1) for the time recorded in 8.1.6.8 (6-1.6.8). The exposure time shall be not less than the time recorded in 8.1.6.8 (6-1.6.8), nor more than 5 seconds longer than that time.

8.1.7 (6-1.7) Wet Conditioning Procedure for Helmets and Faceshield/Goggle Components. Sample specimens 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 specimen shall be tested within 10 minutes after removal from water.

8.1.8 (6-1.8) Wet Conditioning Procedure for Gloves.

8.1.8.1 (6-1.8.1) Specimens shall be conditioned by complete immersion in water at a temperature of 21°C, ±3°C (70°F, ±5°F) for 2 minutes.

8.1.8.2 (6-1.8.2) Specimens shall be removed from water, hung in a vertical position with glove or glove pouch opening facing down for 5 minutes, and laid horizontal with AATCC textile blotting paper both under and over the specimen under a weight of 0.0020 kg/cm^2, ±0.0002 kg/cm^2 (0.50 psi, ±0.05 psi) for a period of 20 minutes in accordance with paragraph 7.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test.*

8.1.9 (6-1.9) Wet Conditioning Procedure for Footwear. Where indicated, samples shall be preconditioned by immersion in tap water of 21°C (70.0°F) for 1 hour, ±5 minutes. Samples shall be drained upside down for 5 minutes. Testing shall be done 5 minutes, ±3 seconds after draining.

8.1.10 (6-1.10) Flexing Procedure for Gloves. Glove specimens shall be selected to fit the individual test subject. The test subject shall don the glove specimen. Glove specimens shall be flexed by making a tight fist ten times during a 30-second period.

8.1.11 (6-1.11) Washing and Drying Procedure for Whole Garments.

8.1.11.1 (6-1.11.1) The complete garment shall be washed with all closures fastened.

8.1.11.2 (6-1.11.2) A front-loading washer/ extractor shall be used.

8.1.11.3 (6-1.11.3) Two-thirds the rated capacity of the washer shall not be exceeded.

8.1.11.4 (6-1.11.4) The following wash cycle procedure in Table 8.1.11.4 (6-1.11.4) shall be followed.

Table 8.1.11.4 (6-1.11.4) Wash Cycle Procedure for Whole Garments

Operation	Time (minutes)	Temperature		Water Level
		°C	(°F)	
Suds using AATCC Detergent #1993, 45.0 grams	10	49	(120)	low
Drain	1			
Carry-over	5	49	(120)	low
Drain	1			
Rinse	2	38	(100)	high
Drain	1			
Rinse	2	38	(100)	high
Drain	1			
Rinse	2	38	(100)	high
Drain	1			
Extract	5			

8.1.11.5 (6-1.11.5) The garment shall be dried using a tumble dryer with a stack temperature of 38°C to 49°C (100°F to 120°F).

8.1.11.6 (6-1.11.6) The garment 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 garment shall be allowed to air dry for at least 48 hours prior to conducting the test.

8.1.11.7 (6-1.11.7) The garment shall be washed and dried for a total of five cycles consisting of five washings and five dryings.

8.1.12 Flexural Fatigue Procedure for Chemical/Biological/ Particulate Barrier Layers. Specimens shall be subjected to flexural fatigue in accordance with ASTM F 392, *Standard Test Method for Flex Durability of Flexible Barrier Materials*, with the following modifications:

(1) In lieu of Flexing Conditions A, B, C, D, or E, test specimens shall have a flex period of 100 cycles at 45 cycles per minute. A cycle shall be full flex and twisting action.

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

8.1.13 Abrasion Procedure for Chemical/Biological/Particulate Barrier Layers. Specimens shall be abraded in accordance with ASTM D 4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, under the following conditions:

(1) A 2.3 kg (5 lb) tension weight shall be used.

(2) A 1.6 kg (3.5 lb) head weight shall be used.

(3) The wire screen of the test apparatus shall be used be used as the abradant.

(4) The specimen shall be abraded for 100 continuous cycles.

8.1.14 Cycling Procedure for Garment Hook and Pile Fastener Tapes.

8.1.14.1 Sample hook and pile fastener tapes shall be conditioned by cycling them in accordance with the procedures specified in 8.1.14.2 through 8.1.14.5

8.1.14.2 The Dynamic Cycling Machine (DCM) shall be utilized.

8.1.14.3 The pile side of the fastener component sample shall be mounted on the hollow drum with the drum's open end facing outward.

8.1.14.3.1 Both ends of the test sample shall be threaded through the slots in the drum. One end of the sample shall be secured to a fixed post extending outward from the back closed end of the drum.

8.1.14.3.2 The other end of the sample shall be attached to a spring loaded ratchet mechanism that allows the slack to be taken up pulling the sample taught against the drum surface.

8.1.14.6 The hook side of the fastener component, in a length that is approximately that of the drum circumference, shall be placed onto the endless belt. The sample shall then be threaded over the series of rollers and guides.

8.1.14.5 The conditioning parameters shall be:

(a) Tape width = 25 mm (1 in.)

(b) Drum speed = 16 rpm

(c) Peeling angle = 135 degrees

(d) Mating pressure = 5 kg (11 lb)

(e) Number of cycles = 5,000

8.2 (6-2) Flame Resistance Test 1.

8.2.1 (6-2.1) Application.

8.2.1.1 (6-2.1.1) This test method shall apply to protective garment textiles, drag rescue devices, hoods, wristlets, gauntlets, helmet ear covers, and trim materials.

8.2.1.2 (6-2.1.2) Modifications to this test method for testing woven textile materials shall be as specified in 8.2.8 (6-2.8).

8.2.1.3 (6-2.1.3) Modifications to this test method for testing knit textile materials shall be as specified in 8.2.9 (6-2.9).

8.2.1.4 (6-2.1.4) Modifications to this test method for testing nonwoven textile materials shall be as specified in 8.2.10 (6-2.10).

8.2.1.5 (6-2.1.5) Modifications to this test method for testing trim materials shall be as specified in 8.2.11 (6-2.11).

8.2.1.6 (6-2.1.6) Modifications to this test method for testing hood label materials shall be as specified in 8.2.12 (6-2.12).

8.2.1.7 (6-2.1.7) Modifications to this test method for testing lettering that is transfer film shall be as specified in 8.2.13 (6-2.13).

8.2.1.8 (6-2.1.8) Modifications to this test method for testing small specimens not meeting the specimen size requirements in 8.2.2.1 (6-2.2.1) shall be tested as specified in 8.2.14 (6-2.14.)

8.2.1.9 (6-2.1.9) Modifications to the test method for testing helmet chin straps shall be as specified in 8.2.15 (6-2.15).

8.2.1.10 Modifications to the test method for testing Drag Rescue Device (DRD) materials shall be as specified in 6.2.16.

8.2.2 (6-2.2) Specimens.

8.2.2.1 (6-2.2.1) Specimens shall consist of a 75-mm × 305-mm (3-in. × 12-in.) rectangle with the long dimension parallel to either the warp or filling, the wale or coarse, or the machine or cross-machine direction of the material.

8.2.2.2 (6-2.2.2) Each separable layer of multilayer material systems or composites shall be individually tested.

8.2.3 (6-2.3) Sample Preparation.

8.2.3.1 (6-2.3.1) Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.2.3.2 (6-2.3.2) All specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.2.4 (6-2.4) Apparatus. The test apparatus specified in Method 5903.1, *Flame Resistance of Cloth; Vertical*, of Federal Test Method Standard 191A, *Textile Test Methods*, shall be used.

8.2.5 (6-2.5) Procedure.

8.2.5.1 (6-2.5.1) Flame resistance testing shall be performed in accordance with Method 5903.1, *Flame Resistance of Cloth; Vertical*, of Federal Test Method Standard 191A, *Textile Test Methods.*

8.2.5.2 (6-2.5.2) Each specimen shall be examined for evidence of melting or dripping.

8.2.6 (6-2.6) Report.

8.2.6.1 (6-2.6.1) Afterflame time and char length shall be recorded and reported for each specimen. The average afterflame time and char length for each material in each direction tested shall be calculated and reported. The afterflame time shall be recorded and reported to the nearest 0.2 second and the char length to the nearest 3.2 mm (1/8 in.).

8.2.6.2 (6-2.6.2) Observations of melting or dripping for each specimen shall be recorded and reported.

8.2.7 (6-2.7) Interpretation.

8.2.7.1 (6-2.7.1) 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 (6-2.7.2) Failure in either direction shall constitute failure of the material.

8.2.8 (6-2.8) Specific Requirements for Testing Woven Textile Materials.

8.2.8.1 (6-2.8.1) Five specimens from each of the warp and filling directions shall be tested. No two warp specimens shall contain the same warp yarns, and no two filling specimens shall contain the same filling yarns.

8.2.8.2 (6-2.8.2) Samples for conditioning shall be at least a 1-m (1-yd) square of each material.

8.2.8.3 (6-2.8.3) Testing shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7).

8.2.9 (6-2.9) Specific Requirements for Testing Knit Textile Materials.

8.2.9.1 (6-2.9.1) Five specimens from each of the wale and course directions shall be tested.

8.2.9.2 (6-2.9.2) Samples for conditioning shall include material that is a minimum of 75 mm × 305 mm (3 in. × 12 in.).

8.2.9.3 (6-2.9.3) Testing shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7).

8.2.10 (6-2.10) Specific Requirements for Testing Nonwoven Textile Materials.

8.2.10.1 (6-2.10.1) Five specimens from each of the machine and cross machine directions shall be tested.

8.2.10.2 (6-2.10.2) Samples for conditioning shall include material that is a minimum of 75 mm × 305 mm (3 in. × 12 in.).

8.2.10.3 (6-2.10.3) Testing shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7).

8.2.11 (6-2.11) Specific Requirements for Testing Trim Materials.

8.2.11.1 (6-2.11.1) Five trim specimens for flammability testing shall be at least 50 mm (2 in.) wide and no more than 75 mm (3 in.) wide. Where trim material specimens are not wide enough to fit into the test frame, a narrower test frame of sufficient width to accommodate the available trim width shall be constructed. The cut edge of the trim specimen shall be oriented so that it is exposed directly to the burner flame.

8.2.11.2 (6-2.11.2) Samples for conditioning shall include material 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.* Specimens shall be removed from the ballast material prior to testing.

8.2.11.3 (6-2.11.3) Testing shall be performed in only one direction.

8.2.11.4 (6-2.11.4) Testing shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7).

8.2.12 (6-2.12) Specific Requirements for Testing Hood Label Materials.

8.2.12.1 (6-2.12.1) Five specimens of hood labels attached to the hood material shall be tested. The hood label specimen shall be cut from conditioned samples so that the edge of the hood label is at the bottom of the specimen.

8.2.12.2 (6-2.12.2) Samples for conditioning shall be whole hoods, including the label as normally attached.

8.2.12.3 (6-2.12.3) Testing shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7) with the flame applied to the edge of the label.

8.2.13 (6-2.13) Specific Requirements for Testing Lettering Including Transfer Film.

8.2.13.1 (6-2.13.1) Lettering, including transfer film, shall be applied to outer shell material meeting the requirements of this standard for testing as specified in 8.2.13.2 (6-2.13.2). The method of applying lettering, including transfer film, shall be representative of methods used in attaching lettering during the manufacture of the protective element.

8.2.13.2 (6-2.13.2) Lettering specimens for flammability testing shall be at least 50 mm (2 in.) and no more than 75 mm (3 in.) in width. Specimens shall be selected where lettering is most dense.

8.2.13.3 (6-2.13.3) Samples for conditioning shall include material 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.* Specimens shall be removed from the ballast material prior to testing.

8.2.14 (6-2.14) Specific Requirements for Testing Small Specimens.

8.2.14.1 (6-2.14.1) 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.

8.2.14.2 (6-2.14.2) Samples for conditioning shall be at least 1-m (1-yd) square of the textile layer on which the small specimens are attached.

8.2.14.3 (6-2.14.3) Testing shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7). Char length shall not be measured.

8.2.15 (6-2.15) Specific Requirements for Test Helmet Chin Straps.

8.2.15.1 (6-2.15.1) Helmet chin straps for flammability testing shall be at least 305 mm (12 in.) in length by the widest width of chin strap used on the helmet.

8.2.15.2 (6-2.15.2) Testing shall be performed in only one direction.

8.2.15.3 (6-2.15.3) Test shall be performed as specified in 8.2.2 (6-2.2) through 8.2.7 (6-2.7).

8.2.16 Specific Requirements for Testing Drag Rescue Device (DRD) Materials.

8.2.16.1 Five specimens of the materials used in the construction of DRDs shall be tested.

8.2.16.2 DRD materials shall be at least 305 mm (12 in.) in length by the widest width of the material used in the DRD.

8.2.16.3 Testing shall be performed in only one direction.

8.2.16.4 Test shall be performed as specified in 8.2.2 through 8.2.7.

8.3 (6-3) Flame Resistance Test 2.

8.3.1 (6-3.1) Application. This test method shall apply to protective helmets.

8.3.2 (6-3.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2).

8.3.3 (6-3.3) Sample Preparation. No sample conditioning shall be performed.

8.3.4 (6-3.4) Apparatus.

8.3.4.1 (6-3.4.1) A standard Bunsen burner shall be used.

8.3.4.2 (6-3.4.2) The Bunsen burner shall be fueled by a bottled methane gas, lab grade or better, of 3.72×10^7 J/m^3, $\pm 1.8 \times 10^6$ J/m^3 (1000 Btu/ft^3, ±50 Btu/ft^3).

8.3.4.3 (6-2.4.3) A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 0.0020 kg/cm^2, +0.0004/-0 kg/cm^2 (1/2 psi, +0.1/-0 psi) at the burner shall be utilized.

8.3.4.4 (6-3.4.4) The barrel of the Bunsen burner shall be 13 mm, ±3 mm (1/2 in., ± 1/8 in.) in diameter. A flame spreader shall not be used.

8.3.5 (6-3.5) Procedure A.

8.3.5.1 (6.3.5.1) Helmets shall be seated on the ISO size J headform specified in Figure 8.16.4.1 (6-16.4.1) according to the helmet's positioning index. The test setup shall be as shown in Figure 8.3.5.1 (6-3.5.1.)

FIGURE 8.3.5.1 (6-3.5.1) Test procedure A. [Existing Figure 6-3.5.1, 2000 ed., (no change)]

8.3.5.2 (6-3.5.2) The tip of the inner cone of a Bunsen burner flame of 25 mm to 38 mm (1 in. to 1 1/2 in.) in length shall be placed at the outer edge of the helmet shell at the front, sides, and rear. Where a helmet hanger is provided, the test flame shall be applied off the edge of the helmet hanger at the shell edge.

8.3.5.3 (6-3.5.3) After 15 seconds, +1/-0 second, the flame shall be removed and the duration of the afterflame and afterglow shall be measured.

8.3.6 (6-3.6) Procedure B.

8.3.6.1 (6-3.6.1) Specimens of faceshield/ goggle components shall be attached to an appropriate test fixture so that the lower edge of the specimen is exposed. The test setup shall be as shown in Figure 8.3.6.1 (6-3.6.1).

FIGURE 8.3.6.1 (6-3.6.1) Test procedure B. [Existing Figure 6-3.6.1, 2000 ed., (no change)]

8.3.6.2 (6-3.6.2) The tip of the inner cone of a Bunsen burner flame 25 mm to 38 mm (1 in. to 1$^1/_2$ in.) in length shall be placed on the outer edge of the specimen at the lowest exposed edge of the specimen. The burner shall be held to the test point of the specimen at an angle of 45 degrees, ±10 degrees.

8.3.6.3 (6-3.6.3) After 15 seconds, +1/-0 second, the flame shall be removed and the duration of afterflame shall be measured.

8.3.7 (6-3.7) Procedure C.

8.3.7.1 (6-3.7.1) Helmets shall be seated on the ISO size J headform specified in Figure 8.16.4.1 (6-16.4.1) and shall be positioned according to the helmet's positioning index. The helmet shall be positioned under the radiant heat source specified in 8.1.6.4 (6-1.6.4), with the basic plane of the headform parallel to the radiant heat source as shown in Figure 8.3.7.1 (6-3.7.1).

FIGURE 8.3.7.1 (6-3.7.1) Test procedure C. [Existing Figure 6-3.7.1, 2000 ed., (no change)]

8.3.7.2 (6-3.7.2) Sample helmets shall be positioned so that the area to be tested receives a radiant flux of 1.0 W/cm^2, ± 0.1 W/ cm^2. After 60 seconds, +5/-0 seconds, exposure to the radiant flux and without removing the radiant heat source, the tip of the inner cone of a Bunsen burner flame 25 mm to 38 mm (1 in. to 1$^1/_2$ in.) in length shall be placed against the helmet test area so that the flame creates an angle of 45 degrees, ±10 degrees, with the plane tangent to the test area at the point of contact.

8.3.7.3 (6-3.7.3) After 15 seconds, +1/-0 second, the flame shall be removed and the duration of afterflame and afterglow shall be measured.

8.3.8 (6-3.8) Report. Afterflame and afterglow times shall be recorded and reported for each specimen at each flame impingement location. The afterflame and afterglow times shall be recorded and reported to the nearest 0.2 second.

8.3.9 (6-3.9) Interpretation. Pass or fail performance shall be based on the longest measured afterflame and afterglow times.

8.4 (6-4) Flame Resistance Test 3.

8.4.1 (6-4.1) Application. This test method shall apply to protective gloves.

8.4.2 (6-4.2) Specimens.

8.4.2.1 (6-4.2.1) Each specimen to be tested shall be a rectangle at least 50 mm × 150 mm (2 in. × 6 in.). Specimens shall be the composite used in actual glove construction consisting of each single layer, with all layers arranged in proper order. In each test, the specimen's normal outer surface shall be exposed to the flame.

8.4.2.2 (6-4.2.2) Three specimens shall be tested for each material.

8.4.2.3 (6-4.2.3) If a proposed glove construction has stitched-through seams, three additional specimens containing these seams shall be tested. The seam shall be in the direction of the 150-mm (6-in.) dimension.

8.4.3 (6-4.3) Sample Preparation.

8.4.3.1 (6-4.3.1) Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.4.3.2 (6-4.3.2) All specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.4.3.3 (6-4.3.3) Samples to be conditioned shall be the composite used in actual glove construction consisting of each single layer, with all layers arranged in proper order and stitched along the edges using the same thread as used in the construction of the glove.

8.4.4 (6-4.4) Apparatus.

8.4.4.1 (6-4.4.1) The test apparatus specified in Method 5905.1, *Flame Resistance of Material; High Heat Flux Flame Contact*, of Federal Test Method Standard 191A, *Textile Test Methods*, shall be used.

8.4.4.2 (6-4.4.2) 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.

8.4.4.3 (6-4.4.3) A specimen support assembly shall be used that consists of a frame and steel rod of 2 mm ($^1/_{16}$ in.) in diameter to support the specimen in an L-shaped position as shown in Figure 8.4.4.3 (6-4.4.3).

FIGURE 8.4.4.3 (6-4.4.3) Relationship of test material to burner. [Existing Figure 6-4.4.3, 2000 ed., (no change)]

8.4.4.4 (6-4.4.4) 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 8.4.4.3 (6-4.4.3).

8.4.5 (6-4.5) Procedure.

8.4.5.1 (6-4.5.1) A balance shall be used to determine the weight of each specimen to the nearest 0.1 g (0.04 oz) before and after testing.

8.4.5.2 (6-4.5.2) The burner shall be ignited and the test flame shall be adjusted to a height of 75 mm (3 in.) with the gas on/off valve fully open and the air supply completely and permanently off, as it is important that the flame height be closely controlled. The 75-mm (3-in.) height shall be obtained by adjusting the orifice in the bottom of the burner so that the top of the flame is level with the marked flame height indicator.

8.4.5.3 (6-4.5.3) With the specimen mounted in the support assembly, the burner shall be moved so that the middle of the folded corner projects into the flame 38 mm (1 1/2 in.) as shown in Figure 8.4.4.3 (6-4.4.3).

8.4.5.4 (6-4.5.4) The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

8.4.5.5 (6-4.5.5) The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 second that the specimen continues to flame after the burner is removed from the flame.

8.4.5.6 (6-4.5.6) Each layer of the specimen shall be examined for melting or dripping.

8.4.5.7 (6-4.5.7) Each tested sample shall be reconditioned as specified in 8.1.3 (6-1.3) and then weighed to the nearest 0.1 g (0.04 oz).

8.4.5.8 (6-4.5.8) The specimen then shall 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 8.4.5.8.1 (6-4.5.8.1) through 8.4.5.8.4 (6-4.5.8.4).

8.4.5.8.1 (6-4.5.8.1) The specimen shall be folded lengthwise and creased, by hand, along a line through the highest peak of the charred area.

8.4.5.8.2 (6-4.5.8.2) The hook shall be inserted into a hole punched in the specimen that is 6.4 mm ($^1/_4$ in.) in diameter or less. The hole shall be punched out for the hook at one side of the charred area that is 6.4 mm ($^1/_4$ in.) from the adjacent outside edge, at the point where the specimen contacted the steel rod, and 6.4 mm ($^1/_4$ in.) in from the lower end.

8.4.5.8.3 (6-4.5.8.3) A weight of sufficient size so that the weight and hook together equal the total tearing weight required by Table 8.4.5.8.3 (6-4.5.8.3) shall be attached to the hook. The total tearing weight for determining char length shall be based on the weight of the composite specimen and shall be determined from Table 8.4.5.8.3 (6-4.5.8.3).

Table 8.4.5.8.3 (6-4.5.8.3) Determining Tearing Weight

Specified Weight per Square Yard of Material Before Any Fire-Retardant Treatment or Coating		Total Tearing Weight for Determining Charred Length	
g/m²	**(oz/yd²)**	**kg**	**(lb)**
68 203	(2.0 6.0)	0.1	($^1/_4$)
over 203 508	(over 6.0 15.0)	0.2	($^1/_2$)
over 508 780	(over 15.0 23.0)	0.3	($^3/_4$)
over 780	(over 23.0)	0.45	(1)

8.4.5.8.4 (6-4.5.8.4) A tearing force shall be applied gently to the specimen by grasping the side of the material at the edge of the char opposite 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.

8.4.6 (6-4.6) Report.

8.4.6.1 (6-4.6.1) The afterflame time and char length shall be recorded and reported for each specimen. The average afterflame time and char length shall also be calculated and reported. The afterflame time shall be recorded and reported to the nearest 0.2 second and the char length to the nearest 2.5 mm (0.10 in.).

8.4.6.2 (6-4.6.2) The percent consumed shall be calculated using the following formula:

$$\text{Percent consumed} = \frac{W - R}{W} \times 100$$

where:

W = original preconditioned weight

R = conditioned weight 24 hours after testing

The percent consumed shall be recorded and reported for each specimen to the nearest 0.1 percent. The average percent consumed shall be calculated and reported to the nearest 0.1 percent.

8.4.6.3 (6-4.6.3) Observations of melting or dripping for each specimen shall be recorded and reported.

8.4.7 (6-4.7) Interpretation. Pass or fail performance shall be based on melting or dripping, the average afterflame time, and the average char length.

8.5 (6-5) Flame Resistance Test Four.

8.5.1 (6-5.1) Application. This test method shall apply to protective footwear.

8.5.2 (6-5.2) Specimens. Three complete footwear items shall be tested.

8.5.3 (6-5.3) Sample Preparation.

8.5.3.1 (6-5.3.1) Samples for conditioning shall be whole boots.

8.5.3.2 (6-5.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.5.4 (6-5.4) Apparatus.

8.5.4.1 (6-5.4.1) The test apparatus specified in Method 5905.1, *Flame Resistance of Material, High Heat Flux Flame Contact*, of Federal Test Method Standard 191A, *Textile Test Methods,* shall be used.

8.5.4.2 (6-5.4.2) 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.

8.5.4.3 (6-5.4.3) A specimen support assembly shall be used to support the footwear specimen above the burner flame.

8.5.5 (6-5.5) Procedure.

8.5.5.1 (6-5.5.1) The burner shall be ignited and the test flame shall be adjusted to a height of 75 mm (3 in.) with the gas on/off valve fully open and the air supply completely and permanently off, as it is important that the flame height be closely controlled. The 75-mm (3-in.) height shall be obtained by adjusting the orifice in the bottom of the burner so that the top of the flame is level with the marked flame height indicator.

8.5.5.2 (6-5.5.2) With the specimen mounted in the support assembly, the burner shall be moved so that the flame contacts the specimen at a distance of 38 mm ($^1/_2$ in.) at the angles in the areas shown in Figure 8.5.5.2 (6-5.5.2).

FIGURE 8.5.5.2 (6-5.5.2) Test areas. [Existing Figure 6-5.5.2, 2000 ed., (no change)]

8.5.5.3 (6-5.5.3) The burner flame shall be applied to the specimen for 12 seconds. After 12 seconds, the burner shall be removed.

8.5.5.4 (6-5.5.4) The afterflame time shall be measured as the time, in seconds, to the nearest 0.2 second that the specimen continues to flame after the burner is removed from the flame.

8.5.5.5 (6-5.5.5) Following the flame exposure, the specimen shall be removed and examined for burn-through. Each layer of the specimen shall be examined for melting or dripping.

8.5.6 (6-5.6) Report.

8.5.6.1 (6-5.6.1) The afterflame time shall be recorded and reported for each specimen. The average afterflame time shall be calculated and reported. The afterflame time shall be recorded and reported to the nearest 0.2 second.

8.5.6.2 (6-5.6.2) Observations of burn-through, melting, or dripping for each specimen shall be recorded and reported.

8.5.7 (6-5.7) Interpretation. Pass or fail performance shall be based on any observed burn-through, melting or dripping, and the average afterflame time.

8.6 (6-6) Heat and Thermal Shrinkage Resistance Test.

8.6.1 (6-6.1) Application.

8.6.1.1 (6-6.1.1) This test method shall apply to the following:

(1) Garment outer shells, moisture barriers, thermal barriers, collar linings, winter liners, trim, lettering, and other materials used in garment construction, including, but not limited to, padding, reinforcement, labels, interfacing, binding, hanger loops, emblems or patches, and elastic and hook and pile fasteners (when used where in contact with the wearer's body)

(2) Moisture barrier seams

(3) Hood, wristlet, helmet ear cover materials, innermost glove liner, trim, and label materials

(4) Protective helmets, protective gloves, and protective footwear

8.6.1.2 (6-6.1.2) Modifications to this test method for testing garment outer shell, moisture barrier, thermal barrier, winter liner, helmet ear cover, and innermost glove liner materials shall be as specified in 8.6.8 (6-6.8).

8.6.1.3 (6-6.1.3) Modifications to this test method for testing garment moisture barrier seams shall be as specified in 8.6.9 (6-6.9).

8.6.1.4 (6-6.1.4) Modifications to this test method for testing other garment, trim, and label materials shall be as specified in 8.6.10 (6-6.10).

8.6.1.5 (6-6.1.5) Modifications to this test method for testing hardware shall be as specified in 8.6.11 (6-6.11).

8.6.1.6 (6-6.1.6) Modifications to this test method for testing helmets shall be as specified in 8.6.12 (6-6.12).

8.6.1.7 (6-6.1.7) Modifications to this test method for testing gloves shall be as specified in 8.6.13 (6-6.13.)

8.6.1.8 (6-6.1.8) Modifications to this test method for testing footwear shall be as specified in 8.6.14 (6-6.14).

8.6.1.9 (6-6.1.9) Modifications to this test method for testing lettering, including transfer film, shall be as specified in 8.6.15 (6-6.15).

8.6.1.10 (6-6.1.10) Modifications to this test method for testing hoods shall be as specified in 8.6.16 (6-6.16).

8.6.2 (6-6.2) Specimens.

8.6.2.1 (6-6.2.1) Only heat resistance testing shall be conducted on a minimum of three specimens for each moisture barrier seam, hardware item, glove liner material, trim material, label material, other protective garment materials, helmets, and footwear not specified in 8.6.2.2 (6-6.2.2).

8.6.2.2 (6-6.2.2) Both heat and thermal shrinkage resistance testing shall be conducted on a minimum of three specimens of whole gloves and for each garment outer shell, moisture barrier, thermal liner, winter liner, and helmet ear cover. Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

8.6.3 (6-6.3) Sample Preparation. All specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.6.4 (6-6.4) Apparatus.

8.6.4.1 (6-6.4.1) The test oven shall be a horizontal flow circulating oven with minimum interior dimensions so that the specimens can be suspended and are at least 50 mm (2 in.) from any interior oven surface or other test specimens.

8.6.4.2 (6-6.4.2) 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.

8.6.4.3 (6-6.4.3) 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.

8.6.5 (6-6.5) Procedure.

8.6.5.1 (6-6.5.1) 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*.

8.6.5.2 (6-6.5.2) The specimen shall be suspended by metal hooks at the top and centered in the oven so that the entire specimen is not less than 50 mm (2 in.) from any oven surface or other specimen, and air is parallel to the plane of the material.

8.6.5.3 (6-6.5.3) The oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and turned on when the door is closed. The total oven recovery time after the door is closed shall not exceed 30 seconds.

8.6.5.4 (6-6.5.4) The specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +0.15/-0 minute. 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).

8.6.5.5 (6-6.5.5) Immediately after the specified exposure, the specimen shall be removed and examined for evidence of ignition, melting, dripping, or separation.

8.6.5.6 (6-6.5.6) After the specified exposure, the specimen also shall be measured to determine pass or fail performance. Knit fabric shall be pulled to its original dimensions and shall be allowed to relax for 1 minute prior to measurement to determine pass or fail performance.

8.6.6 (6-6.6) Report.

8.6.6.1 (6-6.6.1) Observations of ignition, melting, dripping, or separation shall be recorded and reported for each specimen.

8.6.6.2 (6-6.6.1) The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be recorded and reported as the average of all three specimens in each dimension.

8.6.7 (6-6.7) Interpretation.

8.6.7.1 (6-6.7.1) Any evidence of ignition, melting, dripping, or separation on any specimen shall constitute failing performance.

8.6.7.2 (6-6.7.2) The average percent change in both dimensions shall be used to determine pass or fail performance. Failure in any one dimension constitutes failure for the entire sample.

8.6.8 (6-6.8) Specific Requirements for Testing Garment Outer Shell, Moisture Barrier, Thermal Liner, Winter Liner Materials, Helmet Ear Cover, and Glove Liner Materials.

8.6.8.1 (6-6.8.1) Samples for conditioning shall be at least 1 m (1 yd) square of each material.

8.6.8.2 (6-6.8.2) Each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., $\pm^{1}/_{2}$ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.6.8.3 (6-6.8.3) Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.6.8.4 (6-6.8.4) Testing shall be performed as specified in 8.6.2 (6-6.2) through 8.6.7 (6-6.7).

8.6.8.5 (6-6.8.5) For protective garment outer shell and collar lining materials, any evidence of charring on any specimen of outer shell fabric shall also constitute failing performance in addition to 8.6.7.1 (6-6.7.1).

8.6.9 (6-6.9) Specific Requirements for Testing Moisture Barrier Seams.

8.6.9.1 (6-6.9.1) Samples for conditioning shall be a minimum of 1 linear m (1 linear yd) with a minimum of 150 mm (6 in.) of material on each side of the seam.

8.6.9.2 (6-6.9.2) Moisture barrier seam specimens shall consist of two 75-mm × 150-mm (3-in. × 6-in.) pieces of moisture barrier fabric utilized in the garment and sewn together with the same thread,

stitch type, and seam type as used in the moisture barrier, with seam-sealing material applied.

8.6.9.3 (6-6.9.3) Specimens shall be tested with the sealed seam oriented vertically, and shall be tested both before and after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.6.9.4 (6-6.9.4) For moisture barrier seam seal materials, observations shall be limited to seam material ignition and dripping.

8.6.9.5 (6-6.9.5) Testing shall be performed as specified in 8.6.2 (6-6.2) through 8.6.7 (6-6.7). Thermal shrinkage shall not be measured.

8.6.10 (6-6.10) Specific Requirements for Testing Other Garment, Clothing, Trim, and Label Materials.

8.6.10.1 (6-6.10.1) Samples for conditioning shall include material 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*. Specimens shall be removed from the ballast material prior to testing.

8.6.10.2 (6-6.10.2) Specimen length shall be 150 mm (6 in.) other than for textiles utilized in the clothing item in lengths less than 150 mm (6 in.) where length shall be the same as utilized in the clothing item. Specimen width shall be 150 mm (6 in.), other than for textiles utilized in the clothing item in widths less than 150 mm (6 in.), where widths shall be the same as utilized in the clothing item.

8.6.10.3 (6-6.10.3) Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.6.10.4 (6-6.10.4) Testing shall be performed as specified in 8.6.2 (6-6.2) through 8.6.7 (6-6.7). Thermal shrinkage shall not be measured.

8.6.11 (6-6.11) Specific Requirements for Testing Hardware.

8.6.11.1 (6-6.11.1) A minimum of three complete hardware items shall be tested.

8.6.11.2 (6-6.11.2) Observations of hardware condition following heat exposure shall be limited to ignition.

8.6.11.3 (6-6.11.3) Hardware shall be evaluated for functionality within 10 minutes following removal from the oven.

8.6.11.4 (6-6.11.4) Testing shall be performed as specified in 8.6.2 (6-6.2) through 8.6.7 (6-6.7). Thermal shrinkage shall not be measured.

8.6.12 (6-6.12) Specific Requirements for Testing Helmets.

8.6.12.1 (6-6.12.1) Samples for conditioning shall include complete helmets.

8.6.12.2 (6-6.12.2) Specimens shall be selected as specified in 4.3.4.1 (2-3.4.1).

8.6.12.3 (6-6.12.3) Helmets with ear covers deployed and with the faceshield/goggle component in the stowed position shall be seated on the nonconductive test headform specified in Figure 8.6.12.3 (6-6.12.3) and shall be positioned according to the helmet's positioning index. The headform with helmet attached shall be placed in the center of the test oven with the centerline of the front of the helmet facing the airflow.

FIGURE 8.6.12.3 (6-6.12.3) Nonconductive test headform.
[Existing Figure 6-6.12.3, 2000 ed., (no change)]

8.6.12.4 (6-6.12.4) The minimum interior dimensions of the test oven shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

8.6.12.5 (6-6.12.5) The test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted test helmet. 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.

8.6.12.6 (6-6.12.6) Following removal from the oven, the helmet shall be allowed to cool at room temperature for not less than 2 minutes. The shell distortion shall then be measured at the front, back, and sides at eight points radially separated by 45 degrees relative to their original position. The helmet shall be examined to ascertain any effects of the heat exposure.

8.6.12.7 (6-6.12.7) Testing shall be performed as specified in 8.6.2 (6-6.2) through 8.6.7 (6-6.7). Thermal shrinkage shall not be measured.

8.6.13 (6-6.13) Specific Requirements for Testing Gloves.

8.6.13.1 (6-6.13.1) Samples for conditioning shall be whole gloves.

8.6.13.2 (6-6.13.2) Conditioning shall be performed as specified in 8.1.2 (6-1.2).

8.6.13.3 (6-6.13.3) Specimens shall include complete gloves with labels.

8.6.13.4 (6-6.13.4) The minimum interior dimensions of the test oven shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

8.6.13.5 (6-6.13.5) The glove body shall be filled with dry vermiculite, taking care to tightly pack the vermiculite into the fingers of the glove and glove body. The opening of the glove shall be clamped together, and the specimen shall be suspended by the clamp in the oven so that the entire glove is not less than 50 mm (2 in.) from any oven surface or other specimen, and airflow is parallel to the plane of the material. Not more than six glove specimens and not less than three glove specimens shall be placed in the test oven at one time.

8.6.13.6 (6-6.13.6) The glove specimen dimensions also shall be measured to determine pass or fail. The length measurement of the glove specimen shall be from the tip of the middle finger to the end of the glove body on the palm side. The width measurement of the glove specimen shall be the width measurement on the palm side 25 mm (1 in.) below the base of the fingers.

8.6.13.7 (6-6.13.7) The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be recorded and reported as the average of all three specimens in each dimension.

8.6.13.8 (6-6.13.8) Specimens shall be donned and flexed as specified in 8.1.10 (6-1.10) before and after the heat exposure.

8.6.13.9 (6-6.13.9) Testing shall be performed as specified in 8.6.2 through 8.6.7 (6-6.7).

8.6.14 (6.6.14) Specific Requirements for Testing Footwear.

8.6.14.1 (6-6.14.1) Samples for conditioning shall be whole boots.

8.6.14.2 (6-6.14.2) Footwear specimens for testing shall be size 9.

8.6.14.3 (6-6.14.3) Footwear specimens shall include sole, heel, and upper. Footwear specimens shall be filled with dry vermiculite. Any closures shall be fastened.

8.6.14.4 (6-6.14.4) 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.

8.6.14.5 (6-6.14.5) The minimum interior dimensions of the test oven shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

8.6.14.6 (6-6.14.6) Footwear specimens shall be placed in the center of the test oven with the centerline of the front of the specimen facing the airflow.

8.6.14.7 (6-6.14.7) Testing shall be performed as specified in 8.6.2 (6-6.2) through 8.6.7 (6-6.7). Thermal shrinkage shall not be measured.

8.6.14.8 (6-6.14.8) A minimum of three footwear items shall be tested.

8.6.14.9 (6-6.14.9) 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.

8.6.14.10 (6-6.14.10) Each test specimen shall then be reconditioned as specified in 8.1.3 (6-1.3), and then reexamined inside and outside for evidence of melting, separation, or ignition.

8.6.14.11 (6-6.14.11) 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*, and then examined for evidence of sole separation, seam separation, or component breakage.

8.6.14.12 (6-6.14.12) After flexing, the footwear specimen shall be placed in a container that allows its immersion in tap water, treated with a dye and surfactant that achieves a surface tension of 34 dynes/cm, ±5 dynes/cm, to a height of not less than 25 mm (1 in.) from the lowest point of the throat. The paper toweling required in FIA 1209 shall be placed inside the footwear specimen such that the paper toweling intimately contacts all areas inside the footwear specimen to a height not less than 25 mm (1 in.) from the lowest point of the throat.

8.6.14.13 (6-6.14.13) After 2 hours, ±10 minutes, the paper toweling shall be removed and examined for evidence of liquid leakage.

8.6.14.14 (6-6.14.14) 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.

8.6.15 (6-6.15) Specific Requirements for Testing Lettering, Including Transfer Film.

8.6.15.1 (6-6.15.1) Lettering, including transfer film, shall be applied to outer shell material, meeting the requirements of this standard, for testing as specified in 8.6.15.4 (6-6.15.4).

8.6.15.2 (6-6.15.2) Lettering specimens for heat resistance testing shall be at least a 150-mm (6-in.) square. Samples shall be selected where lettering is most dense.

8.6.15.3 (6-6.15.3) Samples for conditioning shall be outer shell material of 1-m (1-yd) square with letters applied.

8.6.15.4 (6-6.15.4) Testing shall be performed as described in 8.6.2 (6-6.2) through 8.6.7 (6-6.7). Thermal shrinkage shall not be measured.

8.6.16 (6-6.16) Specific Requirements for Testing Hoods.

8.6.16.1 (6-6.16.1) Samples for conditioning shall include complete hoods, with labels.

8.6.16.2 (6-6.16.2) Hoods shall be tested both before and after the conditioning specified in 8.1.2 (6-1.2).

8.6.16.3 (6-6.16.3) Testing shall be performed as specified in 8.6.4 (6-6.4) through 8.6.4 (6-6.6) unless modified herein.

8.6.16.4 (6-6.16.4) Hoods shall be donned on an nonconductive test headform specified in Figure 8.6.12.3 (6-6.12.3). The dimensions of the face opening shall be measured as specified in 8.47.4.2 (6-47.4.2). Measurements shall also be made at the back and both sides of the hood from the top of the hood to the basic plane. The location of the basic plan on the hood shall be marked at each location.

8.6.16.5 (6-6.16.5) The headform with hood attached shall be placed in the center of the test oven with the centerline of the front of the hood facing the airflow.

8.6.16.6 (6-6.16.6) The minimum interior dimensions of the test oven shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

8.6.16.7 (6-6.16.7)) The test thermocouple shall be positioned so that it is level with the horizontal centerline of a mount test hood. The thermocouple shall be equidistant between the vertical centerline of a mounted test hood placed in the middle of the oven wall where the airflow enters the test chamber.

8.6.16.8 (6-6.16.8) Following removal from the oven, the hood shall be examined for evidence of ignition, melting, dripping, or separation. The hood shall also be allowed to cool at room temperature for not less than 2 minutes. The hood opening shall be measured as specified in 8.47.4.6 (6-47.4.6). The distance from the top of the hood to the three marks along the basic plane shall also be measured.

8.6.16.9 (6-6.16.9) The percentage change in the hood opening dimensions and the distances between the top of the hood and the marks along the basic plane shall be calculated and reported for each specimen. The average percentage change shall be calculated for each individual dimension and used to determine pass or fail performance.

8.6.16.10 (6-6.16.10) Failure in any one dimension constitutes failure of the entire sample.

8.7 (6-7) Conductive Heat Resistance Test 1.

8.7.1 (6-7.1) Application.

8.7.1.1 (6-7.1.1) This test method shall apply to protective gloves and footwear upper material.

8.7.1.2 (6-7.1.2) Modifications for this test method for testing gloves shall be as specified in 8.7.7 (6-7.7).

8.7.1.3 (6-7.1.3) Modifications for this test method for testing footwear shall be as specified in 8.7.8 (6-7.8).

8.7.2 (6-7.2) Specimens.

8.7.2.1 (6-7.2.1) Samples for conditioning shall be whole gloves and boots.

8.7.2.2 (6-7.2.2) A total of three specimens of gloves and three specimens of footwear shall be tested.

8.7.3 (6-7.3) Sample Preparation. Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.7.4 (6-7.4) Procedure. Specimens shall be tested in accordance with ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, with the following modifications.

(a) Specimens shall be tested using an exposure temperature of 280°C (536°F). The pressure applied during the test shall be 3.45 kPa, ±0.35 kPa (0.5 psi, ±0.05 psi).

(b) The time in seconds to pain and to second-degree burn and blister, as predicted by the Stoll Human Tissue Burn Tolerance Criteria, shall be recorded.

(c) The time to thermal end point shall be determined graphically from the recorder chart of the sensor response and the criterion overlay prepared in 10.5 of ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*. The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the point on the recorder chart corresponding to the time at which the sensor and specimen were placed in direct contact with the hot plate. The horizontal (time) axis shall be placed in line with the initial trace of the pen. The overlay shall be kept square with the recorder chart. Exposure time shall be read to the nearest 0.1 second from the overlay chart at the point where the sensor response and the tissue tolerance curve cross.

8.7.5 (6-7.5) Report. The time to pain and time to second-degree burn for each specimen shall be recorded and reported. The average time to pain and time to second-degree burn shall be calculated and reported. If the time to pain or time to second-degree burn is greater than 30 seconds, the time to pain or time to second-degree burn shall be recorded and reported as ">30 seconds" for time to pain and ">30 seconds" for time to second-degree burn.

8.7.6 (6-7.6) Interpretation.

8.7.6.1 (6-7.6.1) Pass or fail determinations shall be based on the average time to pain and time to second-degree burn of all specimens tested.

8.7.6.2 (6-7.6.2) If an individual result from any test set varies more than ±8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

8.7.7 (6-7.7) Specific Requirements for Testing Gloves.

8.7.7.1 (6-7.7.1) Specimens shall be representative of glove body composite construction at the palm of the hand and at the palm side of the fingers.

8.7.7.2 (6-7.7.2) Specimens shall be stitched around the perimeter using the same thread used in glove construction.

8.7.7.3 (6-7.7.3) Specimens shall be tested after being subjected to the procedure specified in 8.1.3 (6-1.3) both before and after laundering as specified in 8.1.2 (6-1.2).

8.7.7.4 (6-7.7.4) Specimens shall also be tested after being subjected to wet conditioning as specified in 8.1.8 (6-1.8) both before and after laundering as specified in 8.1.2 (6-1.2).

8.7.7.5 (6-7.7.5) Testing shall be performed as specified in 8.7.2 (6-7.2) through 8.7.6 (6-7.6).

8.7.8 (6-7.8) Specific Requirements for Testing Footwear Upper Materials.

8.7.8.1 (6-7.8.1) Footwear specimens shall include the thinnest portions of the footwear upper.

8.7.8.2 (6-7.8.2) Testing shall be performed as specified in 8.7.2 (6-7.2) through 8.7.6 (6-7.6).

8.8 (6-8) Conductive Heat Resistance Test 2.

8.8.1 (6-8.1) Application. This test method shall apply to the protective footwear sole.

8.8.2 (6-8.2) Specimens. A minimum of three complete footwear items shall be tested.

8.8.3 (6-8.3) Sample Preparation.

8.8.3.1 (6-8.3.1) Samples for conditioning shall be whole footwear.

8.8.3.2 (6-8.3.2) Specimens shall be preconditioned as specified in 8.1.3 (6-1.3).

8.8.4 (6-8.4) Apparatus. The apparatus shall consist of an iron plate measuring 25 mm × 150 mm × 460 mm (1 in. × 6 in. × 18 in.) and an oven capable of heating the plate to a temperature of 500°C (932°F), a Type J or Type K thermocouple, and a meter to read the thermocouple temperature.

8.8.5 (6-8.5) Procedure.

8.8.5.1 (6-8.5.1) The thermocouple shall be affixed to the insole surface of the specimen next to the foot, directly above the ball of the foot. The thermocouple shall be taped to the surface with electrical tape to hold it onto the insole surface.

8.8.5.2 (6-8.5.2) The plate shall be heated to a temperature of 500°C, ±10°C (932°F, ±18°F) and shall maintain this temperature throughout the test period.

8.8.5.3 (6-8.5.3) The specimen shall be filled with 4.55 kg (10 lb) of 5 mm ($^3/_8$ in.) steel balls. The weight of the steel balls shall be evenly distributed inside the boot. The specimen shall be placed on the plate in the upright position for 30 seconds.

8.8.5.4 (6-8.5.4) The thermocouple temperature shall be recorded at 30.0 seconds, +2/-0 seconds, after the specimen is placed on the heated metal plate.

8.8.6 (6-8.6) Report. The temperature at 30 seconds of exposure shall be recorded and reported for each specimen. The average temperature at 30 seconds of exposure for all specimens shall also be calculated and reported.

8.8.7 (6-8.7) Interpretation. The average temperature at 30 seconds of exposure for all specimens shall be used to determine pass or fail performance.

8.9 (6-9) Radiant Heat Resistance Test 1.

8.9.1 (6-9.1) Application. This test method shall apply to protective footwear.

8.9.2 (6-9.2) Specimens. A minimum of three complete footwear items shall be tested.

8.9.3 (6-9.3) Sample Preparation.

8.9.3.1 (6-9.3.1) Samples for conditioning shall be complete footwear.

8.9.3.2 (6-9.3.2) Specimens shall be tested after being subjected to the conditioning procedure specified in 8.1.3 (6-1.3).

8.9.3.3 (6-9.3.3) Specimens shall also be tested separately following conditioning as specified in 8.1.9 (6-1.9).

8.9.4 (6-9.4) Apparatus. The apparatus shall consist of the following:

(1) A radiometer with a spectral response flat to within ±3 percent of not less than 1.10 mm to 10.0 mm (0.04 in. to 0.4 in.) with an accuracy of ±5 percent

(2) A radiant panel with an effective radiating surface of not less than 150 mm × 150 mm (6 in. × 6 in.) and an emittance approximating that of a blackbody of 1000°K, ±200°K (1340°F, ±360°F)

(3) A thermocouple with meter

(4) A test chamber that prevents interference from air movement

8.9.5 (6-9.5) Procedure.

8.9.5.1 (6-9.5.1) Tests shall be done on the toe, vamp, quarter, gusset if present, and shaft. If different types or thickness of materials are utilized for other areas of the upper, these areas shall also be tested.

8.9.5.2 (6-9.5.1) The radiant panel shall be placed in front of the radiometer, parallel to the plane tangent to the radiometer. The radiant panel shall be adjusted to obtain a stable, uniform irradiance of 1.0 W/cm^2, +0.01/-0 W/cm^2, over a minimum 75-mm (3-in.) diameter circle located on the above plane and centered at the center of the test area. Calibration shall be achieved when the irradiance changes by less than 10 percent during a 3-minute period.

8.9.5.3 (6-9.5.3) The thermocouple shall be affixed to the inside surface of the lining next to the foot in the center of the test area. The radiometer shall be replaced with the protective footwear with the test area oriented parallel to the plane tangent to the heat source at the same distance from the heat source. The area shall be exposed for 1 minute, +5/-0 seconds.

8.9.5.4 (6-9.5.4) The thermocouple temperature shall be recorded at 1 minute, +5/-0 seconds, of exposure.

8.9.6 (6-9.6) Report. The temperature at 1 minute of exposure shall be recorded and reported for each specimen. The average temperature at 1 minute of exposure for all specimens shall also be calculated and reported.

8.9.7 (6-9.7) Interpretation. The average temperature at 1 minute of exposure for all specimens tested shall be used to determine pass or fail performance.

8.10* (6-10) Thermal Protective Performance (TPP) Test.

8.10.1 (6-10.1) Application.

8.10.1.1* (6-10.1.1) This test method shall apply to multilayer protective garment composites, gloves, glove gauntlets, wristlets, helmet ear covers, and hoods including single layer knit hoods that are worn in contact with the skin.

8.10.1.2 (6-10.1.2) Modifications to this test method for testing garment composites shall be as specified in 8.10.8 (6-10.8).

8.10.1.3 (6-10.1.3) Modifications to this test method for testing hoods shall be as specified in 8.10.9 (6-10.9).

8.10.1.4 (6-10.1.4) Modifications to this test method for testing wristlets shall be as specified in 8.10.10 (6-10.10).

8.10.1.5 (6-10.1.5) Modifications to this test method for testing gloves shall be as specified in 8.10.11 (6-10.11).

8.10.1.6 Modifications to this test method for testing glove gauntlets shall be as specified in 8.10.12.

8.10.1.7 Modifications to this test method for testing helmet ear covers shall be as specified in 8.10.13.

8.10.2 (6-10.3) Samples. Thermal protective performance testing shall be conducted on three specimens.

8.10.3 (6-10.2) Specimens.

8.10.3.1 Specimens shall measure 150 mm × 150 mm, ±6 mm (6 in. × 6 in., ±1/4 in.), and shall consist of all layers representative of the clothing item to be tested.

8.10.3.2 Specimens shall be tested both before and after preconditioning as specified in 8.1.2 (6-1.2) and then conditioning as specified in 8.1.3 (6-1.3).

8.10.4 (6-10.4) Apparatus.

8.10.4.1 (6-10.4.1) The test apparatus shall consist of a specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder. The apparatus shall also have a gas supply, gas rotameter, burners, and sensor.

8.10.4.1.1 (6-10.4.1.1) The specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder mounting plates shall be 152 mm × 152 mm, ±2 mm, × 6mm, ±1 mm (6 in. × 6 in., $\pm^1/_{16}$ in., × $^1/_4$ in., $\pm^5/_{16}$ in.). The lower specimen mounting plate shall have a centered 102 mm × 102 mm, ±2 mm (4 in. × 4 in., $\pm^1/_{16}$ in.) hole. The upper specimen mounting plate shall have a centered 133.4 mm × 133.4 mm, ±1.6 mm ($5^1/_4$ in. × $5^1/_4$ in., $\pm^1/_{16}$ in.) hole. The lower specimen mounting plate shall have a 25 mm, ±2 mm high, × 3 mm, ±1 mm (1 in, $\pm^1/_{16}$ in. high, × 0.13 in., ±0.0315 in.) thick steel post welded to each corner 6.4 mm, ±1.6 mm ($^1/_4$ in., $\pm^1/_{16}$ in.) from each side and perpendicular to the plane of the plate, or some other method for aligning the specimen shall be provided. The upper sample mounting plate shall have a corresponding hole in each corner so that the upper specimen mounting plate fits over the lower specimen mounting plate. Specifications for the specimen holder assembly shall be as shown in Figure 8.10.4.1.1 (6-10.4.1.1).

FIGURE 8.10.4.1.1 (6-10.4.1.1) Lower specimen mounting plate. [Existing Figure 6-10.4.1.1, 2000 ed., (no change)]

8.10.4.1.2 (6-10.4.1.2) The specimen holder assembly support shall consist of a steel frame that rigidly holds and positions in a reproducible manner the specimen holder assembly and specimen relative to the thermal flux.

8.10.4.1.3 (6-10.4.1.3) The thermal flux source shall consist of a convective thermal flux source and a radiant thermal flux source. The convective thermal flux source shall consist of two Meker or Fisher burners that are affixed beneath the specimen holder assembly opening, and are subtended at a nominal 45-degree angle from the vertical so that the flames converge at a point immediately beneath the specimen. The radiant thermal flux source shall consist of nine quartz T-150 infrared tubes affixed beneath and centered between the burners as shown in Figure 8.10.4.1.3 (6-10.4.1.3).

FIGURE 8.10.4.1.3 (6-10.4.1.3) Specifications for TPP tester thermal flux source. [Existing Figure 6-10.4.1.3, 2000 ed., (no change)]

8.10.4.1.4 (6-10.4.1.4) A protective shutter shall be placed between the thermal flux source and the specimen. The protective shutter shall be capable of completely dissipating thermal load from the thermal flux source of the time periods before and after specimen exposure.

8.10.4.1.5 (6-10.4.1.5) The sensor assembly shall be fitted into the opening in the top plate of the specimen holder and be in contact with the surface of the thermal barrier normally facing the wearer as detailed in Figure 8.10.4.1.10 (6-10.4.1.10). The sensor assembly shall consist of 133.4 mm × 133.4 mm × 13 mm ($5^1/_4$ in. × $5^1/_4$ in. × $^1/_2$ in.) heat-resistant block that fits without binding into the hole of the upper specimen mounting plate and shall be uniformly weighted such that the complete sensor assembly, including copper calorimeter, weighs 1000 g, ±10 g (2.2 lb, ±0.022 lb).

8.10.4.1.6 (6-10.4.1.6) The recorder shall be any strip chart recorder with full-scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ±0.1 second. Alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

8.10.4.1.7 (6-10.4.1.7) The gas supply shall be propane, methane, or natural gas with appropriate reducer and valving arrangements to control the gas supply pressure at 8 psig, ±0.1 psig, and capable of providing flow equivalent to 2 L/min (0.07 ft^3/min) air at standard conditions.

8.10.4.1.8 (6-10.4.1.8) The gas rotameter shall be any gas rotameter with range to give flow equivalent to 2 L (0.07 ft^3/min) air at standard conditions.

8.10.4.1.9 (6-10.4.1.9) The burners shall be Meker or Fisher burners with 38 mm, ±2 mm ($^1/_2$ in., ±0.1 in.) diameter top and with orifice size of 1 mm (0.05 in.).

8.10.4.1.10 (6-10.4.1.10) The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 8.10.4.1.10 (6-10.4.1.10). The sensor shall be coated with a flat black paint.

8.10.4.2 (6-10.4.2) A radiometer shall be used in the calibration of the test apparatus.

8.10.4.2.1 (6-10.4.2.1) The radiometer shall be a Gardon-type radiation transducer with a diameter of 25 mm (1 in.). The heat flux operating range shall be from 0 kW/m^2 to 60 kW/ m^2 (0 cal/cm^2/s to 1.4 cal/cm^2/s or 0 Btu/ft^2/ s to 5 Btu/ft^2/s).

FIGURE 8.10.4.1.10 (6-10.4.1.10) Sensor assembly. [Existing Figure 6-10.4.1.10, 2000 ed., (no change)]

8.10.4.2.2 (6-10.4.2.2) The radiometer shall be water cooled and the cooling water temperature shall be above the ambient dew point temperature.

8.10.5 (6-10.5) Procedure.

8.10.5.1 (6-10.5.1) General Procedures.

8.10.5.1.1 (6-10.5.1.1) All testing and calibration shall be performed in a hood or ventilated area to carry away combustion products, smoke, or fumes. If air currents disturb the flame, the apparatus shall be shielded. Procedures for testing and calibration shall be performed using the same hood and ventilation conditions.

8.10.5.1.2 (6-10.5.1.2) Care shall be exercised in handling the burner with open flame. Adequate separation shall be maintained between flame and combustible materials. Because the specimen holder and sensor assembly become heated during prolonged testing, protective gloves shall be used when handling these hot objects. Because some test specimens become hazardous when exposed to direct flame, care shall be used when the specimen ignites or releases combustible gases. If specimens ignite, the gas supply at the cylinder shall be shut off and the flame shall be allowed to burn the gas.

8.10.5.2 (6-10.5.2) Calibration Procedure.

8.10.5.2.1 (6-10.5.2.1) Specimens shall be exposed to a thermal flux of 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/s, ±0.1 cal/cm^2/s) as measured with the copper calorimeter. The copper calorimeter shall be the only heat sensor used in setting the total 83 kW/m^2 (2 cal/ cm^2/s) exposure condition. The total heat flux shall be calculated directly and only from the voltage output of the thermocouples, using the measured temperature rise of the testing copper calorimeter, the area and mass of the calorimeter, and the heat capacity of copper to calibrate the heat flux. Other heat-sensing devices shall not be used to reference or adjust the total heat flux read by the copper calorimeter.

8.10.5.2.2 (6-10.5.2.2) The total heat flux and the 50/50 percent, ±5 percent radiant/convective balance of the energy sources shall be set in accordance with the procedures in 8.10.5.2.3 (6-10.5.2.3) through 8.10.5.2.6 (6-10.5.2.6). The level of the radiant heat flux shall be determined using a radiometer and the level of the total heat flux shall be determined by using a calibration copper calorimeter designated and used only to set the total exposure level.

8.10.5.2.3 (6-10.5.2.3) Once an initial setting of 12 kW/m^2, ±1.2 kW/m^2 (0.3 cal/cm^2/s, ±0.03 cal/cm^2/s) has been made to the array of new quartz lamps, the operating voltage shall be recorded and permanently retained for test purposes. During all future calibration procedures, the voltage setting of the quartz lamps shall be compared to the current voltage setting of the new quartz lamps, and if the voltage increase is 5 V or greater from the initial setting, the lamps shall be replaced.

8.10.5.2.4* (6-10.5.2.4) The two Meker or Fisher burners shall be initially adjusted so that the flames converge upon each other just below the center of the radiometer. The color of the flame shall primarily be blue.

8.10.5.2.5 (6-10.5.2.5) The radiant thermal flux source of nine quartz infrared tubes alone shall be set to an incoming radiant heat flux of 12 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^2/s, ±0.1 cal/cm^2/s) using a commercial radiometer meeting the specifications of 8.10.4.2 (6-10.4.2). The radiometer window shall be positioned at the geometric center of the sample holder and at the same plane as a test specimen. The radiometer shall be mounted in a holder of the same overall size, shape, and material as the one used for the copper calorimeter to ensure similar heat and flame patterns across the faces of the radiometer and calorimeters. The radiant quartz tubes shall be turned to the on position for a minimum of 2 minutes prior to measuring the radiant heat flux.

8.10.5.2.6 (6-10.5.2.6) The total heat flux shall be set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/ cm^2/s, ±0.1 cal/cm^2/s) using the calibration copper calorimeter, defined in 8.10.4.1.10 (6-10.4.1.10), by adjusting only the gas supply to the Meker or Fisher burners. Without a mounted specimen, the calibration copper calorimeter shall be placed on top of the specimen holder with the blackened copper calorimeter facing down, and then exposed directly to the flame of the burner. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall also be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±4°C (267°F, ±7°F) equivalent to 7.86 mV, ±0.20 mV for an iron–constantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2.0 cal/cm^2/s, ±0.05 cal/cm^2/s).

8.10.5.3 (6-10.5.3) Test Procedure.

8.10.5.3.1 (6-10.5.3.1) After the total thermal heat flux has been set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/s, ±0.1 cal/cm^2/s) using the calibration procedure in 8.10.5.2.4 (6-10.5.2.4) through 8.10.5.2.6 (6-10.5.2.6), the testing copper calorimeter shall be used to measure the total heat flux. Prior to testing, the testing copper calorimeter shall be used to measure the total heat flux by placing the calorimeter face down, and then exposing it directly to the total heat source. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±4°C (267°F, ±7°F) equivalent to 7.86 mV, ±0.20 mV for an iron– constantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2.0 cal/ cm^2/s, ±0.05 cal/cm^2/s).

8.10.5.3.2 (6-10.5.3.2) If the measurement from the testing copper calorimeter is within +4/-0 kW/m^2 (+0.1/-0 cal/cm^2/s), then testing shall be done. If the measurement from the testing copper calorimeter does not agree within +4 kW/m^2 (+0.1 cal/cm^2/s) of the measurement of the calibration calorimeter, the testing copper calorimeter shall be repaired, reconditioned, or replaced to achieve agreement.

8.10.5.3.3 (6-10.5.3.3) Specimens shall be mounted by placing the surface of the material to be used as the outside of the garment face down on the mounting plate. The subsequent layers shall be placed on top in the order used in the garment, with the surface to be worn toward the skin facing up. With the protective shutter engaged, the specimens shall be placed on the specimen holder.

8.10.5.3.4 (6-10.5.3.4) The testing copper calorimeter shall be placed directly on the specimen in contact with the surface to be worn toward the skin.

8.10.5.3.5 (6-10.5.3.5) The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 8.10.5.4.1 (6-10.5.4.1). The start time of the exposure shall be indicated. The exposure shall be continued for 30 seconds. The protective shutter shall be engaged (closed), the recorder shall be stopped, the calorimeter shall be removed and cooled, and then the specimen holder and exposed specimen shall be removed.

8.10.5.3.6 (6-10.5.3.6) After each exposure, the calorimeter shall be cooled to 33°C, ±1°C (91°F, ±2°F) before the next heat flux determination. The sensor shall be cooled after exposure with a jet of air or by contact with a cold surface.

8.10.5.3.7 (6-10.5.3.7) The sensor face shall be wiped immediately after each run, while hot, to remove any decomposition products that condense and could be a source of error. If a deposit collects and appears to be thicker than a thin layer of paint, or is irregular, the sensor surface shall be reconditioned. The cooled sensor shall be carefully cleaned with acetone or petroleum solvent, making certain there is no ignition source nearby.

8.10.5.3.7.1* (6-10.5.3.7.1) If copper is showing on the testing copper calorimeter, the surface shall be completely repainted with a thin layer of flat black spray paint. At least one calibration run shall be performed comparing the testing copper calorimeter with the calibration copper calorimeter.

8.10.5.3.7.2 (6-10.5.3.7.2) If the testing calorimeter is in error by more than +4/-0 kW/m^2 (+0.1/-0 cal/cm^2/s), all electrical connections and points where thermocouples are secured to the testing calorimeter shall be checked. Two more calibration runs shall be conducted by comparing the testing copper calorimeter with the calibration grade copper calorimeter. The average error shall be calculated. If the average error of the testing calorimeter is more than +4 kW/m^2 (+0.1 cal/ cm^2/s), then the testing calorimeter shall be repaired and recalibrated or the testing calorimeter shall be replaced.

8.10.5.4 (6-10.5.4) Preparation of Human Tissue Burn Tolerance Overlay.

8.10.5.4.1 (6-10.5.4.1) Tolerance Overlay. The thermal end point shall be determined with a plot of energy versus the time to cause a second-degree burn in human tissue as shown in Table 8.10.5.4.1 (6-10.5.4.1). The calorimeter equivalent from Table 8.10.5.4.1 (6-10.5.4.1) that corresponds to the recorder scale shall be plotted on recorder chart paper. The columns DT°F, DT°C, and DmV (columns 6, 7, and 8) shall be plotted on the vertical axis and the corresponding exposure time (column 1) shall be plotted on the horizontal axis. Chart units based on the recorder full-scale deflection and the chart speed for a graph directly comparable to the recorder sensor trace shall be used. If pen deflection is from left to right and paper movement is down, the plot shall be from right to left with origin at lower right. If recorder trace differs, the graph shall be adjusted accordingly. An exact transparent duplicate shall be made for the overlay. The overlay shall be compared with the original to ensure change in the overlay size.

8.10.5.4.2 (6-10.5.4.2) Computer Processing of the Data. The information provided in Table 8.10.5.4.1 (6-10.5.4.1) shall be permitted to be used as the criteria of performance in the software of a computer program. In this case, the sensor response shall be compared with the thermal response, either pain sensation or second-degree burn in human tissue to determine the thermal end points. The product of the time to a second-degree burn in human tissue and the exposure energy heat flux shall be the TPP rating.

8.10.5.5 (6-10.5.5) Determination of Test Results.

8.10.5.5.1 (6-10.5.5.1) The time to the second-degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 8.10.5.4.1 (6-10.5.4.1). The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the exposure start time resulting from heat transfer. The horizontal axis (time) shall be placed in line with the initial trace of the pen, keeping the overlay square with the recorder chart. The time to the second-degree burn shall be read to the nearest 0.1 second from the overlay chart at the point when the sensor response curve and the tissue tolerance curve cross. If the sensor response curve and the tissue tolerance curves do not cross, ">30" shall be recorded as the test result.

8.10.5.5.1.1 (6-10.5.5.1.1) If a computer software program is used, the sensor response shall be compared with the data describing the human tissue heat tolerance to determine like values. The time from the start of the exposure to the time when these values are the same shall be taken at the exposure time.

8.10.5.5.2 (6-10.5.5.2) The TPP rating shall be calculated as the product of exposure energy heat flux and time to burn as follows:

$$\text{TPP rating} = F \times T$$

where:

F = exposure energy heat flux (cal/cm^2/s)

T = time to burn(s)

8.10.6 (6-10.6) Report.

8.10.6.1 The individual test TPP rating of each specimen shall be recorded and reported.

8.10.6.2 The average TPP rating shall be calculated and reported. If a TPP rating is greater than 60, then the TPP rating shall be recorded and reported as ">60."

8.10.7 (6-10.7) Interpretation.

8.10.7.1 (6-10.7.1) Pass or fail determinations shall be based on the average reported TPP rating of all specimens tested.

8.10.7.2 (6-10.7.2) Where an individual result from any test set varies more than ±8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

8.10.8 (6-10.8) Specific Requirements for Testing Garments.

8.10.8.1 (6-10.8.1) Specimens shall consist of outer shell, moisture barrier, and thermal barrier. Winter liners shall not be included in the test composite. Collar lining fabric shall be permitted to be included in the protective garment collar fabric composite specimen. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

8.10.8.2 (6-10.8.2) Samples for conditioning shall be at least a 1-m (1-yd) square of each material.

8.10.8.3 (6-10.8.3) Testing shall be performed as described in 8.10.2 (6-10.2) through 8.10.7 (6-10. 7).

8.10.9 (6-10.9) Specific Requirements for Testing Protective Hoods.

8.10.9.1 (6-10.9.1) Specimens shall consist of materials from the portion of the protective hood that covers the neck and facial area. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

8.10.9.2 (6-10.9.2) Samples for conditioning shall include hood material that is a minimum of 178-mm (7-in.) square.

8.10.9.3 (6-10.9.3) Testing shall be performed as described in 8.10.2 (6-10.2) through 8.10.7 (6-10.7).

8.10.10 (6-10.10) Specific Requirements for Testing Protective Wristlets.

8.10.10.1 (6-10.10.1) Specimens shall consist of materials from the portion of the protective wristlet that covers the wrist area. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

8.10.10.2 (6-10.10.2) Samples for conditioning shall include wristlet material that is a minimum of 180-mm (7-in.) square.

8.10.10.3 (6-10.10.3) Testing shall be performed as described in 8.10.2 (6-10.2) through 8.10.7 (6-10.7).

8.10.11 (6-10.11) Specific Requirements for Testing Protective Glove Body Composites.

8.10.11.1 Samples for conditioning shall be glove composite pouches as specified in 8.10.11.3.

8.10.11.2 Specimens shall be representative of each glove body composite construction.

Table 8.10.5.4.1 (6-10.5.4.1) Human Tissue Tolerance to Second-Degree Burn

Exposure Time(s)	Heat Flux		Total Heat		Calorimeter* Equivalent		
	cal/cm^2/ s	kW/m^2	cal/cm^2/ s	kW/m^2	DT°F	DT°C	DmV
1	1.2	50	1.20	50	16.0	8.9	0.46
2	0.73	31	1.46	61	19.5	10.8	0.57
3	0.55	23	1.65	69	22.0	12.2	0.63
4	0.45	19	1.80	75	24.0	13.3	0.69
5	0.38	16	1.90	80	25.3	14.1	0.72
6	0.34	14	2.04	85	27.2	15.1	0.78
7	0.30	13	2.10	88	28.0	15.5	0.80
8	0.274	11.5	2.19	92	29.2	16.2	0.83
9	0.252	10.6	2.27	95	30.2	16.8	0.86
10	0.233	9.8	2.33	98	31.1	17.3	0.89
11	0.219	9.2	2.41	101	32.1	17.8	0.92
12	0.205	8.6	2.46	103	32.8	18.2	0.94
13	0.194	8.1	2.52	106	33.6	18.7	0.97
14	0.184	7.7	2.58	108	34.3	19.1	0.99
15	0.177	7.4	2.66	111	35.4	19.7	1.02
16	0.168	7.0	2.69	113	35.8	19.8	1.03
17	0.160	6.7	2.72	114	36.3	20.2	1.04
18	0.154	6.4	2.77	116	37.0	20.6	1.06
19	0.148	6.2	2.81	118	37.5	20.8	1.08
20	0.143	6.0	2.86	120	38.1	21.2	1.10
25	0.122	5.1	3.05	128	40.7	22.6	1.17
30[1,2]	0.107	4.5	3.21	134	42.8	23.8	1.23

[1]Stoll, A. M. and M. A. Chianta, "Method and Rating System for Evaluation of Thermal Protection," *Aerospace Medicine*, vol. 40, 1968, pp. 1232–1238.

[2]Iron-contantan thermocouple.

8.10.11.3 For glove body composites, specimens for conditioning shall be in the form of an 200 mm x 200 mm (8in. x 8in.) pouch. The pouch shall be made of two glove body composite swatches. The two composite swatches shall be 200 mm x 200 mm (8in. x 8in.) and shall be constructed to simulate the actual layers of the glove arranged in proper order. Each of the two composite swatches shall be stitched on all four sides using the same thread as used in the glove construction. The two composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

8.10.11.4 Specimens shall be tested both before and after preconditioning as specified in 8.1.2 and then conditioning as specified in 8.1.3.

8.10.11.5 After conditioning, the pouch and stitching shall be cut to form 175 mm x 175mm (7in. x 7in.) specimens for testing. Specimens shall not include seams where multiple layers are involved. Specimens shall not be stitched to hold individual layers together during testing.

8.10.11.6 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.12 Specific Requirements for Testing Protective Glove Gauntlets.

8.10.12.1 Samples for conditioning shall be glove gauntlet composite swatches as specified in 8.10.12.3.

8.10.12.2 Specimens shall be representative of the glove gauntlet composite construction.

8.10.12.3 For glove gauntlet composites, samples for conditioning shall include glove material that is a minimum of 200 mm (8in.) square consisting of the composite used in the actual glove gauntlet construction with the layers arranged in proper order and stitched using the same thread used in the construction of the glove gauntlet.

8.10.12.4 Specimens shall be tested both before and after preconditioning as specified in 8.1.2 and then conditioning as specified in 8.1.3.

8.10.12.5 After conditioning, the stitching shall be cut to form 175 mm × 175 mm (7in. × 7in.) specimens for testing. Specimens shall not include seams where multiple layers are involved. Specimens shall not be stitched to hold individual layers together during testing.

8.10.12.6 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.13 (6-10.9) Specific Requirements for Testing Helmet Ear Covers.

8.10.13.1 Specimens shall consist of materials from the portion of the ear covers that cover the ear and neck area. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

8.10.13.2 Samples for conditioning shall include ear cover material that is a minimum of 180-mm (7-in.) square.

8.10.13.3 Testing shall be performed as described in 8.10.2 (6-10.2) through 8.10.7 (6-10.7).

8.11 (6-11) Thread Melting Test.

8.11.1 (6-11.1) Application. This test shall apply to sewing thread used in the construction of protective garments, hoods, wristlets, gloves, helmets, and footwear.

8.11.2 (6-11.2) Specimens. Three different specimens shall be used.

8.11.3 (6-11.3) Sample Preparation. Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.11.4 (6-11.4) Procedure. Specimens shall be tested in accordance with Method 1534, *Melting of Synthetic Fiber* of Federal Test Method Standard 191A, *Textile Test Methods*, at a test temperature of 260°C (500°F).

8.11.5 (6-11.5) Report. The condition of specimens shall be observed at 260°C (500°F).

8.11.6 (6-11.6) Interpretation. Any specimen exhibiting melting at 260°C (500°F) shall constitute failure of this test.

8.12 (6-12) Tear Resistance Test.

8.12.1 (6-12.1) Application. This test shall apply to woven materials used in protective garments, hoods, and wristlets.

8.12.2 (6-12.2) Sample Preparation.

8.12.2.1 (6-12.2.1) Samples for conditioning shall be at least 1-m (1-yd) square of material.

8.12.2.2 (6-12.2.2) Samples shall be tested both before and after being conditioned as specified in 8.1.2 (6-1.2).

8.12.3 (6-12.3) Specimens.

8.12.3.1 (6-12.3.1) A minimum of five specimens in each of the warp, machine or coarse, direction and the filling, cross-machine or wales, direction shall be tested.

8.12.3.2 (6-12.3.2) Where the material is isotropic, then ten specimens shall be tested.

8.12.4 (6-12.4) Procedure. Specimens shall be tested in accordance with ASTM D 5733, *Standard Test Method for the Tearing Strength of Nonwoven Fabrics by the Trapezoidal Procedure.*

8.12.5 (6-12.5) Report.

8.12.5.1 (6-12.5.1) The tear resistance of an individual specimen shall be the average of the five highest peak loads of resistance registered. The tear strength of each specimen shall be recorded and reported to the nearest 0.5 N (0.1 lbf) of force.

8.12.5.2 (6-12.5.2) An average tear strength shall be calculated for warp and filling directions.

8.12.6 (6-12.6) Interpretation.

8.12.6.1 (6-12.6.1) Pass or fail performance shall be based on the average tear resistance in the warp and filling directions.

8.12.6.2 (6-12.6.2) Failure in any one direction constitutes failure for the material.

8.12.7 (6-12.7) Specific Requirements for Testing Protective Garments.

8.12.7.1 (6-12.7.1) Where configured as individual barrier layers, specimens of garment moisture barriers, thermal barriers, and winter liners, where provided, shall be tested.

8.12.7.2 (6-12.7.2) Where one or more of these barriers are configures as a single barrier layer by bonding or laminating individual barriers together so that the individual layers do not retain their individuality and are not separable, they shall be tested as a composite.

8.13 (6-13) Burst Strength Test.

8.13.1 (6-13.1) Application. This test shall apply to knit materials used in protective garments, hoods, and wristlets.

8.13.2 (6-13.2) Specimens. A total of ten specimens shall be tested.

8.13.3 (6-13.3) Sample Preparation.

8.13.3.1 (6-13.3.1) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.13.3.2 (6-13.3.2) Samples for conditioning shall be 1-m (1-yd) square of material.

8.13.4 (6-13.4) Procedure. Specimens shall be tested as specified in ASTM D 3787, *Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics—Ball Burst Testing Method*.

8.13.5 (6-13.5) Report. The burst strength of each specimen shall be recorded and reported. The average burst strength of all specimens shall be calculated and reported.

8.13.6 (6-13.6) Interpretation. The average burst strength shall be used to determine pass or fail performance.

8.14 (6-14) Seam-Breaking Strength Test.

8.14.1 (6-14.1) Application.

8.14.1.1 (6-14.1.1) This test shall apply to seams used in protective garments, garment wristlets, glove wristlets, glove gauntlets, and hoods.

8.14.1.2 (6-14.1.2) Modifications to this test method for testing garment wristlets, glove wristlets, and glove gauntlets shall be as specified in 8.14.7 (6-14.7).

8.14.2 (6-14.2) Specimens.

8.14.2.1 (6-14.2.1) A minimum of five seam specimens representative of the garment shall be tested for each seam type.

8.14.2.2 (6-14.2.2) The five seam specimens shall be straight seams. Seam specimens shall be permitted to be cut from the finished garment or shall be permitted to be prepared by joining two pieces of the garment fabric. Where specimens are cut from finished garments, such specimens shall be preconditioned after being cut from the finished garment.

8.14.2.2.1 (6-14.2.2.1) Where two pieces of woven garment fabric are joined, the woven fabric seam specimen shall be prepared as specified in 8.2.1.2 of ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, and shall use the same thread, seam type, and stitch type as used in the finished garment.

8.14.2.2.2 (6-14.2.2.2) Where two pieces of knit or stretch woven garment fabric are joined, the knit fabric seam specimen shall be prepared as specified in 7.2.2 of ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*, using the same thread, seam type, and stitch type as used in the finished garment.

8.14.2.2.3 (6-14.2.2.3) Specimens of garment seam assemblies constructed from other than woven or knit textiles shall be tested as specified in 8.14.2.2.1 (6-14.2.2.1).

8.14.2.2.4 (6-14.2.2.4) Where a piece of woven garment fabric and a knit or stretch woven fabric are joined, the seam specimen shall be prepared as specified in 8-2.1.2 of ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, and shall use the same thread, seam type, and stitch type as used in the finished garment.

8.14.3 (6-14.3) Sample Preparation.

8.14.3.1 (6-14.3.1) Samples for conditioning shall be 1-m (1-yd) square of material.

8.14.3.2 (6-14.3.2) Specimens shall be tested after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.14.4 (6-14.4) Procedure.

8.14.4.1 (6-14.4.1) All woven seam assemblies shall be tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*. The test machine shall be operated at a rate of 305 mm/min (12 in./ min).

8.14.4.2 (6-14.4.2) All knit seam assemblies and all stretch woven seam assemblies shall be tested in accordance with ASTM D 3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*.

8.14.4.3 (6-14.4.3) Combination woven and knit or stretch woven seam assemblies shall be tested in accordance with ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics.* The test machine shall be operated at a rate of 304.8 mm/min (12 in./min).

8.14.5 (6-14.5) Report.

8.14.5.1 (6-14.5.1) The seam-breaking strength for each seam specimen shall be recorded and reported. The average seam-breaking strength for each seam type shall also be reported.

8.14.5.2 (6-14.5.2) The type of seams tested shall be recorded and reported as to whether the specimens were cut from the finished garment or prepared from fabric samples.

8.14.6 (6-14.6) Interpretation. The average seam-breaking strength for each seam type shall be used to determine pass or fail performance.

8.14.7 (6-14.7) Specific Requirements for Testing Protective Garment Wristlets, Glove Wristlets, and Glove Gauntlets.

8.14.7.1 (6-14.7.1) Specimens for conditioning and testing shall consist of seams taken from the wristlet/garment sleeve, the wristlet/glove body junction, or the gauntlet/glove body junction.

8.14.7.2 Whole gloves shall be permitted to be used for conditioning.

8.14.7.3 Specimen sizes shall be 100 mm × 200 mm (4 in. × 8 in.), with the seam horizontally in the middle of the 100-mm (4-in.) dimension.

8.14.7.4 (6-14.7.2) Evaluation for sewn seam strength in accordance with Section 11.1 of ASTM D 1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, shall be used to determine pass or fail performance.

8.15 (6-15) Top Impact Resistance Test (Force).

8.15.1 (6-15.1) Application. This test shall apply to complete helmets.

8.15.2 (6-15.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2).

8.15.3 (6-15.3) Sample Preparation.

8.15.3.1 (6-15.3.1) Samples for conditioning shall be complete helmets.

8.15.3.2 (6-15.3.2) Specimens shall be conditioned for each environmental condition specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.5 (6-1.5), 8.1.6 (6-1.6), and 8.1.7 (6-1.7) prior to each impact.

8.15.4 (6-15.4) Apparatus.

8.15.4.1 (6-15.4.1) An aluminum ISEA size 7 headform shall be used. The headform shall have a mass of 3.6 kg, ±0.5 kg (8 lb, ±1 lb) and shall be of the nominal dimensions of the headform in Table 8.15.4.1 (6-15.4.1) and Figures 8.15.4.1(A) [6-15.4.1(a)] through (c).

8.15.4.2 (6-15.4.2) A steel drop mass of 3.58 kg, ±0.05 kg (7.90 lb, ±0.10 lb) shall be used. The striking face of the drop mass shall be a spherical segment with a radius of 50 mm, ±8 mm ($1^{7}/_{8}$ in., $\pm^{5}/_{16}$ in.) and a chord length of at least 75 mm (3 in.).

8.15.4.3 (6-15.4.3) An electronic force measurement system with the following minimum specifications shall be used:

(1) Range — 4450 N (1000 lbf)

(2) Peak force measurement accuracy — ±2.5 percent

(3) Resolution — 22 N (5 lbf)

(4) Load cell rigidity — 4.4×10^{9} N/m (2.5×10^{7} lbf/in.)

(5) Minimum mechanical resonant frequency of the headform/load cell system — 5000 Hz

(6) Load cell diameter — 75 mm (3 in.)

8.15.4.4 (6.15.4.4) The system frequency response shall comply with SAE J211, *Instrumentation for Impact Test*, Channel Frequency Class 1000, specifications. The minimum mechanical resonant frequency shall be calculated from the following formula:

$$f = \frac{\left(\sqrt{kg / m}\right)}{2\pi}$$

where:

kg = load cell rigidity [N/m (lbf/ft)]

m = mass of the structure on top of the load cell [kg (slugs)]

8.15.4.5 (6-15.4.5) All surfaces in contact with the load cell shall have a surface finish of at least 0.8×10^{-6} m (32×10^{-6} in.) rms. In addition, those surfaces in contact with the load cell shall be flat to within 12.7×10^{-6} m (500×10^{-6} in.).

8.15.4.6 (6-15.4.6) The load cell shall have a backup mass of at least 540 kg (1200 lb). The load cell assembly shall be rigidly mounted between the headform structure and a steel plate at least 305-mm (1-ft) square and 25 mm (1 in.) thick. The backup mass shall be concrete or a rigid material of equal or greater density at least 610 mm^2 (2 ft^2).

8.15.4.7 (6-15.4.7) The surface of the steel plate, in the area of the load cell assembly mounting, shall be flat within ±0.15 mm (±0.005 in.) and within 1 degree of level. The steel plate shall be rigidly attached to, and in intimate contact with, the backup mass.

8.15.4.8 (6-15.4.8) The vertical centerline of the drop mass, the headform, and the load cell shall all be colinear within 3 mm ($^{1}/_{8}$ in.). The sensitive axis of the load cell shall be aligned within 1 degree of vertical. The guide or guides shall be vertical, and in the case of a double guide system, parallel to within 6.4 mm per 3 m ($^{1}/_{4}$ in. per 10 ft) of length.

8.15.4.9* (6-15.4.9) The instrumentation calibration shall be verified at least before and after each test series or at the beginning and end of each day of testing, whichever is the shorter length of time.

8.15.4.10 (6-15.4.10) The test system shall be analyzed dynamically to ensure that any mechanical resonance associated with transducer mountings do not distort the output data.

8.15.4.11 (6-15.4.11) Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

8.15.4.12 (6-15.4.12) Throughout calibration, verification, and testing, the ambient temperature shall be 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

8.15.5 (6-15.5) Procedure.

8.15.5.1 (6-15.5.1) Where faceshield/goggle component(s) are provided, the device shall be removed from the helmet for this test. Specimen helmets shall be adjusted to a size sufficient to properly fit on the headform. Specimens shall be positioned on the headform with the horizontal center plane parallel within 5 degrees of the reference plane. The front-to-back centerline of the shell shall be within 13 mm ($^{1}/_{2}$ in.) of the midsagittal plane of the headform. Specimens shall be subjected to the environmental conditions specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.5 (6-1.5), 8.1.6 (6-1.6), and 8.1.7 (6-1.7) prior to each impact and within the specified time after being removed from conditioning.

8.15.5.2 (6-15.5.2) The impactor shall be dropped from a height that yields an impact velocity within 2 percent of 5.47 m/sec (17.9 ft/sec). A means of verifying the impact velocity to within 2 percent for each impact shall be incorporated.

8.15.5.3 (6-15.5.3) The verification tests shall demonstrate an accuracy of 2.5 percent or better in the measured force.

8.15.6 (6.15.6) Report.

8.15.6.1 (6-15.6.1) The results of each system verification shall be made part of the test results for specimens being tested.

8.15.6.2 (6-15.6.2) The peak force and impact velocity shall be recorded for each test.

8.15.7 (6-15.7) Interpretation. Pass or fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

8.16 (6-16) Impact Resistance Test (Acceleration).

8.16.1 (6-16.1) Application. This test shall be applied to complete helmets.

8.16.2 (6-16.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2.)

8.16.3 (8-16.3) Sample Preparation.

8.16.3.1 (8-16.3.1) Specimens shall be conditioned for each environmental condition specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.6 (6-1.6), and 8.1.7 (6-1.7) prior to each impact.

8.16.3.2 (8-16.3.2) Samples for conditioning shall be complete helmets.

8.16.4 (8.16.4) Apparatus.

8.16.4.1 (8-16.4.1) An ISO size J headform conforming to the nominal dimensions in Figure 8.16.4.1 (6-16.4.1) shall be used. The ISO size J test headform shall exhibit no resonant frequencies below 3000 Hz, and it shall be made of any low-resonance alloy, such as magnesium K-1A.

FIGURE 8.16.4.1(a) [6-15.4.1(a)] ISEA size 7 headform, top. [Existing Figure 6-15.4.1(a), 2000 ed., (no change)]

FIGURE (8.16.4.1(b) [6-15.4.1(b)] ISEA size 7 headform, side with modification for steel terminal junction bolt. [Existing Figure 6-15.4.1(b), 2000 ed., (no change)]

FIGURE 8.16.4.1(c) [6-15.4.1(c)] ISEA size 7 headform, front. [Existing Figure 6-15.4.1(c), 2000 ed., (no change)]

FIGURE 8.16.4.1 (6-16.4.1) Location of reference plane (all dimensions in mm). [Existing Figure 6-16.4.1, 2000 ed., (no change)]

Table 8.16.4.1 (6-16.4.1) Data for Contour Drawing of ISEA Headform (all dimensions in mm)

	Horizontal Plane	Distance from Datum Plane	Vertical Sections												
			0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
	0-0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
	1-1	95	22.5	22.5	23	25.5	26.5	28	28.5	31	33	36	39	38.7	40
	2-2	90	39.5	40	40	40.5	40.5	40.5	41.5	43.5	47.5	50	53	53	54.5
	3-3	85	53.5	54	55.7	51.5	50.5	50	51.5	53.5	57	60.5	64	64.5	65.5
	4-4	80	62.5	63	60.9	59	57	57	57.5	60.5	63.5	67.3	70.7	70.7	72.2
	5-5	70	72.5	74	71.5	68.2	65.5	64.5	65.3	68	72	75.7	79.1	80	82
	6-6	60	82	82	79.5	75	71.0	69.4	70.1	73	77.5	81.7	85.1	87.5	87.9
	7-7	50	87.3	87	84.5	79	74	71.5	72	75.7	80.9	85.8	89.4	91	92.3
	8-8	40	90.2	90.5	87.5	81.5	75.5	73.0	73.5	76.9	82.7	88.3	91.3	93.5	95
	9-9	20	94.0	94	90.5	83.5	77.1	73.7	74.2	77.8	84.3	91	95.5	97.6	98.5
Datum Plane	10-10	0	96.5	96.5	93.0	84.6	77.5	73.5	74.2	79	85	92.5	96.5	98.8	99.9
	11-11	20	96.5	96.5	93.0	84.6	77.5	73.5	72	70	78.5	84	90	91	95
	12-12	40	96.5	96.5	93.0	84.6	77.5	73.5	70	63.5	70	75	81	82	84
	13-13	60	96.5	96.5	93.0	84.6	77.5	73.5	68	58	57.5	63	69	69	72
	14-14	80	96.5	96.5	93.0	84.6	77.5	73.5	66	54	48	53	59	60	63
	15-15	100	96.5	96.5	93.0	84.6	77.5	73.5	64	52	48	49	54	56	59
	16-16	115.9	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5
	17-17	128.6	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5

Note: All dimensions ±5 mm.

For SI units, 1 in. = 25.4 mm.

8.16.4.2 (6-16.4.2) There shall be a drop assembly consisting of the test headform, the accelerometer, and the moving portion of the headform guidance assembly. The drop assembly shall have a total mass of 5.17 kg, ±0.18 kg (11.4 lb, ±0.4 lb).

8.16.4.3 (6-16.4.3) The guidance assembly shall comprise not more than 20 percent of the total mass of the drop assembly.

8.16.4.4 (6-16.4.4) The center of mass of the drop assembly shall lie within a cone of 10 degrees included angle about the vertical, with the apex at the point of impact.

8.16.4.5 (6-16.4.5) A steel test anvil shall be used and shall have a smooth, flat striking surface 125 mm, ±15 mm (5 in., ± $^1/_{16}$ in.) in diameter. The anvil shall be mounted securely on a steel plate at least 305-mm (1-ft) square and 25 mm (1 in.) thick. The steel plate shall be rigidly attached to and in intimate contact with a backup mass of at least 540 kg (1200 lb). The backup mass shall be of concrete or a rigid material of equal or greater density at least 610 mm^2 (2 ft^2).

8.16.4.6 (6-16.4.6) An electronic acceleration measurement system with the following minimum specifications shall be used:

(1) Range — 500 Gn

(2) Peak acceleration measurement — ±2.5 percent accuracy

(3) Resonant frequency — 5000 Hz

(4) Accelerometer shock limit — 2000 Gn

(5) Resolution — 5 Gn

8.16.4.7 (6-16.4.7) The system frequency response shall comply with SAE J211, *Instrumentation for Impact Test*, Channel Frequency Class 1000, specifications. The time duration of acceleration levels shall be measured to within ±0.2 millisecond.

8.16.4.8 (6-16.4.8) A reference anvil shall be substituted for the test anvil to verify the calibration of the acceleration measurement system. The reference anvil shall be constructed of any material that will yield reproducible test results during a period of at least four months.

8.16.4.9* (6-16.4.9) For calibration, the center of the reference anvil shall be aligned within 3 mm ($^1/_8$ in.) of the impact point on the headform. The sensitive axis of the accelerometer shall be aligned within 1 degree of vertical and shall be colinear within 3 mm ($^1/_8$ in.), with the center of the reference anvil and the impact point on the headform. The guide or guides shall be vertical and, in the case of a double guide system, parallel to within 6 mm per 3 m ($^1/_4$ in. per 10 ft) of length.

8.16.4.10 (6-16.4.10) The instrumentation calibration shall be verified at least before and after each test series or at the beginning and end of each day of testing, whichever is the shorter length of time.

8.16.4.11 (6-16.4.11) The test system shall be analyzed dynamically to ensure that any mechanical resonance does not distort the output data.

8.16.4.12 (6-16.4.12) Prior to testing, the instrumentation shall be allowed to warm up until stability is achieved.

8.16.4.13 (6-16.4.13) Throughout calibration, verification, and testing, the ambient temperature shall be 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

8.16.5 (6-16.5) Procedure.

8.16.5.1 (6-16.5.1) A conditioned specimen with faceshield/goggle component(s) removed shall be positioned on the headform with the horizontal center plane of the helmet parallel within 5 degrees of the reference plane of the headform and shall be secured to the drop assembly by its retention system so as to maintain this position during the test. No part of the helmet shell shall be cut away to accommodate the test system, and no part of the test system shall contact the helmet shell either as mounted or during an impact test.

8.16.5.2 (6-16.5.2) The drop assembly with a helmet attached shall be dropped from a height that yields an impact velocity within 2 percent of 6.0 m/sec (19.7 ft/sec). A means of verifying the impact velocity within 2 percent for each impact shall be incorporated in the test system. The acceleration time duration values, peak acceleration, and

impact velocity shall be recorded for each test. Each helmet shall be environmentally conditioned prior to each impact in each of the five impact areas specified in Figure 8.1.6.1 (6-1.6.1). Test series number 1 shall require helmet specimens 5, 6, 8, and 10 to be impacted at the front, rear, and side impact areas at a distance of 68 mm, +13/ -0 mm ($2^1/_2$ in, +0.5/-0 in.) when measured from the test line to the center of the impact anvil.

8.16.5.3 (6-16.5.3) The impact areas shall be as specified in Figure 8.1.6.1 (6-1.6.1). The top, front, rear, and side areas of the helmet shall be tested.

8.16.5.4 (6-16.5.4) The top impact area shall consist of a 30-mm (1.2-in.) radius measured from a point located on the headform at the junction of the coronal plane and midsagittal plane.

8.16.5.5 (6-16.5.5) The front impact test area shall consist of an area defined as extending forward on the headform from the front vertical transverse plane to the test line.

8.16.5.6 (6-16.5.6) The rear impact test area shall consist of an area defined as extending backward on the headform from the rear vertical transverse plane extending down to the test line.

8.16.5.7 (6-16.5.7) The side test areas shall consist of the areas between the top test area and test line extending from the rear vertical transverse plane and the front vertical transverse plane.

8.16.5.8 (6-16.5.8) Each conditioned specimen in a series shall be impacted one on the top, rear, front, and side test areas of the helmets as defined in Figure 8.1.6.1 (6-1.6.1). At least one impact shall occur in each test area.

8.16.5.9 (6-16.5.9) The center of the test anvil shall be no lower than 68 mm ($2^1/_2$ in.) above the test line.

8.16.5.10 (6-16.5.10) The verification tests shall demonstrate an accuracy of 20 percent or better in the measured acceleration.

8.16.6 (6-16.6) Report.

8.16.6.1 (6-16.6.1) The results of each system verification shall be made part of the test results for the specimens being tested.

8.16.6.2 (6-16.6.2) The maximum acceleration, duration of acceleration above 200 Gn, and duration of acceleration above 150 Gn shall be recorded for each test.

8.16.7 (6-16.7) Interpretation. Pass or fail performance shall be determined for each specimen. One or more helmet specimens failing this test shall constitute failing performance.

8.17 (6-17) Faceshield/Goggle Component Lens Impact Resistance Test.

8.17.1 (6-17.1) Application. This test shall apply to complete helmets.

8.17.2 (6-17.2) Specimens.

8.17.2.1 (6-17.2.1) Where the manufacturer produces helmets with faceshield components, a minimum of four complete faceshield components shall be tested.

8.17.2.2 (6-17.2.2) Where the manufacturer produces helmets with goggle components, a minimum of four complete goggle components shall be tested.

8.17.2.3 (6-17.2.3) Where the manufacturer produces helmets with both faceshield and goggle components attached to a single helmet a minimum of four faceshield and four goggle components shall be tested.

8.17.3 (6-17.3) Sample Preparation.

8.17.3.1 (6-17.3.1) Samples shall be preconditioned for each of the environmental conditions specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.5 (6-1.5), and 8.1.7 (6-1.7).

8.17.3.2 (6-17.3.2) Samples for conditioning shall be as defined in 8.17.2 (6-17.2).

8.17.4 (6-17.4) Test One, High Mass Impact.

8.17.4.1 (6-17.4.1) Apparatus.

8.17.4.1.1 (6-17.4.1.1.1) An Alderson 50th-percentile male headform specified in Figure 8.17.4.1.1 (6-17.4.1.1) shall be used to hold the protective device. It shall be rigidly mounted in the horizontal position, face up, on a base that has a mass of 30 kg (66 lb) or greater. The static stiffness of the headform shall be such that, when a vertical downward force of 20 kg (44 lb) is applied to the forehead of the headform, the back of the headform shall not deflect more than 2 mm ($^1/_{16}$ in.).

FIGURE 8.17.4.1.1 (6-17.4.1.1) Alderson headform. [Existing Figure 6-17.4.1.1, 2000 ed., (no change)]

8.17.4.1.2 (6-17.4.1.2) The missile shall have a 30-degree conical tip with a 1-mm (1/25-in.) radius, shall weigh 500 g (17.6 oz), and shall have a diameter of 25 mm (1 in.). The missile shall be held in position over the headform, tip down, at the designated test height. The missile shall have a heat-treated steel tip.

8.17.4.1.3* (6-17.4.1.3) The missile shall be dropped through a loose-fitting guide tube having a smooth internal diameter.

8.17.4.2 (6-17.4.2) Procedure.

8.17.4.2.1 (6-17.4.2.1) Only one faceshield/ goggle component shall be tested at a time.

8.17.4.2.2 (6-17.4.2.2) The complete helmet shall be placed on the headform in accordance with the helmet positioning index. The alignment shall be such that, with the faceshield/goggle component deployed, when the missile is dropped, it points in line with one of the eyes of the headform.

8.17.4.2.3 The helmet positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the brow at the lateral midpoint of the helmet to the basic plane of the International Standards Organization (ISO) size J headform when the helmet is firmly positioned on the headform.

8.17.4.2.4 (6-17.4.2.3) The missile shall be dropped from a height of 1300 mm ($51^3/_{16}$ in.). Four samples shall be tested.

8.17.4.3 (6-17.4.3) Report. The pass or fail result for each device shall be recorded and reported.

8.17.5 (6-17.5) Test Two, High Velocity Impact.

8.17.5.1 (6-17.5.1) Apparatus.

8.17.5.1.1* (6-17.5.1.1) The test apparatus shall consist of a device capable of propelling a steel ball reproducible at the velocity designated at 250 ft/sec. The device shall show a sample standard deviation of not greater than 2 percent of 250 ft/sec based on a test series of 30 shots. The velocity of the steel ball shall be determined at a distance not greater than 250 mm (10 in.) from point of impact. The projectiles used in this test shall be 6-mm ($^1/_4$-in.) diameter steel balls weighing approximately 1.06 g (0.04 oz). These balls are damaged during impact and shall be changed frequently to avoid impacts at unexpected locations and large variations in velocity.

8.17.5.1.2 (6-17.5.1.2) An Alderson 50th-percentile male headform specified in Figure 8.17.4.1.1 (6-17.4.1.1) shall be used for mounting the helmet with faceshield/goggle component. The headform shall be capable of being rotated on a vertical axis through each corneal vertex in 15-degree increments, from a first position 15 degrees to the nasal side of straight-ahead-viewing out to 90 degrees temporally, given that the headform is vertical such that the two eyes lie in a horizontal reference plane. The headform shall be capable of being raised 10 mm (0.394 in.) and lowered 10 mm (0.394 in.) with respect to the horizontal plane to carry out testing at the 90 degrees angular position.

8.17.5.2 (6-17.5.2) Procedure.

8.17.5.2.1 (6-17.5.2.1) Only one faceshield/ goggle component shall be tested at a time.

8.17.5.2.2 (6-17.5.2.2) The helmet with faceshield/goggle component deploy shall be mounted to the Alderson 50th-percentile male headform in accordance with the eye / face positioning index.

8.17.5.2.3 The helmet eye / face-positioning index shall be the vertical distance, as specified by the helmet manufacturer, from the top lateral midpoint of the faceshield or the faceshield / goggle component to the basic plane of the Alderson 50th percent male adult headform where the faceshield or the faceshield / goggle component is positioned on the headform.

8.17.5.2.4 (6-17.5.2.3) The headform shall be adjusted so that the path of the projectile passes through the center of the right eye. It is then rotated to the first test position, which shall be 15 degrees to the nasal side. The faceshield/goggle component shall be impacted at the test velocity. A new faceshield/ goggle component shall be placed on the headform and impacted at 0 degree. A new faceshield/goggle component shall be placed on the headform and impacted at 45 degrees. A new faceshield/goggle component shall be placed on the headform and impacted at 90 degrees. The impacts at the 45-degree and 90-degree positions shall be at either 10 mm (0.394 in.) above or 10 mm (0.394 in.) below the plane of the eyes.

8.17.5.2.5 (6-17.5.2.4) The headform shall be adjusted so that the path of the projectile passes through the center of the left eye. It is then rotated to the first test position, which shall be 15 degrees to the nasal side. The faceshield/goggle component shall be impacted at the test velocity. A new faceshield/ goggle component shall be placed on the headform and impacted at 0 degree. A new faceshield/goggle component shall be placed on the headform and impacted at 45 degrees. A new faceshield/goggle component shall be placed on the headform and impacted at 90 degrees. The impacts at the 45-degree and 90-degree positions shall be at either 10 mm (0.394 in.) above or 10 mm (0.394 in.) below the plane of the eyes.

8.17.5.2.6 (6-17.5.2.5) Eight specimens shall be tested.

8.17.6 (6-17.6) Report. The pass or fail performance for each helmet shall be recorded and reported.

8.17.7 (6-17.7) Interpretation. One or more helmet specimens failing this test shall constitute failing performance.

8.18 (6-18) Impact and Compression Tests.

8.18.1 (6-18.1) Application. This test method shall apply to the toe section of protective footwear.

8.18.2 (6-18.2) Specimens. A minimum of three footwear specimens shall be tested for both impact and compression.

8.18.3 (6-18.3) Sample Preparation.

8.18.3.1 (6-18.3.1) Samples for conditioning shall be complete footwear toe sections.

8.18.3.2 (6-18.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.18.4 (6-18.4) Procedure. Footwear specimens shall be tested in accordance with Section 1.4 of ANSI Z41, *Standard for Personal Protection — Protective Footwear.*

8.18.5 (6-18.5) Report. The impact and compression forces for each specimen shall be recorded and reported. The clearance after impact and the compression forces shall be recorded.

8.18.6 (6-18.6) Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

8.19 (6-19) Physical Penetration Resistance Test.

8.19.1 (6-19.1) Application. This test method shall apply to protective helmets.

8.19.2 (6-19.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2).

8.19.3 (6-19.3) Sample Preparation.

8.19.3.1 (6-19.3.1) Samples for conditioning shall be complete helmets.

8.19.3.2 (6-19.3.2) Specimens shall be conditioned for each environmental condition specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.5 (6-1.5), 8.1.6 (6-1.6), and 8.1.7 (6-1.7) prior to each physical penetration.

8.19.4 (6-19.4) Apparatus.

8.19.4.1 (6-19.4.1) The ISO size J headform shall conform to the nominal dimensions in Figure 8.16.4.1 (6-16.4.1). Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

8.19.4.2 (6-19.4.2) The penetration striker shall have a mass of 1 kg, +0.02/-0.0 kg (2.2 lb, +0.01/-0.0 lb). The point of the striker shall be a cone with an included angle of 60 degrees, ±0.5 degree, a height of 38 mm ($^1/_2$ in.), and a tip radius of 0.5 mm, ±0.1 mm (0.020 in., ±0.004 in.). The hardness of the striking tip shall be Rockwell Scale C-60, minimum. The penetration striker shall be electrically connected to the contact indicator.

8.19.4.3 (6-19.4.3) 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.

8.19.4.4 (6-19.4.4) 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.

8.19.5 (6-19.5) Procedure.

8.19.5.1 (6-19.5.1) The environmentally conditioned helmet shall be placed on the rigidly mounted test headform and secured by the helmet retention system or by other means that will not interfere with the test. The helmet shall be positioned so that the penetration striker shall impact perpendicular to the helmet anywhere above the test line. The impact site shall be at least 75 mm (3 in.) from the center of a previous penetration or impact site.

8.19.5.2 (6-19.5.2) The drop height of the penetration striker shall be adjusted so that the velocity at impact is at 7 m/s, ±0.1 m/s (23 ft/s, ±0.5 ft/s). A total of two penetration tests for each of the five environmental conditions specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.5 (6-1.5), 8.1.6 (6-1.6), and 8.1.7 (6-1.7) shall be conducted in such a manner that at least one penetration test shall be performed in each of the test areas defined in Figure 8.1.6.1 (6-1.6.1). The helmet shall be environmentally conditioned prior to each penetration test. A minimum of two penetration test blows shall be applied at different test areas on each helmet.

8.19.6 (6-16.6) Report. The pass or fail result for each helmet shall be recorded and reported.

8.19.7 (6-16.7) Criteria. One or more helmet specimens failing this test shall constitute failing performance.

8.20 (6-20) Puncture Resistance Test 1.

8.20.1 (6-20.1) Application. This test method shall apply to protective gloves and footwear uppers.

8.20.2 (6-20.2) Specimens. A minimum of three specimens measuring at least 150-mm (6-in.) square shall be tested.

8.20.3 (6-20.3) Sample Preparation.

8.20.3.1 (6-20.3.1) Samples for conditioning shall be complete gloves or footwear upper sections.

8.20.3.2 (6-20.3.2) Specimens shall be tested after conditioning as specified in 8.1.3 (6-1.3).

8.20.4 (6-20.4) Procedure. Specimens shall be tested in accordance with ASTM F 1342, *Standard Test Method for Protective Clothing Material Resistance to Puncture*.

8.20.5 (6-20.5) Report. The puncture force in N (lbf) shall be recorded and reported for each specimen. The average puncture force in N (lbf) shall be recorded and reported for all specimens tested.

8.20.6 (6-20.6) Interpretation. The average puncture force shall be used to determine pass or fail performance.

8.20.7 (6-20.7) Specific Requirements for Testing Gloves.

8.20.7.1 (6-20.7.1) Specimens shall consist of each composite of the palm, palm side of the fingers, and back of the glove used in the actual glove construction with the layers arranged in proper order. Where the specimen composites of the palm, palm side of the fingers, and back of the glove are identical, only one representative composite shall be required to be tested.

8.20.7.2 (6-20.7.2) Glove specimens shall also be tested after wet conditioning as specified in 8.1.8 (6-1.8).

8.20.7.3 (6-20.7.3) Testing shall be performed as specified in 8.20.2 (6-20.2) through 8.20.6 (6-20.6).

8.20.8 (6-20.8) Specific Requirements for Testing Footwear Uppers.

8.20.8.1 (6-20.8.1) Specimens shall consist of each composite of footwear item used in the actual footwear construction with the layers arranged in proper order. Specimens shall be taken from the thinnest portion of the footwear upper.

8.20.8.2 (6-20.8.2) Testing shall be performed as specified in 8.20.2 (6-20.2) through 8.20.6 (6-20.6).

8.21 (6-21) Puncture Resistance Test 2.

8.21.1 (6-21.1) Application. This test method shall apply to protective footwear soles.

8.21.2 (6-21.2) Specimens. A minimum of three footwear soles shall be tested.

8.21.3 (6-21.3) Sample Preparation.

8.21.3.1 (6-21.3.1) Samples for conditioning shall be footwear sole sections.

8.21.3.2 (6-21.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.21.4 (6-21.4) Procedure. Puncture resistance tests shall be performed in accordance with ANSI Z41, *Standard for Personal Protection — Protective Footwear.*

8.21.5 (6-21.5) Report. The force necessary to puncture the sole reinforcement device of each specimen shall be recorded and reported.

8.21.6 (6-21.6) Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

8.22 (6-22) Cut Resistance Test.

8.22.1 (6-22.1) Application.

8.22.1.1 (6-22.1.1) This test method shall apply to gloves, glove gauntlets, glove wristlets, and footwear upper materials.

8.22.1.2 This test method shall also apply to the chemical/biological/particulate (CBR) barrier layer used in protective elements when the CBR barrier layer is the external layer.

8.22.1.3 (6-22.1.2) Modifications to this test method for evaluation of gloves shall be as specified in 8.22.7 (6-22.7).

8.22.1.4 (6-22.1.2) Modifications to this test method for evaluation of glove gauntlets shall be as specified in 8.22.9.

8.22.1.5 (6-22.1.2) Modifications to this test method for evaluation of glove wristlets shall be as specified in 8.22.10.

8.22.1.6 (6-22.1.3) Modifications to this test method for evaluation of footwear upper materials shall be as specified in 8.22.8 (6-22.8).

8.22.1.7 Modifications to this test method for the evaluation of external CBR barrier layers shall be as specified in 8.22.11.

8.22.2 (6-22.3) Samples. (6.22.3.2) Samples shall be conditioned as specified in 8.1.2 (6-1.2).

8.22.3 (6-22.2) Specimens. A minimum of three specimens, consisting of all layers, shall be tested.

8.22.4 (6-22.4) Procedure. Specimens shall be evaluated in accordance with ASTM F 1790, *Standard Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, with the modification that specimens shall be tested to a specific load with the measurement of cut distance.

8.22.5 (6-22.5) Report.

8.22.5.1 (6-22.5.1) The distance of blade travel shall be recorded and reported to the nearest 1 mm ($^{3}/_{64}$ in.) for each sample specimen.

8.22.5.2 (6-22.5.2) The average distance of blade travel in mm (in.) shall be recorded and reported for all specimens tested.

8.22.6 (6-22.6) Interpretation. The average average blade travel distance shall be used to determine pass or fail performance.

8.22.7 (6-22.7) Specific Requirements for Testing Glove Body Materials.

8.22.7.1 Samples for conditioning shall be glove composite pouches as specified in 8.22.7.3.

8.22.7.2 Specimens shall be representative of the glove body composite construction at the palm of the hand and at the back of the hand and shall not include seams.

8.22.7.3 For glove body composites, specimens for conditioning shall be in the form of an 200 mm × 200 mm (8 in. × 8 in. pouch).

8.22.7.3.1 The pouch shall be made of two glove body composite swatches.

8.22.7.3.2 The two composite swatches shall be 200 mm × 200 mm (8 in. × 8 in.) and shall be constructed to simulate the actual layers of the glove, arranged in proper order.

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

8.22.7.3.4 The two composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

8.22.7.4 After conditioning, the pouch and necessary stitching shall be cut to form 50 mm × 100 mm (2 in. × 4 in.) specimens for testing.

8.22.7.5 The swatch shall be permitted to be left stitched, restitched, or otherwise held together at the ends of the swatch for placement on the test apparatus. No stitching or binding mechanism shall be used in the test area.

8.22.7.6 Cut resistance testing shall be performed under a load of 400g.

8.22.8 (6.22.8) Specific Requirements for Testing Footwear Upper Materials.

8.22.8.1 Samples for conditioning shall be footwear uppers.

8.22.8.2 (6-22.8.1) Specimens shall be taken from the parts of the footwear upper that provide uniform thickness and shall not include seams.

8.22.8.3 (6-22.8.2) Cut resistance testing shall be performed under a load of 800 g.

8.22.9 Specific Requirements for Testing Glove Gauntlets.

8.22.9.1 Samples for conditioning shall be glove gauntlet composite swatches as specified in 8.22.9.3.

8.22.9.2 Specimens shall be representative of the glove gauntlet composite construction.

8.22.9.3 For glove gauntlet composites, samples for conditioning shall include glove material that is a minimum of 200 mm (8 in.) square consisting of the composite used in the actual glove gauntlet construction with the layers arranged in proper order and stitched using the same thread used in the construction of the glove gauntlet.

8.22.9.4 After conditioning, the stitching shall be cut to form 50 mm × 100 mm (2 in. × 4 in.) specimens for testing.

8.22.9.5 Specimens shall not include seams where multiple layers are involved.

8.22.9.6 The swatch shall be permitted to be left stitched, restitched, or otherwise held together at the ends of the swatch for placement on the test apparatus.

8.22.9.7 No stitching or binding mechanism shall be used in the test area.

8.22.10 Specific Requirements for Testing Glove Wristlets.

8.22.10.1 Samples for conditioning shall be glove wristlet composite swatches as specified in 8.22.10.3.

8.22.10.2 Specimens shall be representative of the glove wristlet composite construction.

8.22.10.3 For glove wristlet composites, samples for conditioning shall include wristlet material.

8.22.10.4 After conditioning, the material shall be cut to form 50 mm × 100 mm (2 in. × 4 in.) specimens for testing. Specimens shall not include seams where multiple layers are involved.

8.22.10.5 The swatch shall be permitted to stitched, or otherwise held together at the ends of the swatch for placement on the test apparatus.

8.22.10.6 No stitching or binding mechanism shall be used in the test area.

8.22.11 Specific Requirements for Testing External Chemical/Biological/Particulate (CBR) Barrier Layers.

8.22.11.1 Specimens shall consist of only the CBR barrier layer material, as specified by the manufacturer.

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

8.23 (6-23) Faceshield/Goggle Component Lens Scratch Resistance Test.

8.23.1 (6-23.1) Application. This test method shall apply to faceshield/goggle component lenses.

8.23.2 (6-23.2) Specimens. A minimum of four faceshield/goggle component lenses shall be selected.

8.23.3 (6-23.3) Sample Preparation.

8.23.3.1 (6-23.3.1) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.23.3.2 (6-23.3.2) Samples for conditioning shall be faceshield/goggle component lenses.

8.23.3.3 (6-23.3.3) Seven samples shall be chosen from a minimum of four lenses. Four samples shall be taken from the left viewing area and three samples shall be taken from the right viewing area. One of the four samples taken from the left viewing area shall be the setup sample.

8.23.3.4 (6-23.3.4) The left viewing area test samples shall include all of the following criteria:

(1) The sample shall be a square measuring 51 mm × 51 mm (2 in. × 2 in.).

(2) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the sample.

(3) The sample shall be taken from the left side of the faceshield/goggle component lens and shall, as a minimum, contain that portion of the lens that is directly in front of the pupil of the left eye as defined by positioning a complete faceshield/goggle component in accordance with the eye/face positioning index on an Alderson 50th-percentile male headform.

8.23.3.5 (6-23.3.5) The right viewing area test samples shall include all of the following criteria:

(1) The sample shall be a square measuring 51 mm × 51 mm (2 in. × 2 in.).

(2) Two edges of the square section shall be parallel within ±2 degrees of the axis of the cylinder or cone in the center of the sample.

(3) The sample shall be taken from the right side of the faceshield/ goggle component lens and shall, as a minimum, contain that portion of the lens that is directly in front of the pupil of the right eye as defined by positioning a complete faceshield/goggle component in accordance with the eye/ face positioning index on an Alderson 50th-percentile male headform.

8.23.3.6 (6-23.3.6) Each of the samples shall be cleaned in the following manner:

(1) The sample shall be rinsed with clean tap water.

(2) The sample shall be washed with a solution of nonionic, low-phosphate detergent and water using a clean, soft gauze pad.

(3) The sample shall be rinsed with clean tap water.

(4) The sample shall be blown dry with filtered compressed air or nitrogen.

8.23.4 (6-23.4) Apparatus.

8.23.4.1 (6-23.4.1) The faceshield/goggle component lens scratch test apparatus shall be constructed in accordance with Figure 8.23.4.1 (6-23.4.1).

8.23.4.2 (6-23.4.2) The sample holder shall be configured with a flat surface under the lens or with an inner radius support.

8.23.4.3 (6-23.4.3) The pad holder shall consist of a cylinder 10 mm (0.38 in.) high and 25 mm (1 in.) in diameter with a radius of curvature equal to the radius of curvature of the outside of the lens in the viewing area ±0.25 diopter. This cylinder shall be rigidly affixed to the stroking arm by a No. 10-32 UNF threaded rod.

8.23.4.4 (6-23.4.4) The pad shall be a Blue Streak M306M or equivalent wool felt polishing pad 30 mm ($1^{3}/_{16}$ in.) in diameter.

8.23.4.5 (6-23.4.5) The abrasive disc shall be made from 3M Part No. 7415, Wood Finishing Pad or equivalent. A disc 25 mm (1 in.) in diameter shall be cut from the abrasive sheet.

8.23.5 (6-23.5) Procedure.

8.23.5.1 (6-23.5.1) The haze of the sample shall be measured using a haze meter in accordance with ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, and shall be recorded as follows:

(1) The haze shall be measured in the center of the sample ±1.6 mm ($\pm^{1}/_{16}$ in.).

(2) The sample shall be repositioned to achieve the maximum haze value within the area specified in 8.23.5.1.(1) [6-23.5.1(1)].

(3) The haze meter shall have a specified aperture of 22.3 mm (0.88 in.).

(4) The haze meter shall have a visual display showing 0.1 percent resolution.

(5) The haze meter shall be calibrated before and after each day's use following the procedures outlined in ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.*

8.23.5.2 (6-23.5.2) The setup sample shall be placed cover side up in the test apparatus sample holder.

8.23.5.3 (6-23.5.3) The pad holder, pad, and abrasive disc shall be installed on the stroking arm. The stroking arm shall be leveled to ±3 degrees by adjusting the threaded pin. The pin shall be secured to prevent rotation of the pad holder. The axis of curvature of the pad holder shall be coincident with the axis of curvature of the lens.

8.23.5.4 (6-23.5.4) The stroking arm shall be counterbalanced with the pad holder, pad, and abrasive disc in place.

8.23.5.5 (6-23.5.5) The setup sample shall be replaced with one of the six samples to be tested.

8.23.5.6 (6-23.5.6) A test weight of 1 kg, ±8 g (2.2 lb, ±0.2 oz) shall be installed on the pin above the test sample.

8.23.5.7 (6-23.5.7) The test shall be run for 200 cycles, ±1 cycle. One cycle shall consist of a complete revolution of the eccentric wheel.

8.23.5.8 (6-23.5.8) The length of stroke shall be 14 mm (0.56 in.), producing a pattern 38 mm ($1^{1}/_{2}$ in.) long. The frequency of the stroke shall be 60 cycles/min, ±1 cycle/min. The center of the stroke shall be within 1.6 mm ($\pm^{1}/_{16}$ in.) of the center of the sample.

8.23.5.9 (6-23.5.9) The sample shall be removed and cleaned following the procedure specified in 8.23.3.6 (6-23.3.6). The abrasive disc shall be discarded.

8.23.5.10 (6-23.5.10) The testing steps specified in 8.23.5 (6-23.5) shall be repeated five additional times with a new sample and abrasive disc.

FIGURE 8.23.4.1 (6-23.4.1) Faceshield/ goggle component lens test apparatus. [Existing Figure 6-23.4.1, 2000 ed., (no change)]

8.23.6 (6-23.6) Report.

8.23.6.1 (6-23.6.1) After each of the six samples have been tested and cleaned, the haze of the sample shall be measured following the procedure specified in 8.23.5.1 (6-23.5.1).

8.23.6.2 (6-23.6.2) The delta haze shall be calculated by subtracting the initial haze measurement from the final haze measurement.

8.23.7 (6-23.7) Interpretation. The six delta haze values shall be averaged. The resultant value shall be compared to the value specified in 7.2.19 (5-2.19) to determine pass or fail performance.

8.24 (6-24) Abrasion Resistance Test.

8.24.1 (6-24.1) Application. This test method shall apply to protective footwear soles with heels.

8.24.2 (6-24.2) Specimens. A minimum of three footwear soles with heels shall be tested.

8.24.3 (6-24.3) Sample Preparation.

8.24.3.1 (6-24.3.1) Samples for conditioning shall be complete footwear soles with heels.

8.24.3.2 (6-24.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.24.4 (6-24.4) Procedure. Abrasion resistance tests shall be performed in accordance with ASTM D 1630, *Standard Test Method for Rubber Property — Abrasion Resistance (Footwear Abrader*).

8.24.5 (6-24.5) Report. The abrasion resistance rating of each specimen shall be recorded and reported.

8.24.6 (6-24.6) Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

8.25 (6-25) Cleaning Shrinkage Resistance Test.

8.25.1 (6-25.1) Application.

8.25.1.1 (6-25.1.1) This test method shall apply to the protective garment outer shell, moisture barrier, thermal barrier, winter liner, hood, and wristlet.

8.25.1.2 (6-25.1.2) Modifications to this test method for testing woven textile materials shall be as specified in 8.25.7 (6-25.7).

8.25.1.3 (6-25.1.3) Modifications to this test method for testing knit and stretch woven materials shall be as specified in 8.25.8 (6-25.8).

8.25.2 (6-25.2) Specimens. Cleaning shrinkage resistance testing shall be conducted on three specimens of each material and each separable layer of a composite material shall be tested separately.

8.25.3 (6-25.3) Sample Preparation. Specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.25.4 (6-25.4) Procedure.

8.25.4.1 (6-25.4.1) 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*.

8.25.4.2 (6-25.4.2) A 1.8-kg, ±0.1 kg (4.0-lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

8.25.4.3 (6-25.4.3) 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*.

8.25.4.4 (6-25.4.4) Knit fabric specimens shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement.

8.25.5 (6-25.5) Report. The percent change in the width and length dimensions of each specimen shall be calculated. Results shall be recorded and reported as the average of all three specimens in each dimension.

8.25.6 (6-25.6) Interpretation. The average percent change in both dimensions shall be used to determine pass or fail performance. Failure of either dimension shall constitute failure for the entire sample.

8.25.7 (6-25.7) Specific Requirements for Testing Woven Textile Materials.

8.25.7.1 (6-25.7.1) Each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., ±$^1/_2$ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.25.7.2 (6-25.7.2) Samples for conditioning shall be at least 1-m (1-yd) square of each material.

8.25.7.3 (6-25.7.3) Testing shall be performed as specified in 8.25.2 (6-25.2) through 8.25.6 (6-25.6).

8.25.8 (6-25.8) Specific Requirements for Testing Knit and Stretch Woven Textile Materials.

8.25.8.1 (6-25.8.1) Other than for wristlets, the dimensions of each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., ±$^1/_2$ in.) and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.25.8.2 (6-25.8.2) The dimensions of wristlet specimens shall be 113 mm × 113 mm, ±13 mm (4$^1/_2$ in. × 4$^1/_2$ in., ±$^1/_2$ in.) and shall be cut from the wristlet fabric.

8.25.8.3 (6-25.8.3) Samples for conditioning shall include material that is at least 50 mm (2 in.) larger in each of the two required specimen dimensions.

8.25.8.4 (6-25.8.4) Testing shall be performed as specified in 8.25.2 (6-25.2) through 8.25.6 (6-25.6).

8.26 (6-26) Water Absorption Resistance Test.

8.26.1 (6-26.1) Application. This test method shall apply to the protective garment outer shell and collar lining materials.

8.26.2 (6-26.2) Specimens. Three specimens of outer shell material and collar lining material measuring at least 200 mm × 200 mm (8 in. × 8 in.) shall be tested separately for water absorption.

8.26.3 (6-26.3) Sample Preparation.

8.26.3.1 (6-26.3.1) Samples for conditioning shall be at least 1-m (1-yd) square of each material.

8.26.3.2 (6-26.3.2) Specimens shall be tested after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.26.4 (6-26.4) Procedure.

8.26.4.1 (6-26.4.1) Specimens shall be tested in accordance with Method 5504, *Water Resistance of Coated Cloth; Spray Absorption Method*, of Federal Test Method Standard 191A, *Textile Test Methods.* The normal outer surface shall be exposed to the water spray.

8.26.4.2 (6-26.4.2) For collar lining materials, the exposure surface shall be the surface of the fabric that is next to the skin when the collar is closed in the raised position.

8.26.5 (6-26.5) Report.

8.26.5.1 (6-26.5.1) The percent water absorbed for each specimen shall be recorded and reported.

8.26.5.2 (6-26.5.2) The average percent water absorption shall be calculated and reported.

8.26.6 (6-26.6) Interpretation. The average percent water absorption shall be used for determining pass or fail performance.

8.27 (6-27) Water Penetration Resistance Test.

8.27.1(6-27.1) Application. This test method shall apply to moisture barrier materials.

8.27.2 (6-27.2) Specimens.

8.27.2.1 (6-27.2.1) Samples for conditioning shall be at least 1-m (1-yd) square.

8.27.2.2 (6-27.2.2) Samples for the conditioning specified in 8.1.5 (6-1.5) shall be 150 mm (6 in.) squares cut from sample subjected to the procedures specified in 8.1.2 (6-1.2) and 8.1.3 (6-1.3).

8.27.3 (6-27.3) Sample Preparation.

8.27.3.1 (6-27.3.1) A minimum of five specimens of moisture barrier material shall be tested.

8.27.3.2 (6-27.3.2) Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.27.3.3 (6-27.3.3) Specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.27.3.4 (6-27.3.4) Specimens to be tested shall then be conditioned as specified in 8.1.5 (6-1.5).

8.27.4 (6-27.4) Procedure. Specimens shall be tested at 172 kPa (25 psi) in accordance with Method 5512, *Water Resistance of Coated Cloth; High Range, Hydrostatic Pressure Method*, of Federal Test Method Standard 191A, *Textile Test Methods.*

8.27.5 (6-27.5) Report. The pass or fail performance for each specimen shall be recorded and reported.

8.27.6 (6-27.6) Interpretation.

8.27.6.1 (6-27.6.1) The appearance of any water shall constitute failure.

8.27.6.2 (6-27.6.2) One or more test failures of any specimen against any liquid shall constitute failure of the material.

8.28 (6-28) Liquid Penetration Resistance Test.

8.28.1 (6-28.1) Application.

8.28.1.1 (6-28.1.1) This test shall apply to garment moisture barrier materials and moisture barrier seams, gloves, and footwear.

8.28.1.2 (6-28.1.2) Modifications to this test method for testing garment moisture barrier materials and moisture barrier seams shall be as specified in 8.28.7 (6-28.7).

8.28.1.3 (6-28.1.3) Modifications to this test method for testing gloves shall be as specified in 8.28.8 (6-28.8).

8.28.1.4 (6-28.1.4) Modifications to this test method for testing footwear shall be as specified in 8.28.9 (6-28.9).

8.28.2 (6-28.2) Samples. Samples for conditioning shall be as specified in 8.28.7.1 (6-28.7.1) for moisture barriers and moisture barrier seams, 8.28.8.2 (6-28.8.2) for glove materials, and 8.28.9.1 (6-28.9.1) for footwear materials.

8.28.3 (6-28.3) Specimen Preparation.

8.28.3.1 (6-28.3.1) A minimum of three specimens shall be tested for each material type.

8.28.3.2 (6-28.3.2) Glove specimens shall be tested after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.28.3.3 (6-28.3.3) Glove and footwear specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.28.3.4 (6-28.3.4) Glove and footwear specimens to be tested shall then be conditioned as specified in 8.1.5 (6-1.5).

8.28.3.5 (6-28.3.5) Moisture barrier materials and moisture barrier seam specimens shall be tested after being twice subjected to the following conditioning.

(1) Specimens shall first be subjected to the procedure specified in 8.1.2 (6-1.2).

(2) Specimens shall then be conditioned as specified in 8.1.3 (6-1.3).

(3) Specimens shall then be conditioned as specified in 8.1.5 (6-1.5).

(4) Specimens shall then be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and at a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8.28.4 (6-28.4) Procedure.

8.28.4.1 (6-28.4.1) Liquid penetration resistance testing shall be conducted in accordance with ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, using exposure Procedure C.

8.28.4.2 (6-28.4.2) Each of the following liquids shall be tested separately against each test specimen:

(1) Aqueous film-forming foam (AFFF), 3 percent concentrate

(2) Battery acid (37 percent w/w sulfuric acid)

(3) Fire-resistant hydraulic fluid, phosphate ester base

(4) Surrogate gasoline fuel C as defined in ASTM D 471, *Standard Test Method for Rubber Property-Effect of Liquids*, a 50/50 percent by volume of toluene and iso-octane

(5) Swimming pool chlorinating chemical containing at least 65 percent-free chlorine (saturated solution)

8.28.4.3 (6-28.4.3) The normal outer surface of the material shall be exposed to the liquid as oriented in the clothing item.

8.28.5 (6-28.5) Report. The pass or fail performance for each specimen shall be recorded and reported.

8.28.6 (6-28.6) Interpretation. One or more test failures of any specimen against any liquid shall constitute failure of the material.

8.28.7 (6-28.7) Specific Requirements for Testing Moisture Barrier Materials and Moisture Barrier Seams.

8.28.7.1 (6-28.7.1) Samples for conditioning shall be at least 380-mm (15-in.) square and shall consist of a composite constructed using a layer of 7.5 oz natural Nomex®, the moisture barrier, a layer of Q9 thermal barrier material, and another layer of 7.5 oz natural Nomex®. Where the sample includes the seam, the moisture barrier layer shall be constructed with a center seam that shall extend across the entire 380 mm (15 in.) width of the specimen. The four-layer composite shall be stitched around the entire periphery.

8.28.7.1.1 (6-28.7.1.1) Where the layer intended to be the moisture barrier is configured of a composite that includes outer shell, moisture barrier, or thermal barrier combinations, the samples to be preconditioned shall be constructed using those materials.

8.28.7.2 (6-28.7.2) The moisture barrier layer shall be removed from the four-layer composite samples after all preconditioning has been completed and shall become the moisture barrier specimen.

8.28.7.2.1 (6-28.7.2.1) Where the moisture barrier is configured as indicated in 8.28.7.1.1 (6-28.7.1.1), specimens shall be permitted to be a composite of layers provided that the layer intended to be the moisture barrier is visible in the test cell, and provided that the specimen was pre-conditioned according to 8.28.7.1.1 (6-28.7.1.1).

8.28.7.3 (6-28.7.3) Testing shall be performed as specified in 8.28.3 (6-28.3) through 8.28.6 (6-28.6).

8.28.8 (6.28.8) Specific Requirements for Testing Glove Materials.

8.28.8.1 (6-28.8.1) Three specimens each shall be taken from the sample gloves at the palm, back, and seam areas.

8.28.8.2 (6-28.8.2) Samples for conditioning shall be whole gloves.

8.28.8.3 (6-28.8.3) Testing shall be performed as specified in 8.28.2 **(6-28.2)** through 8.28.6 (6-28.6).

8.28.8.4 (6-28.8.4) Specimens for testing shall be permitted to be the barrier layer only.

8.28.9 (6-28.9) Specific Requirements for Testing Footwear Materials.

8.28.9.1 (6-28.9.1) Samples for conditioning shall be whole footwear.

8.28.9.2 (6-28.9.2) Three specimens each shall be taken from the upper, upper seam area, and the vamp seam area.

8.28.9.3 (6-28.9.3) Testing shall be performed as described in 8.28.2 (6-28.2) through 8.28.6 (6-28.6).

8.28.9.4 (6-28.9.4) Specimens for testing shall be permitted to be the barrier layer only.

8.29 (6-29) Viral Penetration Resistance Test.

8.29.1 (6-29.1) Application.

8.29.1.1 (6-29.1.1) This test shall apply to garment moisture barriers and moisture barrier seams, gloves, and footwear.

8.29.1.2 (6-29.1.2) Modifications to this test method for testing moisture barrier materials and moisture barrier seams shall be as specified in 8.29.7 (6-29.7).

8.29.1.3 (6-29.1.3) Modifications to this test method for testing gloves shall be as specified in 8.29.8 (6-29.8).

8.29.1.4 (6-29.1.4) Modifications to this test method for testing footwear shall be as specified in 8.29.9 (6-29.9).

8.29.2 (6-29.2) Samples. Samples for conditioning shall be as specified in 8.29.7.1 (6-29.7.1) for moisture barriers and moisture barrier seams, 8.29.8.2 (6-29.8.2) for glove materials, and 8.29.9.2 (6-29.9.2) for footwear materials.

8.29.3 (6-29.3) Specimen Preparation.

8.29.3.1 (6-29.3.1) A minimum of three specimens shall be tested for each material type.

8.29.3.2 (6-29.3.2) Glove specimens shall be tested after being subjected to the procedure specified in 8.1.2 (6-1.2).

8.29.3.3 (6-29.3.3) Glove and footwear specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.29.3.4 (6-29.3.4) Glove and footwear specimens to be tested shall then be conditioned as specified in 8.1.5 6-1.5.

8.29.3.5 (6-29.3.5) Moisture barrier material and moisture barrier seam specimens shall be tested after being twice subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.2 (6-1.2).

(2) Specimens shall then be conditioned as specified in 8.1.3 (6-1.3).

(3) Specimens shall then be conditioned as specified in 8.1.5 (6-1.5).

(4) Specimens shall then be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and at a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8.29.4 (6-29.4) Procedure. Viral penetration resistance testing shall be conducted in accordance with ASTM F 1671, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X-174 Bacteriophage as a Test System*.

8.29.5 (6-29.5) Report. The pass or fail performance for each specimen shall be recorded and reported.

8.29.6 (6-29.6) Interpretation. A failure of any specimen against any virus constitutes failure of the material.

8.29.7 (6-29.7) Specific Requirements for Testing Moisture Barrier Materials and Moisture Barrier Seams.

8.29.7.1 (6-29.7.1) Samples for conditioning shall be at least 380-mm (15-in.) square and shall consist of a composite constructed using a layer of 7.5 oz natural Nomex®, the moisture barrier, a layer of Q9 thermal barrier material, and another layer of 7.5 oz natural Nomex®. Where the sample includes the seam, the moisture barrier layer shall be constructed with a center seam that shall extend across the entire 380 mm (15 in.) width of the specimen. The four-layer composite shall be stitched around the entire periphery.

8.29.7.2 (6-29.7.2) The moisture barrier layer shall be removed from the four-layer composite samples after all preconditioning has been completed and shall become the moisture barrier test specimen.

8.29.7.3 (6-29.7.3) Testing shall be as specified in 8.29.3 (6-29.3) through 8.29.6 (6-29.6).

8.29.8 (6-29.8) Specific Requirements for Testing Glove Materials.

8.29.8.1 (6-29.8.1) Three specimens each shall be taken from sample gloves at the palm, back, and seam areas.

8.29.8.2 (6-29.8.2) Samples for conditioning shall be whole gloves.

8.29.8.3 (6-29.8.3) Testing shall be as described in 8.29.2 (6-29.2) through 8.29.6 (6-29.6).

8.29.8.4 (6-29.8.4) Specimens for testing shall be the barrier layer only.

8.29.9 (6-29.9) Specific Requirements for Testing Footwear Materials.

8.29.9.1 (6-29.9.1) Three specimens each shall be taken from the upper, upper seam area, and the vamp seam area.

8.29.9.2 (6-29.9.2) Samples for conditioning shall be whole footwear.

8.29.9.3 (6-29.9.3) Testing shall be as described in 8.29.2 (6-29.2) through 8.29.6 (6-29.6).

8.29.9.4 Specimens for testing shall be the barrier layer only.

8.30 (6-30) Corrosion Resistance Test.

8.30.1 (6-30.1) Application.

8.30.1.1 (6-30.1.1) This test method shall apply to hardware items on protective garments, helmets, gloves, and footwear.

8.30.1.2 (6-30.1.2) Modifications to this test method for testing garment and glove hardware shall be as specified in 8.30.7 (6-30.7).

8.30.1.3 (6-30.1.3) Modifications to this test method for testing helmet and partial eye/ face protective devices shall be as specified in 8.30.8 (6-30.8).

8.30.1.4 (6-30.1.4) Modifications to this test method for testing footwear shall be as specified in 8.30.9 (6-30.9).

8.30.2 (6-30.2) Specimens. A total of three specimens of each hardware type shall be tested.

8.30.3 (6-30.3) Sample Preparation. Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.30.4 (6-30.4) Procedure.

8.30.4.1 (6-30.4.1) Specimens shall be tested in accordance with ASTM B 117, *Standard Method of Salt Spray (Fog) Testing*. Hardware items shall be exposed to a 5 percent, ±1 percent saline solution for a period of 20 hours.

8.30.4.2 (6-30.4.2) Immediately following the storage specified in 8.30.4.1 (6-30.4.1) and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

8.30.4.3 (6-30.4.3) Specimens shall then be examined visually with the unaided eye to determine the presence of corrosion.

8.30.4.4 (6-30.4.4) The functionality of each specimen shall be evaluated.

8.30.5 (6-30.5) Report. The presence of corrosion and the functionality for each specimen shall be recorded and reported.

8.30.6 (6-30.6) Interpretation. One or more hardware specimens failing this test shall constitute failing performance for the hardware type.

8.30.7 (6-30.7) Specific Requirements for Testing Garment and Glove Hardware.

8.30.7.1 (6-30.7.1) Samples for conditioning shall be whole hardware items.

8.30.7.2 (6-30.7.2) A total of three specimens of each hardware type shall be tested.

8.30.8 (6-30.8) Specific Requirements for Testing Helmets.

8.30.8.1 (6-30.8.1) Samples for conditioning shall be whole helmets.

8.30.8.2 (6-30.8.2) A total of three different helmets shall be tested.

8.30.9 (6-30.9) Specific Requirements for Testing Footwear.

8.30.9.1 (6-30.9.1) Samples for conditioning shall be whole hardware items.

8.30.9.2 (6-30.9.2) A total of three specimens of each hardware type shall be tested.

8.30.9.3 (6-30.9.3) Functionality of the toe cap, sole plate, and ladder shank shall not be evaluated.

8.31 (6-31) Electrical Insulation Test 1.

8.31.1 (6-31.1) Application. This test method shall apply to protective helmets.

8.31.2 (6-31.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2).

8.31.3 (6-31.3) Sample Preparation.

8.31.3.1 (6-31.3.1) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.31.3.2 (6-31.3.2) Samples for conditioning shall be complete helmets.

8.31.4 (6-31.4) Apparatus.

8.31.4.1 (6-31.4.1) The following equipment shall be provided for Procedure A:

(1) A source of 60-Hz alternating current variable from 0 to 2200 volts true rms

(2) Wiring and terminals for application of voltage to the water in the vessel

(3) A voltmeter to measure the applied voltage to within 2 percent

(4) A millimeter to measure the leakage current to within 2 percent

(5) A vessel, containing tap water, of sufficient size to submerge an inverted helmet to the dielectric test plane

(6) A frame for suspending the test specimen in water

8.31.4.2 (6-31.4.2) The following equipment shall be provided for Procedure B:

(1) A source of 60-Hz alternating current variable from 0 to 2200 volts true rms

(2) Wiring and terminals for application of voltage across the crown of the test specimen

(3) A voltmeter to measure the applied voltage to within 2 percent

(4) A millimeter to measure the leakage current to within 2 percent

(5) A vessel, containing tap water, of sufficient size to completely submerge an inverted helmet

(6) An aluminum ISEA size 7 headform modified in accordance with Table 8.15.4.1 (6-15.4.1) and Figures 8.15.4.1(a) [6-15.4.1(a)] through (c)

8.31.5 (6-31.5) Procedures.

8.31.5.1 (6-31.5.1) Procedure A.

8.31.5.1.1 (6-31.5.1.1) Where helmets have a vertical adjustment to the suspension system, the vertical adjustment shall be set to raise the helmet to the highest position with maximum crown clearance between the headform and the inside of the helmet crown prior to establishing the helmet positioning index. The helmet shall be placed on the ISO size J headform specified in Figure 8.16.4.1 (6-16.4.1) and positioned according to the helmet positioning index. After proper positioning in accordance with the helmet positioning index, the dielectric test plane specified in Figure 8.31.5.1.2 (6-31.5.1.2) shall be determined.

8.31.5.1.2 (6-31.5.1.2) The helmet shall be inverted and positioned in accordance with the inverted helmet positioning index while maintaining all vertical adjustments set at their highest position. The inverted helmet shall be filled with tap water equal to the dielectric test plane as shown in Figure 8.31.5.1.2 (6-31.5.1.2). The helmet shall then be submerged in tap water to the same level as the water on the inside of the helmet.

FIGURE 8.31.5.1.2 (6-31.5.1.2) Test setup. [Existing Figure 6-31.5.1.2, 2000 ed., (no change)]

8.31.5.1.3 (6-31.5.1.3) A 60-Hz alternating current voltage shall be applied to the water in the vessel and increased to 2200 volts. The voltage shall be maintained at 2200 volts, ±2 percent for 1 minute.

8.31.5.2 (6-31.5.2) Procedure B.

8.31.5.2.1 (6-31.5.2.1) The sample helmet and retention system shall be completely submerged in tap water for a period of 15 minutes, +2/-0 minutes. The helmet shall be removed from the tap water and allowed to drain for not longer than 2 minutes.

8.31.5.2.2 (6-31.5.2.2) The sample helmet shall then be mounted on the modified ISEA aluminum size 7 headform, with the chinstrap firmly secured to the headform by means of the conductive terminal junction bolt.

8.31.5.2.3 (6-31.5.2.3) A lead carrying 60-Hz alternating voltage shall be attached to all metal parts on the helmet's exterior, at or above the brim edge. A second pickup lead shall be attached to the terminal junction bolt. Voltage shall be applied to the external helmet shell lead and increased to 2200 volts, ±2 percent volts. The voltage shall be maintained for 15 seconds.

8.31.6 (6-31.6) Report. Any current leakage or evidence of breakdown shall be recorded for each helmet.

8.31.7 (6-31.7) Interpretation. One or more helmet specimens failing this test shall constitute failing performance.

8.32 (6-32) Electrical Insulation Test 2.

8.32.1 (6-32.1) Application. This test shall apply to protective footwear.

8.32.2 (6-32.2) Specimens. A minimum of three footwear items shall be tested.

8.32.3 (6-23.3) Sample Preparation.

8.32.3.1 (6-23.3.1) Samples for conditioning shall be whole footwear.

8.32.3.2 (6-23.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.32.4 (6-32.4) Procedure. Sample footwear shall be tested to 14,000 V (rms) in accordance with Section 5.1.1 of ASTM F 1116, *Standard Test Method for Determining Dielectric Strength of Overshoe Footwear.* The electrode inside the boot shall be conductive metal shot.

8.32.5 (6-32.5) Report. Any current leakage or evidence of breakdown shall be recorded for each footwear item.

8.32.6 (6-32.6) Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

8.33 (6-33) Overall Liquid Integrity Test 1.

8.33.1 (6-33.1) Application. This test shall apply to protective gloves.

8.33.2 (6-33.2) Specimens. A minimum of three glove pairs each for size small and large shall be used for testing.

8.33.3 (6-33.3) Sample Preparation.

8.33.3.1 (6-33.3.1) Samples for conditioning shall be whole gloves.

8.33.3.2 (6-33.3.2) Specimens shall be tested after being subjected to the procedures specified in 8.1.2 (6-1.2) and then conditioned as specified in 8.1.3 (6-1.3).

8.33.3.3 (6-33.3.3) Specimens shall also be tested after being subjected to the procedures specified in 8.1.5 (6-1.5) and then conditioned as specified in 8.1.3 (6-1.3).

8.33.4 (6-33.4) Apparatus.

8.33.4.1* (6-33.4.1) A water markable glove shall cover all areas of the tester's hand. The water markable glove shall be constructed of a fabric that is marked easily by water to determine leakage.

8.33.4.2 (6-33.4.2) Water used for integrity testing shall be treated with a nonfoaming surfactant to lower its surface tension to less than 34 dynes/cm, ±5 dynes/cm.

8.33.5 (6-33.5) Procedure.

8.33.5.1 (6-33.5.1) Test subjects shall be selected so that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference as specified in the tables provided for size small and size large gloves in 6.3.5.3 (4-3.5.3).

8.33.5.2 (6-33.5.2) The test subject shall don the glove specimen over the water markable glove.

8.33.5.3 (6-33.5.3) The test subject shall immerse the glove specimen to within 25 mm (1 in.) of the top of the body of the glove specimen for 5 minutes in 20°C, ±3°C (68°F, ±5°F) water treated with a surfactant to lower its surface tension to 34 dynes/cm, ±5 dynes/cm. The test subject shall flex the glove specimen in a fist-clenching motion every 10 seconds.

8.33.5.4 (6-33.5.4) The glove specimen shall be removed from the test subject's hand and the inner glove shall be inspected for water marks.

8.33.6 (6-33.6) Report. The appearance of any water mark on the inner glove after testing any of the three gloves shall be recorded and reported.

8.33.7 (6-33.7) Interpretation. The appearance of any water mark on the inner glove after testing any glove shall be considered leakage and shall constitute failing performance.

8.34* (6-34) Total Heat Loss Test.

8.34.1 (6-34.1) Application. This test method shall apply to the protective garment composites.

8.34.2 (6-34.2) Specimens.

8.34.2.1 (6-34.2.1) Total heat loss testing shall be conducted on at least three specimens. Specimens shall consist of all layers in the protective garment composite arranged in the order and orientation as worn.

8.34.2.2 (6-34.2.2) Specimens shall be 508-mm (20-in.) squares.

8.34.3 (6-34.3) Sample Preparation.

8.34.3.1 (6-34.3.1) Specimens to be tested shall be conditioned as specified in 8.1.3 (6-1.3).

8.34.3.2 (6-34.3.2) Samples for conditions shall be at lest a 1-m (1-yd) square of each material.

8.34.4 (6-34.4) Apparatus. The test apparatus shall be as specified in ASTM F 1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate.*

8.34.5 (6-34.5) Procedure. Testing shall be conducted in accordance with ASTM F 1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate*, using Part C.

8.34.6 (6-34.6) Report.

8.34.6.1 (6-34.6.1) The average intrinsic thermal resistance (R_{cf}) of the sample shall be recorded and reported.

8.34.6.2 (6-34.6.2) The average apparent intrinsic evaporative resistance (AR_{cf}) of the sample shall be recorded and reported.

8.34.6.3 (6-34.6.3) The average total heat loss (Q_t) of the sample shall be determined and reported.

8.34.7 (6-34.7) Interpretation.

8.34.7.1 (6-34.7.1) Pass or fail determination shall be based on the average reported total heat loss measurement of all specimens tested.

8.34.7.2 (6-34.7.2) If an individual result from any test set varies more than ±10 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

8.35 (6-35) Retention System Test.

8.35.1 (6-35.1) Application. This test shall apply to protective helmets.

8.35.2 (6-35.2) Specimens. Specimens shall be selected as specified in 4.3.54.2 (2-3.4.2).

8.35.3 (6-35.3) Sample Preparation.

8.35.3.1 (6-35.3.1) Samples for conditioning shall be whole helmets.

8.35.3.2 (6-35.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.35.4 (6-35.4) Apparatus.

8.35.4.1 (6-35.4.1) An ISO size J headform conforming to the nominal dimensions in Figure 8.16.4.1 (6-16.4.1) shall be used. A size $7^1/_4$ headform shall be used and shall be of the nominal dimension specified in Figure 8.16.4.1 (6-16.4.1).

8.35.4.2 (6-35.4.2) The mechanical chin structure shall consist of two rollers 13 mm ($^1/_2$ in.) in diameter with centers that are 75 mm (3 in.) apart. The mechanical chin structure shall conform with Figure 8.35.4.2 (6-35.4.2).

8.35.4.3 (6-35.4.3) The mechanical chin structure shall be designed to be used with a calibrated tensile test machine. The calibrated tensile test machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified force.

8.35.4.4 (6-35.4.4) 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.

8.35.4.5 (6-35.4.5) Prior to testing, the test machine shall be allowed to warm up until stability is achieved.

FIGURE 8.35.4.2 (6-35.4.2) Retention system test setup. [Existing Figure 6-35.4.2, 2000 ed., (no change)]

8.35.5 (6-35.5) Procedure.

8.35.5.1 (6-35.5.1) The headform and mechanical chin structure shall be positioned so that the distance between the bottom of the rollers and the top of the headform is 210 mm, ±10 mm ($8^5/_{16}$ in., $\pm^3/_8$ 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, ±5N (10 lbf, ±1 lbf). The distance between the top of the helmet and the rollers shall be measured and recorded to the nearest 0.5 mm ($^1/_{64}$ in.).

8.35.5.2 (6-35.5.2) The force applied to the retention system shall be slowly increased to 445 N, ±5 N (100 lbf, ±1 lbf). The force shall be increased smoothly from 45 N to 445 N (10 lbf to 100 lbf) at between 9 N/sec to 45 N/sec (2 lbf/sec to 10 lbf/sec).

8.35.5.3 (6-35.5.3) Where using a tensile testing machine, the load rate shall be 25 mm/ min (1 in./min) to a limit of 445 N (100 lbf).

8.35.5.4 (6-35.5.4) The distance between the top of the helmet and the rollers shall be measured and recorded again after the force has been maintained at 445 N (100 lbf) for 60 seconds, +15/--0 seconds. The difference between the second measurement and the first shall be the retention system elongation.

8.35.6 (6-35.6) Report. The retention system elongation shall be measured for each helmet specimen.

8.35.7 (6-35.7) Interpretation. One or more helmet specimens failing this test shall constitute failing performance.

8.36 (6-36) Suspension System Retention Test.

8.36.1 (6-36.1) Application. This test shall apply to protective helmets.

8.36.2 (6-36.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2).

8.36.3 (6-36.3) Sample Preparation.

8.36.3.1 (6-36.3.1) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.36.3.2 (6-36.3.2) Samples for conditioning shall be whole helmets.

8.36.4 (6-36.4) Apparatus. The suspension system retention test fixtures shall consist of rigid material of sufficient thickness and optional design to facilitate firm attachment to the helmet suspension and the tensile test machine as shown in Figure 8.36.4 (6-36.4).

FIGURE 8.36.4 (6-36.4) Suspension system test setup. [Existing Figure 6-36.4, 2000 ed., (no change)]

8.36.5 (6-36.5) Procedure. Specimens shall be positioned and secured so that the helmet's reference plane is horizontal. Each attachment point of the crown strap shall be tested by applying a pull force perpendicular to the reference plane to a maximum load of 45 N, ±5 N (10 lbf, ±1 lbf). The force shall be increased from 0 N to 45 N, ±5 N (0 lbf to 10 lbf, ±1 lbf) at a load rate of 25.4 mm/min, ±5 mm/min (1 in./min, ±0.2 in./min). The force shall be applied through the centerline at each attachment point.

8.36.6 (6-36.6) Report. The individual pass or fail results for each attachment point shall be recorded.

8.36.7 (6-36.7) Interpretation. One or more helmet specimens failing this test shall constitute failing performance.

8.37 (6-37) Glove Donning Test.

8.37.1 (6-37.1) Application. This test shall apply to protective gloves.

8.37.2 (6-37.2) Samples.

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

8.37.2.2 (6-37.3.1) Samples for conditioning shall be whole gloves.

8.37.3 (6-37.3) Specimens.

8.37.3.1 (6-37.3.2) Specimens shall be conditioned as specified in 8.1.2 (6-1.2) prior to testing.

8.37.3.2 Specimens shall be donned once after removal from the conditioning specified in 8.37.3.2 before beginning testing.

8.37.3.3 Specimens shall be donned once after removal from the conditioning specified in 8.37.3.2 before beginning testing.

8.37.4 Procedure.

8.37.4.1 Test subjects shall be selected so that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference as specified in the tables provided for size small and size large gloves in 6.7.5.

8.37.4.2 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.

8.37.4.3 The time to don one glove of the 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 specimen glove linings between donning. The glove shall be donned in accordance with the manufacturers donning procedure. The glove shall then be removed by grasping the fingertip of the middle finger and pulling the hand out of the glove. The test subject may don either the right hand glove or left hand glove according to individual preference. If the glove cannot be donned because of detachment of the inner liner and/or moisture barrier, then the trial for that glove should be stopped. If any fingers cannot be fully inserted into the glove, then the trial for that glove should be stopped.

8.37.4.4 The dry hand donning time shall be the average of the first three dry hand donning times as determined in 8.37.4.3.

8.37.4.5 The test subject shall repeat the trial specified in 8.37.4.3 for each pair of gloves.

8.37.4.6 The test hand shall then be completely submerged in room temperature water (21ºC, ±3ºC) (70ºF, ±5ºF) for 10 seconds.

8.37.4.7 Immediately after the hand wetting procedure specified in 8.37.4.6, with no time lapse, the test subject should then don one glove of the pair specimen for three consecutive trials, for each specimen pair of gloves, as specified in 8.37.4.3 and 8.37.4.5. The times shall be recorded.

8.37.4.8 The wet hand donning time shall be the average of the first three wet hand donning times as determined in 8.37.4.7.

8.37.5 Report.

8.37.5.1 The dry hand donning time shall be recorded and reported to the nearest 0.1 second for each trial.

8.37.5.2 The wet hand donning time shall be recorded and reported to the nearest 0.1 second for each trial.

8.37.5.3 The average dry hand and wet hand donning times shall be calculated, recorded, and reported.

8.37.5.4 Any inner liner and/or moisture barrier separations shall be recorded and reported.

8.37.5.5 Any glove digits that do not allow full insertion shall be recorded and reported.

8.37.6 Interpretation.

8.37.6 Pass or fail determinations shall be made using the average dry hand and wet hand donning times.

8.37.6 Any detachment of the inner liner and/or moisture barrier shall constitute failing performance.

8.37.6 Any glove digits that do not allow full insertion shall constitute failing performance.

8.38 (6-38) Glove Hand Function Tests.

8.38.1 (6-38.1) Application. This test shall apply to gloves.

8.38.2 (6-38.3) Samples.

8.38.2.1 (6-38.3.1) Samples for conditioning shall be whole glove pairs.

8.38.2.2 (6-38.3.2) Glove pair samples shall be preconditioned as specified in 8.1.3 (6-1.3).

8.38.3 (6-38.2) Specimens.

8.38.3.1 (6-38.2.1) A minimum of three glove pairs each for size small and size large shall be used for testing.

8.38.3.2 (6-38.2.2) Each glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

8.38.3.3 (6-38.2.3) Glove pair specimens shall not receive special softening treatments prior to tests.

8.38.4 (6-38.4) Procedures.

8.38.4.1 (6-38.4.1) A minimum of three pairs each for size small and size large gloves shall be evaluated.

8.38.4.2 (6-38.4.2) Test subjects shall be selected such that their hand dimensions fall within the range for hand and digit length and circumference as specified in Table 6.4.5.3(b) [4-3.5.3(b)] or Table 6.3.5.3(d) [4-3.5.3(d)]. For digit length and circumference, a maximum of three measurements shall be permitted to fall outside of the range specified, provided that no measurement exceeds the specified range by more than 25 percent. Three test subjects shall be selected for testing size large gloves, and three test subjects shall be selected for testing size small gloves.

8.38.4.3 (6-38.4.3) Each test subject used to perform this testing shall practice the hand functions a minimum of three times before conducting actual testing.

8.38.4.4 (6-38.4.4) Gross Dexterity Procedure B.

8.38.4.4.1 (6-38.4.4.1) A peg board apparatus shall be used that consists of 25 stainless steel pins with a medium diamond knurled 30 degrees, (25 teeth per in.) surface, and a peg board.

8.38.4.4.2* (6-38.4.4.2) Before each test, the pegs and peg board shall be placed on the test surface which shall be a nominally 600-mm × 900-mm (24-in. × 36-in.) sheet of 1.6 mm (0.0625 in.) Neoprene® having a hardness of 50 ±5 Shore A and a thickness of 1.6 mm (0.0625 in.) ±10 percent. The pegs shall be randomly scattered in the working area most comfortable to the test subject (i.e., right side for right-handed subjects, left side for left-handed test subjects, directly in front, etc.).

8.38.4.4.3 (6-38.4.4.3) In starting the test, each peg shall be picked up using a pincer grasp near the center of the barrel of the peg, and shall be placed in the peg board beginning at the upper left corner left to right and top to bottom

8.38.4.4.4 (6-38.4.4.4) The time to place all pegs in the peg board shall be measured for each test subject and shall be known as the dexterity test time.

8.38.4.4.5 (6-38.4.4.5) Each test subject shall perform the test without gloves following the steps in 8.38.4.4.2 (6-38.4.4.2) through 8.38.4.4.4 (6-38.4.4.4) until the variance of the dexterity times of that person's last three repetitions does not exceed 8 percent. Variance shall be calculated by dividing the standard deviation by the average of three repetitions, and multiplying by 100. The average of the three

repetitions shall be used as the baseline dexterity test time (DTT_b), and shall be between 25–45 seconds. The test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

8.38.4.4.6 (6-38.4.4.6) Each test subject shall then perform the test with one pair of gloves following the steps in 8.38.4.4.2 (6-38.4.4.2) through 8.38.4.4.4 (6-38.4.4.4) with the pair of test gloves until the variance of the dexterity times of that person's fastest three repetitions does not exceed 8 percent. Variance shall be calculated as in 8.38.4.4.5 (6-38.4.4.5). The average of the three fastest repetitions shall be used as the dexterity test time with gloves (DTT_g). The test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

8.38.4.4.7 (6-38.4.4.7) The dexterity test times with gloves shall be compared with the baseline dexterity test time for each test subject. The percentage of bare-handed control shall be calculated as follows:

$$\text{Percent of bare-handed control} = \frac{DTT_g}{DTT_b} \times 100$$

where:

DTT_g = dexterity time with glove

DTT_b = baseline dexterity test time

8.38.5 (6-38.5) Report. The average percentage of bare-hand control shall be recorded and reported for each test subject. The average percentage of bare-handed control for all test subjects shall be recorded and reported for each size.

8.38.6 (6-38.6) Interpretation. The average percentage of bare-handed control for size small and size large shall be used to determine pass or fail performance. Failure of either size shall constitute failure of the test.

8.39 (6-39) Grip Test.

8.39.1 (6-39.1) Application. This test method shall apply to protective gloves.

8.39.2 (3-39.3) Samples.

8.39.2.1 (6-39.3.1) Samples for conditioning shall be whole gloves.

8.39.2.2 (6-39.3.2) Sample glove pairs shall be preconditioned as specified in 8.1.2 (6-1.2).

8.39.3 (6-39.2) Specimens.

8.39.3.1 (6-39.2.1) A minimum of three glove pairs each for size small and size large shall be used for testing.

8.39.3.2 (6-39.2.2) Each speimen glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

8.39.3.3 (6-39.2.4) Specimen glove pairs shall be tested for each material and construction combination.

8.39.3.4 (6-39.3.4) Specimen glove pairs shall be tested after being conditioned for wet conditions as specified in 8.1.8 (6-1.8).

8.39.4 (6-39.4) Apparatus. Grip testing shall be evaluated with the use of a 10-mm ($^3/_8$-in.) diameter, three-strand, prestretched polyester rope attached to a calibrated force-measuring device.

8.39.5 (6-39.5) Procedure.

8.39.5.1 Test subjects shall be selected so that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference as specified in the tables provided for size small and size large gloves in 6.3.5.3.

8.39.5.2 Each test subject shall make three successive attempts to exert as much horizontal pulling force as possible using the rope and force measuring device, using both hands, one in front of the other. Thumbs shall not overlap the fingers, and both feet shall be firmly planted on the ground. The average horizontal pulling force over the three attempts shall be the barehanded control value.

8.39.5.3 Wet-conditioned sample gloves shall be tested on a wet rope. Gloves shall be subjected to wet conditioning as specified in 8.1.8. The rope shall be subjected to wet conditioning by immersion in room temperature water (21ºC, ±3ºC (70ºF, ±5ºF) for 2 minutes, followed by horizontal drip-drying for 5 minutes.

8.39.5.4 Each test subject shall test a minimum of three pairs of sample gloves using the method specified in 8.39.5.2. Test subjects shall attempt one trial with each pair of gloves. A trial shall consist of three successive attempts. The average horizontal pulling force over the three attempts shall be the pulling force with gloves. The average horizontal pulling force shall be calculated, recorded, and reported for each glove pair.

8.39.5.5 The average pulling force with gloves over the three trials for each size shall be calculated, recorded, and reported. The average pulling force with gloves shall be compared with the barehanded-control value.

8.39.5.7 The percentage of barehanded control value shall be calculated as follows:

$$\text{Percentage of bare-handed control value} = \frac{PF_g}{CV_b} \times 100$$

where:

PF_g = average pulling force with gloves

CV_b = bare-handed control value

8.39.6 Report. The percentage of barehanded control value shall be recorded and reported for each sample glove size.

8.39.7 Interpretation.

8.39.7.1 The percentage of barehanded control value for size small and size large shall be used to determine pass or fail performance.

8.39.7.2 Failure of either size shall constitute failure of the test.

8.40 (6-40) Ladder Shank Bend Resistance Test.

8.40.1 (6-40.1) Application. This test shall apply to protective footwear.

8.40.2 (6-40.2) Specimens. A minimum of three footwear ladder shanks shall be tested.

8.40.3 (6-40.3) Sample Preparation.

8.40.3.1 (6-40.3.1) Samples for conditioning shall be whole footwear.

8.40.3.2 (6-40.3.2) Ladder shanks shall be conditioned as specified in 8.1.3 (6-1.3).

8.40.4 (6-40.4) 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 ($1^1/_4$-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 8.40.4.4 (6-40.4.4).

FIGURE 8.40.4.4 (6-40.4.4) Shank bend test setup. [Existing Figure 6-40.4.4, 2000 ed., (no change)]

8.40.5 (6-40.5) 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 51 mm/min (2 in./min).

8.40.6 (6-40.6) Report. Deflection at 182 kg (400 lb) shall be recorded and reported to the nearest 1 mm (0.05 in.). The average deflection shall be calculated and reported to the nearest 1 mm (0.05 in.).

8.40.7 (6-40.6) Interpretation. Pass or fail performance shall be determined using the average deflection for all specimens tested.

8.41 (6-41) Slip Resistance Test.

8.41.1 (6-41.1) Application. This test method shall apply to the footwear sole and heel section.

8.41.2 (6-41.2) Specimens. A minimum of three complete footwear items shall be tested.

8.41.3 (6-41.3) Sample Preparation.

8.41.3.1 (6-41.3.1) Samples for conditioning shall be the whole footwear items.

8.41.3.2 (6-41.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.41.4 (6-41.4) Procedure. Slip resistance shall be performed in accordance with ASTM F 489, *Standard Test Method for Static Coefficient of Friction of Shoe Sole and Heel Materials as Measured by the James Machine*, in a dry condition.

8.41.5 (6-41.5) Report.

8.41.5.1 (6-41.5.1) The static coefficient of friction of each specimen under dry conditions shall be recorded and reported.

8.41.5.2 (6-41.5.2) The average static coefficient of friction of each specimen under dry conditions shall be calculated and reported.

8.41.6 (6-41.6) Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

8.42 (6-42) Label Durability and Legibility Test 1.

8.42.1 (6-42.1) Application.

8.42.1.1 (6-42.1.1) This test method shall apply to labels on protective garments, hoods, gloves, and boots.

8.42.1.2 (6-42.1.2) Modifications to this test method for testing garment labels shall be as specified in 8.42.7 (6-42.7).

8.42.1.3 (6-42.1.3) Modifications to this test method for testing hood labels shall be as specified in 8.42.8 (6-42.8).

8.42.1.4 (6-42.1.4) Modifications to this test method for testing glove labels shall be as specified in 8.42.9 (6-42.9).

8.42.1.5 (6-42.1.5) Modifications to this test method for testing footwear labels shall be as specified in 8.42.10 (6-42.10).

8.42.2 (6-42.2) Specimens. A minimum of three of each type of label for each element shall be tested in each test. If labels have areas of "write-in" information, two additional specimens shall be tested that include those areas with sample information written in.

8.42.3 (6-42.3) Sample Preparation. Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.42.4 (6-42.4) Procedures.

8.42.4.1 (6-42.4.1) Laundering Durability Test.

8.42.4.1.1 (6-42.4.1.1) Specimens shall be subjected to ten 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*.

8.42.4.1.2 (6-42.4.1.2) A 1.8-kg, ±0.1 kg (4.0-lb, ±0.2 lb) load shall be used. A laundry bag shall not be used.

8.42.4.1.3 (6-42.4.1.3) 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.

8.42.4.2 (6-42.4.2) Abrasion Durability Test.

8.42.4.2.1 (6-42.4.2.1) Specimens shall be subjected to abrasion in accordance with ASTM D 4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics*, with the following modifications:

(1) The standard abrasive fabric and the felt-backing fabric shall be soaked for 24 hours or agitated in distilled water so that they are thoroughly wet.

(2) The standard abrasive fabric shall be rewetted after each set of cycles by applying 20 ml (0.68 oz) of distilled water from a squeeze bottle by squirting on the center of the abrasive composite pad.

(3) Specimens shall be subjected to 200 cycles, 3200 revolutions, of the test apparatus.

8.42.4.2.2 (6-42.4.2.2) 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.

8.42.4.3 (6-42.4.3) Heat Durability Test.

8.42.4.3.1 (6-42.4.3.1) Specimens shall be subjected to convective heat as specified in 8.1.5 (6-1.5).

8.42.4.3.2 (6-42.4.3.2) 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.

8.42.5 (6-42.5) Report. The legibility for each specimen shall be recorded and reported as acceptable or unacceptable.

8.42.6 (6-42.6) Interpretation. One or more label specimens failing this test shall constitute failing performance.

8.42.7 (6-42.7) Specific Requirements for Testing Garment Labels.

8.42.7.1 (6-42.7.1) 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 51 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.*

8.42.7.2 (6-42.7.2) For testing label legibility after abrasion, specimens shall be individual labels.

8.42.7.3 (6-42.7.3) For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 380-mm, ±13 mm (15-in., $\pm^1/_2$ in.) square of material that meets the outer shell requirements of this standard.

8.42.7.4 (6-42.7.4) Sample conditioning shall be the same conditioning as specified for the respective tests.

8.42.7.5 (6-42.7.5) Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.42.4.1 (6-42.4.1), 8.42.4.2 (6-42.4.2), and 8.42.4.3 (6-42.4.3), respectively.

8.42.8 (6-42.8) Specific Requirements for Testing Hood Labels.

8.42.8.1 (6-42.8.1) For testing label legibility after laundering, specimens shall include complete hoods with labels attached.

8.42.8.2 (6-42.8.2) For testing label legibility after abrasion, specimens shall be individual labels.

8.42.8.3 (6-42.8.3) For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 380-mm, ±13 mm (15-in., $\pm^1/_2$ in.) square of hood material that meets the hood material requirements of this standard.

8.42.8.4 (6-42.8.4) Sample conditioning shall be the same conditioning as specified for the respective tests.

8.42.8.5 (6-42.8.5) Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.42.4.1 (6-42.4.1), 8.42.4.2 (6-42.4.2), and 8.42.4.3 (6-42.4.3), respectively.

8.42.9 (6-42.9) Specific Requirements for Testing Glove Labels.

8.42.9.1 (6-42.9.1) For testing label legibility after laundering and convective heat exposure, specimens shall include complete gloves with labels attached.

8.42.9.2 (6-42.9.2) For testing label legibility after abrasion, specimens shall be individual labels.

8.42.9.3 (6-42.9.3) Sample conditioning shall be the same conditioning as specified for the respective tests.

8.42.9.4 (6-42.9.4) Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.42.4.1 (6-42.4.1), 8.42.4.2 (6-42.4.2), and 8.42.4.3 (6-42.4.3), respectively.

8.42.10 (6-42.10) Specific Requirements for Testing Footwear Labels.

8.42.10.1 (6-42.10.1) For testing label legibility after abrasion, specimens shall be individual labels.

8.42.10.2 (6-42.10.2) Sample conditioning shall be the same conditioning as specified for the respective tests.

8.42.10.3 (6-42.10.3) Specimens shall be tested separately for legibility after abrasion and heat durability tests as specified in 8.42.4.2 (6-42.4.2) and 8.42.4.2 (6-42.4.3), respectively.

8.43 (6-43) Label Durability and Legibility Test 2.

8.43.1 (6-43.1) Application. This test method shall apply to labels on helmets.

8.43.2 (6-43.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2.)

8.43.3 (6-43.3) Sample Preparation.

8.43.3.1 (6-43.3.1) Samples for conditioning shall be whole helmets with the labels attached.

8.43.3.2 (6-43.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3), 8.1.4 (6-1.4), 8.1.6 (6-1.6), and 8.1.7 (6-1.7).

8.43.4 (6-43.4) Procedure. Label specimens shall be examined for legibility by a person with 20/20 vision, or vision corrected to 20/ 20, at a nominal distance of 305 mm (12 in.) in a well-illuminated area.

8.43.5 (6-43.5) Report. The legibility for each label specimen shall be recorded and reported as acceptable or unacceptable.

8.43.6 (6-43.6) Interpretation. One or more label specimens failing this test shall constitute failing performance.

8.44 (6-44) Shell Retention Test.

8.44.1 (6-44.1) Application. This test shall apply to protective helmets.

8.44.2 (6-44.2) Specimens. Specimens shall be selected as specified in 4.3.4.2 (2-3.4.2).

8.44.3 (6-44.3) Sample Preparation.

8.44.3.1 (6-44.3.1) Samples for conditioning shall be whole helmets.

8.44.3.2 (6-44.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.44.4 (6-44.4) Apparatus. The shell retention test fixtures shall consist of rigid material of sufficient thickness and optional design to facilitate firm attachment of the helmet shell while attached to the chin strap tensile-testing machine.

8.44.5 (6-44.5) Procedure. The specimen shall be tested by applying a pull force to the helmet shell perpendicular to the reference plane to a maximum load of 36.5 kg (80 lb) within 30 seconds. The maximum load shall be maintained for 1 minute, +5/-0 seconds.

8.44.6 (6-44.6) Report. The pass or fail results shall be recorded.

8.44.7 (6-44.7) Interpretation. Any one specimen failing the test shall constitute failing performance for the item being tested.

8.45 (6-45) Luminous (Visible) Transmittance Test.

8.45.1 (6-45.1) Application. This test shall apply to faceshield/goggle component lenses.

8.45.2 (6-45.2) Specimens. Specimens shall be selected as specified in 4.3.4.1 (2-3.4.1).

8.45.3 (6-45.3) Sample Preparation.

8.45.3.1 (6-45.3.1) Samples for conditioning shall be complete faceshield/goggle components.

8.45.3.2 (6-45.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.45.4 (6-45.4) Apparatus. The standard source of radiant energy used in the measurement of luminous transmittance of filter lenses shall be a projection-type lamp No. T-8 or other high-powered, gas-filled, tungsten-filament incandescent lamp operated at the color temperature corresponding to Commission Internationale de l'Eclairage (CIE), Source A.

8.45.5* (6-45.5) Procedure. Luminous transmittance shall be determined by one of the following means:

(1) By measuring the spectral transmittance and calculating the luminous transmittance through the use of published data on the spectral radiant energy of CIE Standard Illuminant A as specified in ISO/CIE 10526, *Calorimetric Illuminants*, and the relative luminous efficiency of the average eye

(2) By using a Gardner pivotal sphere hazemeter and the standards of luminous transmittance maintained by the National Bureau of Standards

8.45.6 (6-45.6) Report. The percentage of light transmission shall be recorded and reported for each specimen. The average light transmission of all specimens tested shall be calculated and reported.

8.45.7 (6-45.7) Interpretation. Pass or fail performance shall be based on the average light transmission measured.

8.46 (6-46) Retroreflectivity and Fluorescence Test.

8.46.1 (6-46.1) Application.

8.46.1.1 (6-46.1.1) This test method shall apply to trim materials used on protective garments and helmets.

8.46.1.2 (6-46.1.2) Trim materials shall be tested for each procedure specified in 8.46.4 (6-46.4).

8.46.2 (6-46.2) Specimens.

8.46.2.1 (6-46.2.1) A minimum of three trim test specimens shall be tested.

8.46.2.2 (6-46.2.2) Each trim test specimen shall be 100 mm (4 in.) in length by the width of the finished trim product. Where retroreflective and nonretroreflective surface areas are combined to form a trim, the specimen shall consist of the retroreflective and nonretroreflective portions of the finished trim product.

8.46.3 (6-46.3) Sample Preparation.

8.46.3.1 (6-46.3.1) Samples for conditioning shall include 305-mm (12-in.) long sections of trim.

8.46.3.2 (6-46.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.46.4 (6-46.4) Procedures.

8.46.4.1 (6-46.4.1) Measurement of Coefficient of Retroreflection.

8.46.4.1.1 (6-46.4.1.1) The coefficient of retroreflection (R_a) shall be determined in accordance with ASTM E 809, *Standard Practice for Measuring Photometric Characteristics of Retroreflectors*, using the following modifications.

(1) Test distance shall equal 15.2 m (50 ft).

(2) Observation angle shall equal 0.2 degree.

(3) Entrance angle shall equal -4 degrees.

(4) Receiver shall be provided with an entrance aperture of 26 mm (1.024 in.), ±5 percent in diameter that is equivalent to 0.1 degree angular aperture.

(5) Exit aperture of the source shall be circular and 26 mm (1.024 in.), ±5 percent in diameter that corresponds to 0.1 degree angular aperture.

(6) Retroreflector reference angle shall equal 90 degrees.

(7) Datum mark shall be placed as specified by the trim manufacturer.

8.46.4.1.2 (6-46.4.1.2) The coefficient of retroreflection (R_a) shall be calculated by the following equation:

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

where:

RI =coefficient of luminous intensity measured as specified in 8.46.4.1.1 (6-46.4.1.1)

Ar =only the retroreflective surface area of the trim test specimen's surface area

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

8.46.4.2 (6-46.4.2) Evaluation of Fluorescence.

8.46.4.2.1 (6-46.4.2.1) Trim fluorescence shall be determined by examining the material under a black light at a distance of 305 mm (12 in.) for a period of 30 seconds.

8.46.4.2.2 (6-46.4.2.2) Specimens that exhibit fluorescence shall be designated as fluorescent. Specimens that do not exhibit fluorescence shall be designated as nonfluorescent.

8.46.4.3 (6-46.4.3) Rainfall Test.

8.46.4.3.1 (6-46.4.3.1) Specimens of trim shall be tested for retroreflectivity when wet as specified in Annex A, "Method of Measuring Wet Retroreflective Performance," of EN 471, *Specification for High Visibility Warning Clothing*, at a rate of 110 mm/hr ($4^5/_{16}$ in./hr).

8.46.4.3.2 (6-46.4.3.2) The coefficient of retroreflectivity (*Ra*) shall be measured as specified in (6-46.4.1), 2 minutes, ±15 seconds after the rainfall exposure has been started.

8.46.4.4 (6-46.4.4) Convective Heat Exposure Test.

8.46.4.4.1 (6-46.4.4.1) Specimens of trim shall be tested for retroreflectivity after convective heat exposure as specified in 8.1.5 (6-1.5).

8.46.4.4.2 (6-46.4.4..2) The coefficient of retroreflection (*Ra*) shall be measured as specified in 8.46.4.1 (6-46.4.1).

8.46.4.4.3 (6-46.4.4.3) The fluorescence shall be evaluated as specified in 8.46.4.2 (6-46.4.2).

8.46.5 (6-46.5) Report.

8.46.5.1 (6-46.5.1) The coefficient of retroreflection (*Ra*) shall be recorded and reported for each specimen. The average *Ra* of all specimens shall be calculated and reported separately for each of the test procedures specified in 8.46.2.1 (6-46.4.1), 8.46.4.3 (6-46.4.3), and 8.46.4.4 (6-46.4.4).

8.46.5.2 (6-46.5.2) The number of fluorescent and nonfluorescent specimens shall be recorded and reported separately for each of the test procedures specified in 8.46.4.2 (6-46.4.2), 4.46.4.3 (6-46.4.3), and 8.46.4.4 (6-46.4.4).

8.46.6 (6-46.6) Interpretation.

8.46.6.1 (6-46.6.1) For trim retroreflectivity, pass or fail performance shall be determined using the average coefficient of retroreflection (*Ra*) reported for each group of specimens for each of the procedures specified in 8.46.4.1 (6-46.4.1), 8.46.4.3 (6-46.4.3), and 8.46.4.4 (6-46.4.4).

8.46.6.2 (6-46.6.2) For trim fluorescence, any nonfluorescent specimens in any test procedure shall constitute failing performance.

8.47 (6-47) Hood Opening Size Retention Test.

8.47.1 (6-47.1) Application.

8.47.1.1 (6-47.1.1) This test shall apply to the face openings or SCBA facepiece interface openings of protective hoods.

8.47.1.2 (6-47.1.2) Protective hoods with either elastic face openings or manually adjustable face openings shall be tested by the procedure specified in 8.47.4 (6-47.4).

8.47.1.3 (6-47.1.3) Protective hoods designed for interface with a SCBA facepiece(s) shall be tested by the procedure specified in 8.47.5 (6-47.5).

8.47.2 (6-47.2) Specimens. A minimum of three whole hoods shall be tested.

8.47.3 (6-47.3) Sample Preparation.

8.47.3.1 (6-47.3.1) Samples for conditioning shall be whole hoods.

8.47.3.2 (6-47.3.2) Specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.47.4 (6-47.4) Procedure for Elastic or Manually Adjustable Face Openings.

8.47.4.1 (6-47.4.1) The hood shall be laid on a flat surface with the face opening facing up.

8.47.4.2 (6-47.4.2) The hood face opening shall be measured at a minimum of eight separate locations around the entire perimeter of the face opening. The locations of measurement shall be marked on the hood.

8.47.4.3 (6-47.4.3) The hood shall be positioned on the ISO size J headform specified in Figure 8.16.4.1 (6-16.4.1) so that the hood is around the neck area of the headform with the neck and head area of the headform protruding through the face opening of the hood. The hood shall then be donned and doffed for 50 cycles, passing the hood face opening up and over the headform to cover the head, forehead, sides of face, chin, and neck each time and then passing the hood back down over the headform to the starting area around the neck. Hoods with manually adjustable face openings shall have the face opening adjusted during each cycle, once after donning and again before doffing.

8.47.4.4 (6-47.4.4) Following the 50 cycles, the hood shall be removed from the headform and the hood shall be allowed to relax for 1 minute.

8.47.4.5 (6-47.4.5) The hood shall be laid on a flat surface with the face opening facing up.

8.47.4.6 (6-47.4.6) The opening dimensions shall then be measured at the same locations marked around the entire perimeter of the face opening specified in 8.47.4.2 (6-47.4.2).

8.47.4.7 (6-47.4.7) The percent difference of the hood face opening dimensions before and after donning shall be determined.

8.47.5 (6-47.5) Procedure for SCBA Facepiece Interface Openings.

8.47.5.1 (6-47.5.1) The SCBA facepiece that the hood is designed to interface with shall be properly mounted, according to the SCBA manufacturer's instructions, on an ISO size J headform specified in Figure 8.16.4.1 (6-16.4.1).

8.47.5.2 (6-47.5.2) The hood shall then be donned on the headform, placing it over the SCBA facepiece.

8.47.5.3 (6-47.5.3) The contact surface of the hood face opening with the SCBA facepiece shall be measured at a minimum of eight separate locations around the entire perimeter of the face opening contact area. The locations of measurement shall be marked on the hood.

8.47.5.4 (6-47.5.4) With the SCBA facepiece in place, the hood shall then be positioned so that the hood is around the neck area of the headform with the neck and head area of the headform protruding through the face opening of the hood. The hood shall then be donned and doffed for 50 cycles, passing the hood face opening up and over the headform to cover the head and to contact the SCBA facepiece around the entire perimeter of the face opening contact area each time, and then passing the hood back down over the headform to the starting area around the neck. Where such hoods are designed to be manually adjustable around the hood face opening/ SCBA facepiece interface area, the manual adjustment shall be made during each cycle, once after donning and again before doffing.

8.47.5.5 (6-47.5.5) Following the 50 cycles, the hood shall be removed from the headform, and the hood shall be allowed to relax for 1 minute.

8.47.5.6 (6-47.5.6) The hood shall then be donned on the headform, placing it over the SCBA facepiece.

8.47.5.7 (6-47.5.7) The contact surface of the hood face opening with the SCBA facepiece shall be measured at the same locations marked around the entire perimeter of the face opening contact area specified in 8.47.5.3 (6-47.5.3).

8.47.5.8 (6-47.5.8) The percent difference of the hood face opening dimensions before and after donning shall be determined.

8.47.6 (6-47.6) Report. The percent difference of the hood face opening dimensions shall be recorded and reported for each specimen. The average difference of the hood face opening dimensions shall be calculated and reported.

8.47.7 (6-47.7) Interpretation. Pass or fail performance shall be based on the average difference of the hood face opening dimensions.

8.48 (6-48) Whole Garment and Ensemble Liquid Penetration Test.

8.48.1 (6-48.1) Application.

8.48.1.1 This test method shall apply to protective garments and entire ensembles that are being evaluated for the optional CBR terrorism agent protection.

8.48.1.2 (6-48.1.2) Modifications to this test method for testing protective coats shall be as specified in 8.48.8 (6-48.8).

8.48.1.3 (6-48.1.3) Modifications to this test method for testing protective trousers shall be as specified in 8.48.9 (6-48.9).

8.48.1.4 (6-48.1.4) Modifications to this test method for testing protective coat and trouser sets or protective coveralls shall be as specified in 8.48.10 (6-48.10).

8.48.1.5 Modifications to this test method for testing entire ensembles for optional CBR terrorism agent protection shall be as specified in 8.48.11.

8.48.2 Samples.

8.48.2.1 Samples shall be complete garments or ensemble elements.

8.48.2.2 Samples shall be conditioned as specified in 8.1.2.

8.48.3 (6-48.2) Specimens.

8.48.3.1 A minimum of three specimens shall be tested. Specimens shall consist of individual coats, trousers, coveralls, sets of coats and trousers, or entire ensembles for CBR terrorism agent protection. Each element shall have in place all layers that are required for the element to be compliant.

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

8.48.3.3 Specimens to be tested shall be conditioned as specified in 8.1.11.

8.48.2.1 (6-48.2.1) A minimum of three specimens shall be tested. Specimens shall consist of individual coats, trousers, coveralls, sets of coats and trousers, or overall ensembles as addressed in 8.48.11. Each element shall have in place all layers that are required for the element to be compliant.

8.48.2.2 (6-48.2.2) The size of the elements comprising the specimens shall be chosen to conform with the dimensions of the mannequin for proper fit of the specimen on the mannequin in accordance with the manufacturer's sizing system. The size of the elements comprising the specimen shall be the same size as the mannequin in terms of chest circumference, waist circumference, and inseam height.

8.48.3 (6-48.3) Sample Preparation.

8.48.3.1 (6-48.3.1) Specimens to be tested shall be conditioned as specified in 8.1.11 (6-1.11).

8.48.3.2 (6-48.3.2) Samples to be conditioned shall be complete garments.

8.48.4 (6.48.4) Apparatus. The apparatus and supplies for testing shall be those specified in ASTM F 1359, *Standard Practice for Evaluating the Liquid-Tight Integrity of Chemical Protective Clothing*, with the following modifications:

(1) The surface tension of the water used in testing shall be 35 dynes/cm, ±5 dynes/ cm.

(2)* The mannequin used in testing shall be fully upright and shall have straight arms and legs with the arms positioned at the mannequin's side.

8.48.5 (6.48.5) Procedure. Liquid penetration testing of garments shall be conducted in accordance with ASTM F 1359, *Standard Practice for Evaluating the Liquid-Tight Integrity of Chemical Protective Clothing*, with the following modifications:

(1) No provision for partial garments shall be permitted.

(2) Blocking of the specimen shall be as specified in 8.48.8 (6-48.8), 8.48.9 (6-48.9), and 8.48.10 (6-48.10), as appropriate, for the type of specimen being tested.

(3) The method used for mounting of the mannequin in the spray chamber shall not interfere with the water spray.

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

(5) Fluorescent or visible dyes shall not be used in the water for spraying the suited mannequin.

(6) The suited mannequin shall be exposed to the liquid spray for a total of 20 minutes, 5 minutes in each of the four mannequin orientations.

(7) At the end of the liquid spray exposure period, excess liquid shall be removed from the surface of the specimen.

(8) The specimen shall be inspected within 10 minutes of the end of the liquid spray exposure period for evidence of liquid penetration.

8.48.6* (6-48.6) Report. A diagram shall be prepared for each test that identifies the locations of any liquid leakage as detected on the liquid-absorptive garment and the interior of the garment.

8.48.7 (6-48.7) Interpretation. Any evidence of liquid on the liquid-absorptive garment, as determined by visual, tactile, or absorbent toweling, shall constitute failure of the specimen.

8.48.8 (6-48.8) Specific Requirements for Testing Coats.

8.48.8.1 (6-48.8.1) The liquid-absorptive garment shall only cover the upper torso and arms of the mannequin from the middle of the mannequin's neck, down to the mannequin's waistline, and down to the mannequin's wrist crease.

8.48.8.2 (6-48.8.2) The coat shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.48.8.3 (6-48.8.3) The coat collar shall be placed in the up position on the mannequin with the collar closure system fastened in the closed position. The head of the mannequin shall be sealed off with a plastic bag. The plastic bag shall extend downward over the collar a distance of not greater than 25 mm (1 in.) and shall be taped down using duct tape or similar waterproof tape. The tape shall not extend downward more than 75 mm (3 in.) from the top of the collar. The bottom edge of the tape and the plastic bag shall not come closer than 25 mm (1 in.) of the collar seam where a collar seam is present. Where present, the collar neck seam shall not be covered.

8.48.8.4 (6-48.8.4) The test shall be conducted with the mannequin's hands removed. The coat sleeve hem shall be taped smoothly to a can or an object of similar cylindrical, rigid shape of the same nominal diameter as the sleeve opening. The can or cylindrical object shall be fitted over the wristlet and under the coat outer shell sleeve hem. The tape shall be duct tape or similar waterproof tape.

8.48.8.5 (6-48.8.5) The coat shall be tested in conjunction with the protective trousers specified by the manufacturer, even where the trousers are not being specifically evaluated by this test.

8.48.9 (6-48.9) Specific Requirements for Testing Trousers.

8.48.9.1 (6-48.9.1) The liquid-absorptive garment shall only cover the lower torso and legs of the mannequin from the mannequin's waistline down to the mannequin's ankles.

8.48.9.2 (6-48.9.2) The trousers shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.48.9.3 (6-48.9.3) Trousers shall be tested in conjunction with the protective coat specified by the manufacturer, even where the coat is not being specifically evaluated by this test.

8.48.9.4 (6-48.9.4) Absorbent toweling or similar material shall be placed underneath the mannequin in order to prevent water splashing up inside the trouser leg.

8.48.10 (6-48.10) Specific Requirements for Testing Coveralls and for Testing Sets of Coats and Trousers.

8.48.10.1 (6-48.10.1) The liquid-absorptive garment shall only cover the torso, arms, and legs of the mannequin from the middle of the mannequin's neck, down to the mannequin's wrist crease, and down to 200 mm (8 in.) above the bottom of the heel.

8.48.10.2 (6-48.10.2) The coverall or set of coat and trousers shall be donned on the mannequin in accordance with the manufacturer's instructions for proper wearing.

8.48.10.3 (6-48.10.3) The coat collar shall be placed in the up position on the mannequin with the collar closure system fastened in the closed position. The head of the mannequin shall be sealed off with a plastic bag. The plastic bag shall extend downward over the collar a distance of not greater than 25 mm (1 in.) and shall be taped down using duct tape or similar waterproof tape. The tape shall not extend downward more than 75 mm (3 in.) from the top of the collar. The collar neck seam shall not be covered.

8.48.10.4 (6-48.10.4) The test shall be conducted with the mannequin's hands removed. The coat sleeve hem shall be taped smoothly to a can or an object of similar cylindrical, rigid shape of the same nominal diameter as the sleeve opening. The can or cylindrical object shall be fitted over the wristlet and under the coat outer shell sleeve hem. The tape shall be duct tape or similar waterproof tape.

8.48.10.5 (6-48.10.5) Absorbent toweling or similar material shall be placed underneath the mannequin in order to prevent water splashing up inside the trouser leg.

8.48.11 Specific Requirements for Testing Ensembles for CBR Terrorism Agent Protection.

8.48.11.1 Specimens for testing shall consist of CBR protective ensembles and the garment, helmet, glove, and footwear elements, and the SCBA specified for the ensemble by the ensemble manufacturer. The hood interface component shall also be tested where the hood is not part of the CBR ensemble garment elements.

8.48.11.2 A total of three different ensemble specimens shall be evaluated.

8.48.11.3 Garment, glove, and hood elements shall be conditioned as specified in 8.1.11.

8.48.11.4 Where the ensemble garment element does not include booties and the chemical/ biological/particulate barrier layer is incorporated into footwear, footwear shall be conditioned by flexing for 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*.

8.48.11.5 Specimens provided in 8.48.11.1 shall be donned on the mannequin in accordance with manufacturer specifications.

8.48.11.6 No taping, blockage, coverage, or provision of absorbent toweling of or to any part of the any interface or element on the ensemble shall be permitted.

8.48.11.7 The mannequin with ensemble in place shall be exposed to the liquid spray for a total of 20 minutes, 5 minutes in each of the four mannequin orientations.

8.48.11.8 Other than the exposure duration specified in 8.48.11.4, testing shall be performed as specified in 8.48.3 through 8.48.6.

8.49 (6-49) Eyelet and Stud Post Attachment Test.

8.49.1 (6-49.1) Application. This test method shall apply to protective footwear eyelets and stud posts.

8.49.2 (6-49.2) Specimens.

8.49.2.1 (6-49.2.1) Specimens shall total two eyelets and two stud posts on three separate footwear items.

8.49.2.2 (6-49.2.2) Specimens shall be removed from the footwear and shall be 25.4 mm × 50.8 mm (1 in. × 2 in.).

8.49.3 (6-49.3) Sample Preparation.

8.49.3.1 (6-49.3.1) Samples for conditioning shall be whole footwear.

8.49.3.2 (6-49.3.2) The eyelet and stud post specimens shall be conditioned as specified in 8.1.3 (6-1.3).

8.49.4 (6-49.4) Apparatus. A tensile-testing machine shall be used with a traverse rate of 51 mm/min (2 in./min). Clamps measuring 25 mm × 38 mm (1 in. × 1 1/2 in.) shall have gripping surfaces that are parallel, flat, and capable of preventing slippage of the specimen during the test.

8.49.5 (6-49.5) Procedure. The stud post or eyelet puller shall be inserted or attached to the upper position of the tensile-testing machine. The traverse rate shall be set at 50 mm/min (2 in./min). The test eyelet or stud post shall be attached using the appropriate puller fixture. The eyelet stay shall be clamped, but clamping the metal portion of the eyelets or stud hook in the lower clamps shall not be permitted. The distance between the clamps and stud hooks or eyelets shall be 1.6 mm to 3.2 mm ($^1/_{16}$ in. to $^1/_8$ in.). The test shall then be started.

8.49.6 (6-49.6) Report. The force will reach a peak, decline slightly, and then increase to complete failure; however, the value at which the force first declines shall be recorded and reported as the initial failure point, since this is the separation point of the material around the eyelet or stud post. The average force shall be calculated and reported.

8.49.7 (6-49.7) Interpretation. The average force shall be used to determine pass or fail.

8.50 (6-50) Breaking Strength Test.

8.50.1 (6-50.1) Application. This test shall apply to garment outer shell and collar lining materials used in protective garments.

8.50.2 (6-50.2) Specimens. Five specimens in each of the warp and filling directions shall be tested from each sample unit.

8.50.3 (6-50.3.1) Sample Preparation.

8.50.3.1 (6-50.3.1) Specimens shall be tested after being subjected to the procedure specified in 8.1.2 (6-1.2) at 10 cycles.

8.50.3.2 (6-50.3.2) Samples for conditioning shall be 1-m (1-yd) square of material.

8.50.4 (6-50.4) Procedure. Specimens shall be tested for breaking strength in accordance with ASTM D 5034, *Standard Method for Breaking Force and Elongation of Textile Fabrics (Grab Test)*.

8.50.5 (6-50.5) Report. The breaking strength of each specimen shall be recorded and reported and an average breaking strength shall be calculated for the warp and filling directions.

8.50.6 (6-50.6) Interpretation. Pass or fail performance shall be based on the average breaking strength in the warp and filling directions. Failure in any one direction constitutes failure for the material.

8.51 (6-51) Conductive and Compressive Heat Resistance (CCHR) Test.

8.51.1 (6-51.1) Application. This test method shall apply to the shoulder areas and the knee areas of protective garments.

8.51.2 (6-51.3) Samples.

8.51.2.1 (6-51.2.1) Samples shall consist of composites representative of all layers of the shoulder areas and knee areas used in the actual construction of the protective garment. Different samples shall be made representing each different composite combination used by the garment manufacturer.

8.51.2.1.1 (6-51.2.1.1) Samples of garment shoulder areas shall be representative of the area in the actual garment that measures at least 100 mm (4 in.) along the crown of the shoulder and extending down from the crown on both the front and back of the garment at least 50 mm (2 in.). The crown of the shoulder shall be the uppermost line of the shoulder when the garment is laying flat on an inspection surface with all closures fastened.

8.51.2.1.2 (6-51.2.1.2) Samples of garment knee areas shall be representative of the knee area in the actual garment that measures at least 150 mm × 150 mm (6 in. × 6 in.).

8.51.2.2 (6-51.2.2) Samples shall measure 200 mm × 200 mm (8 in. × 8 in.) and shall be prepared of the composite layers. The sample of the composite layers shall be sewn along two adjacent sides, with the layers arranged in the same order and orientation as intended to be worn.

8.51.2.3 (6-51.2.3) All samples shall first be preconditioned as specified in 8.1.2 (6-1.2).

8.51.3 (6-51.3) Specimen Preparations.

8.51.3.1 (6-51.3.1) A minimum of six specimens for testing shall be taken from the samples after the preconditioning specified in 8.51.2.3 (6-51.2.3).

8.51.3.2 (6-51.3.2) The specimens shall measure 150 mm × 150 mm (6 in. × 6 in.) and shall be cut from the sample excluding the sewn areas so that the composite layers comprising the specimen are not sewn together at any point.

8.51.3.3 (6-51.3.3) Specimens for both wet condition testing and dry condition testing shall then be conditioned as specified in 8.1.3 (6-1.3).

8.51.3.4 (6-51.3.4) For wet condition testing only, the innermost layer of the composite specimen shall then be further conditioned as follows prior to testing:

(1) Blotter paper measuring 225 mm × 225 mm (9 in. × 9 in.) shall be saturated in distilled water.

(2) Two sheets of the saturated blotter paper shall be run together through a wringer that meets the requirements of 10.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test*.

(3) The innermost layer of the composite specimen shall be placed between the two sheets of blotting paper.

(4) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be placed into a 4-L (1-gal) size air- and liquidtight bag and the bag shall be sealed closed.

(5) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be conditioned in the air- and liquidtight bag at room temperature for at least 24 hours, and shall not be removed from conditioning more than 5 minutes prior to testing.

(6) After removal from conditioning, the innermost layer shall be removed from the blotting paper, and the composite specimen shall be resembled with all layers arranged in the same order and orientation as intended to be worn.

8.51.4 (6-51.4) Procedure.

8.51.4.1 (6-51.4.1) A minimum of six specimens shall be tested for shoulder areas, three for wet condition testing, and three for dry condition testing. A minimum of six specimens shall be tested for knee areas, three for wet condition testing and three for dry condition testing.

8.51.4.2 (6-51.4.2) Specimens shall be tested in accordance with ASTM F 1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, with the modifications specified herein.

8.51.4.3 (6-51.4.3) Specimens shall be tested using an exposure temperature of 280°C, +3°/ -0°C (536°F, +5°/-0°F).

8.51.4.4 (6-51.4.4) For the shoulder area CCHR rating, the sensor assembly shall be modified so that the pressure applied to the test specimens shall be 8 g/cm^2, ±0.8 g/cm^2 (2 psi, ±0.2 psi).

8.51.4.5 (6-51.4.5) For the knee area CCHR rating, the sensor assembly shall be modified so that the pressure applied to the test specimens shall be 32 g/cm^2, ±3.2 g/cm^2 (8 psi, ±0.08 psi).

8.51.4.6 (6-51.4.6) The CCHR rating for each specimen in each test shall be the time in seconds to achieve a temperature rise of 24°C (75°F).

8.51.4.7 (6-51.4.7) For purposes of calculating the time to a 24°C (75°F) temperature rise, the room temperature in the testing area shall be determined immediately prior to starting the test and that temperature shall be used as the base temperature in determining the 24°C (75°F) rise. The time shall be measured to the nearest tenth of a second. Time "zero" shall be the time that the sensor and specimen are placed in direct contact with the exposure surface.

8.51.5 (6-51.5) Report.

8.51.5.1 (6-51.5.1) The individual CCHR rating for each specimen in each test shall be recorded and reported.

8.51.5.2 (6-51.5.2) The average CCHR rating for the shoulder area wet condition test specimens shall be separately calculated, recorded, and reported. The average CCHR rating for the shoulder area dry condition test specimens shall be separately calculated, recorded, and reported.

8.51.5.3 (6-51.5.3) The average CCHR rating for the knee area wet condition test specimens shall be separately calculated, recorded, and reported. The average CCHR rating for the knee area dry condition test specimens shall be separately calculated, recorded, and reported.

8.51.6 (6-51.6) Interpretation.

8.51.6.1 (6-51.6.1) Pass or fail determination for shoulder area wet condition test specimens shall be based on the average reported CCHR rating of all wet specimens. Pass or fail determination for shoulder area dry condition test specimens shall be based on the average reported CCHR rating of all dry specimens tested. Failure of

either the wet condition test set or the dry condition test set to achieve an average CCHR of at least 25 shall constitute failing performance.

8.51.6.2 (6-51.6.2) Pass or fail determination for knee area wet condition test specimens shall be based on the average reported CCHR rating of all wet specimens. Pass or fail determination for knee area dry condition test specimens shall be based on the average reported CCHR rating of all dry specimens tested.

8.51.6.3 (6-51.6.3) If an individual CCHR rating from any individual specimen varies more than ±8 percent from the average results for that test set, the results for that test set shall be discarded and another set of specimens shall be tested.

8.52 [1976: 6-10] Radiant Heat Resistance Test 2.

8.52.1 [1976: 6-10.1] Application.

8.52.1.1 [1976: 6-10.1.1] This test method shall apply to garment outer shell materials, gloves, helmet faceshields, footwear, helmet outer covers, and helmet shrouds.

8.52.1.2 [1976: 6-10.1.2] Modifications to this test method for testing garment outer shell and glove outer shell materials shall be as specified in 6-10.8.

8.52.1.3 [1976: 6-10.1.3] Modifications to this test method for testing footwear shall be as specified in 6-10.9.

8.52.2 [1976: 6-10.2] Samples. Samples for conditioning shall be garment and glove outer shell material, helmet faceshields, whole footwear, helmet outer covers, and helmet shrouds.

8.52.3 [1976: 6-10.3] Specimens.

8.52.3.1 [1976: 6-10.3.1] Five specimens of each sample shall be preconditioned in accordance with Section 4, Atmospheric Conditions for Testing, of Federal Test Method Standard 191A, Textile Test Methods, at a relative humidity of 65 percent, ±5 percent.

8.52.3.2 [1976: 6-10.3.2] Test specimens shall be 75 mm × 250 mm (3 in. × 10 in.).

8.52.3.3 [1976: 6-10.3.3] All specimens excluding helmet faceshields shall be conditioned by means of abrading the sample before removing it from the conditioned atmosphere. Specimens shall be tested for radiant heat not more than five minutes after removal from conditioning.

8.52.3.4 [1976: 6-10.3.4] All specimens shall be conditioned on an oscillating drum abrasion apparatus as specified in Method 5304, Abrasion Resistance of Cloth; Oscillatory Method (Wyzenbeek) Method, of Federal Test Method Standard 191A, Textile Test Methods. The specimens shall be mounted on the oscillating drum of the apparatus. The abradant shall be No. 6 hard-textured cotton duck conforming to Type I of Federal Specification CCC-C-419, Cloth, Duck, Unbleached, Plied-Ya77is, Army and Numbered, and shall be cut into strips 45 mm (17/8 in.) wide by 230 mm (9 in.) long with the long dimension in the warp or wale direction. The abradant shall be mounted in the specimen holding clamps under a tension of 13.5 N (3 lbf) and a head load of 1.36 kg (3 lb). A new abradant shall be used for each test, and the contact area of the abradant shall be free of slubs, knots, or other weave imperfections. The test specimens shall be subjected to 300 abrasion cycles.

8.52.4 Procedure.

8.52.4.1 Specimens shall be tested in accordance with ASTM F 1939, *Standard Test Method for Radiant Protective Performance.*

8.52.4.2 The selected test exposure shall be 2 cal/cm^2 as provided for in the test method.

8.52.5 [1976: 6-10.6] Report.

8.52.5.1 [1976: 6-10.6.1] Five specimens shall be run, and the radiant reflective value shall be determined.

8.52.5.2 [1976: 6-10.6.2] The average radiant reflective value of the five specimens shall be calculated, recorded, and reported.

8.52.6 [1976: 6-10.7] Interpretation. The average radiant reflective value of all specimens of an item shall be used to determine pass or fail performance.

8.52.7 [1976: 6-10.8] Modifications for Testing Garment Outer Shell and Glove Outer Shell Materials.

8.52.7.1 [1976: 6-10.8.1] The garment and glove outer shell material test specimens shall be 75 mm × 250 mm (3 in. × 10 in.) with the long dimension in the warp or wale direction.

8.52.7.2 [1976: 6-10.8.2] Specimens shall be tested as specified in 8.52.2 through 8.52.7.

8.52.8 [1976: 6-10.9] Modifications for Testing Footwear.

8.52.8.1 [1976: 6-10.9.1] Footwear specimens shall be five 75-mm × 250-mm (3-in. × 10-in.) pieces cut from the thinnest portions of the footwear upper, or from a composite that is representative of footwear upper construction at the thinnest part.

8.52.8.2 [1976: 6-10.9.2] Specimens shall be tested as specified in 8.52.2 through 8.52.7.

8.53 [1976: 6-11] Radiant Heat Resistance Test 3.

8.53.1 [1976: 6-11.1] Application. This test shall apply to helmet shell systems.

8.53.2 [1976: 6-11.2] Samples. One sample helmet shell, with any reflective outer covering in place as intended for use but with all shock absorbing and/or thermally insulating materials removed from the interior shall be used.

8.53.3 [1976: 6-11.3] Specimens. Specimens shall be conditioned as specified in 6-1.3.2.

8.53.3 [1976: 6-11.4] Apparatus.

8.53.4.1 [1976: 6-11.4.] The test apparatus shall be the radiant exposure chamber as specified in 6-1.6, Radiant Heat Environmental Conditioning Procedure for Helmets.

8.53.4.2 [1976: 6-11.4.2] The sensor shall be an exposed bead Type J or K30 AWG thermocouple that will be connected to a recording device that is capable of reading degrees centigrade.

8.53.5 [1976: 6-11.5] Calibration Procedure. The chamber shall be calibrated according to the calibration procedure specified in 6-1.6, Radiant Heat Environmental Conditioning Procedure for Helmets, to obtain a stable uniform irradiance of 1.0 ± 0.1 W/cm2.

8.53.6 [1976: 6-11.6] Procedure.

8.53.6.1 [1976: 6-11.6.1] One specimen helmet shell, with any reflective outer covering in place as intended for use but with all shock absorbing and/or thermally insulating materials removed from the interior, shall be used.

8.53.6.2 [1976: 6-11.6.2] An exposed bead Type J or K30 AWG thermocouple shall be fastened to the inner surface of the specimen helmet shell in such a way that the thermocouple bead is in contact with the shell material. The thermocouple bead shall be permitted to be placed at any location within a 100-mm (4-in.) diameter of where the front rear axis of the center line of shell and the intersection of the bitragion coronal are met. There shall be no internal or external projections greater than 2 mm (1/16 in.) in height on the shell within 25 mm (1 in.) of the thermocouple bead in any direction. The thermocouple shall be connected to a recording device that reads degrees centigrade.

8.53.6.3 [1976: 6-11.6.3] The specimen helmet with thermocouple shall be placed in the radiant exposure chamber specified in 8.1.6. With the radiant panel adjusted to provide a stable uniform irradiance of 1.0 ±0.1 W/cm2 in accordance with 8.1.6, the sample shall be placed in the chamber so that the thermocouple location is in the center of the area of radiant exposure.

8.53.6.4 [1976: 6-11.6.4] The specimen shall be exposed to an irradiance of 1.0, ±0.1 W/cm^2 for 180 seconds.

8.53.6.5 [1976: 6-11.6.5] Thermocouple temperatures shall be recorded at the beginning and at the end of the 180 seconds.

8.53.7 [1976: 6-11.7] Report. The difference of the initial temperature and the temperature at 180 seconds shall be recorded and reported.

8.53.8 [1976: 6-11.8] Interpretation. Any rise in temperature greater than 25°C shall constitute failure of this test.

8.54 [1976: 6-31] Wet Flex Test.

8.54.1 [1976: 6-31.1] Specimens shall be tested after being subjected to the procedure specified in 8.1.3 (6-1.3).

8.54.2 [1976: 6-31.2] Test specimens shall be 100 mm × 200 mm (4 in. × 8 in.) with the long dimension parallel to the warp or wale direction and shall be from the fabric lot used in the construction of the proximity protective garment. Five (5) specimens from each sample unit shall be tested with no two specimens containing the same yarns.

8.54.3 [1976: 6-31.3] The test specimen shall be immersed in water at 60°C, ±3°C (140°F, ±5°F) for 15 minutes. Upon removal from the water, the test specimen shall be placed on two layers of absorbent-type blotters and covered by two additional layers. After placing the wet specimens between the blotters, a 4.5-kg (10 lb) weight, a steel

rod 75 mm (3 in.) in diameter and 125 mm (5 in.) long, shall be rolled over the test specimen for four complete cycles, eight passes. The specimen shall be removed from between the blotters and placed in the flexing device as specified in 8.54.4. The blotting paper shall conform to requirements detailed in Method 5500, Water Resistance of Cloth; Dynamic Absorption Method, of Federal Test Method Standard 191A, Textile Test Methods.

8.54.4 [1976: 6-31.4] The flexing device as shown in Figures 8.54.4(a) and (b) [1976: 6-31.3(a) and (b)] shall be used. This device shall have a suitable weight on the weight arm to produce a 13.5-N to 15.75-N (3-lb to 3.5-lb) tension on the specimen during flexing. The tensioning jaw or clamp shall be so located that, with tension jaw arm vertical, any point on the tensioning jaw would be the apex of a cone of motion generated between that point and the corresponding point of the moving jaw. The crank arms shall be equal in effective length and in angular phase so that the moving jaw connecting the two arms remains parallel to the tension jaw throughout a complete revolution of the arms. The specimen shall be placed in the device with the moving jaw at bottom dead center, the tension jaw arm vertical, and the face of the cloth down. Each jaw shall clamp the specimen across the entire width. The crank handle shall be turned at a rate of 50 revolutions, ±10 revolutions, per minute of the crank arms and moving jaw during the test. A tray or board, flat black in color and sufficiently large to catch any particles that are removed from the fabric, shall be cleaned before each test and examined for materials particles after each test. A motor-driven apparatus shall be permitted to be used in lieu of the manual device specified.

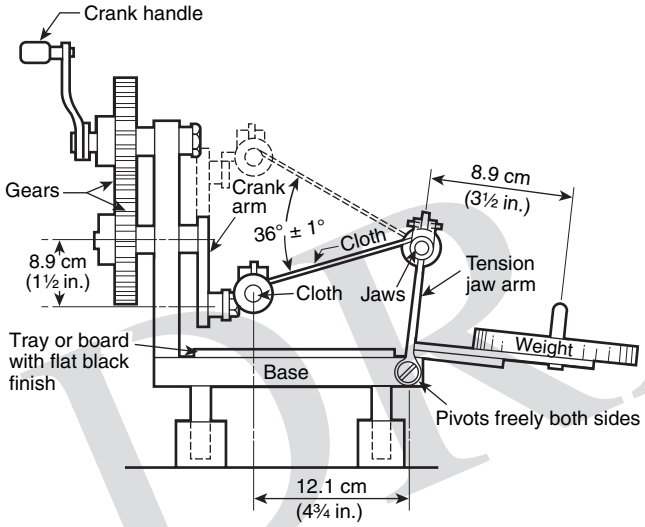

Figure 8.54.4(a) [1976: 6-31.3(a)] **Flexing device — end view.**

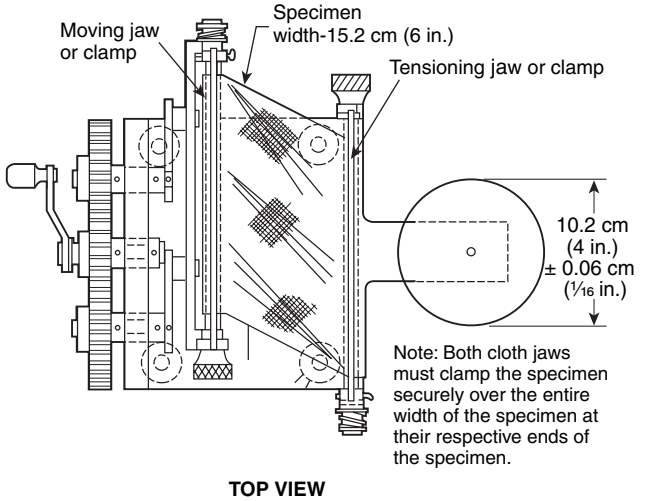

Figure 8.54.4(b) [1976: 6-31.3(b)] **Flexing device — top view.**

8.54.5 [1976: 6-31.5] The specimens shall be taken directly from the blotter paper and placed in the flexing device with the warp or wale direction perpendicular to the jaw line. The distance between jaw lines shall be 135 mm (5 1/4 in.). The specimen shall be flexed for 1000 cycles, then removed from the apparatus, and shall be visually inspected to determine pass/fail.

8.54.6 [1976: 6-31.6] Any cracking or delamination closer than 22 mm (7/8 in.) from either jaw line shall not be considered. Failure of any one specimen shall constitute failure of sample unit of product.

8.55 [1976: 6-32] Adhesion After Wet Flex-Tape Test.

8.55.1 [1976: 6-32.1] Immediately after each of the five specimens has completed the wet flex test in Section 8.? [1976: 6-31], the specimens shall be tested and evaluated for adhesion. This test shall be performed only on coated or laminated materials.

8.55.2 [1976: 6-32.2] A razor cut design shall be symmetrically centered within the 100-mm X 200-mm (4-in. X 8-in.) specimen. Two X cuts and three horizontal cuts shall be made as shown in Figure 8.55.2 [1976: 6-32.2] with a sharp razor blade through the coating or laminate and adhesive layers, but not through the base cloth.

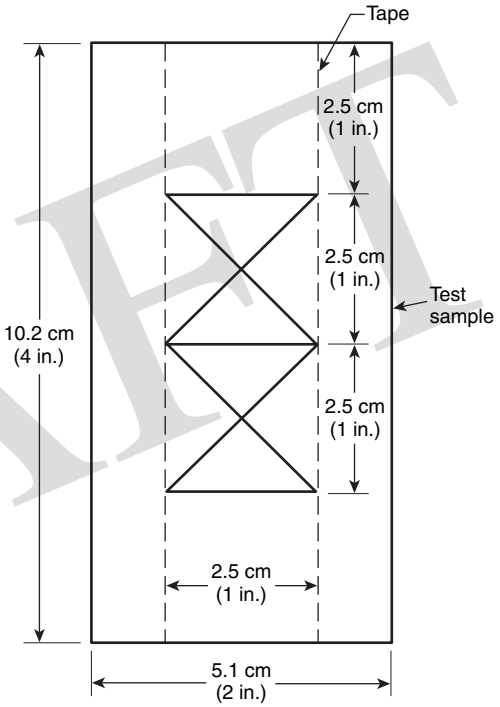

Figure 8.55.2 [1976: 6-32.2] **Cuts.**

8.55.3 [1976: 6-32.3] The pressure sensitive tape used for testing the adhesion of the coating or the laminate shall have an adhesion value of not less than 1.150 N/cm (2 3/4 lb/in.) width or more than 0.191 N/cm (3 1/2 lb/in.) width. Five 25-mm × 200-mm (1-in. × 8-in.) specimens of the tape shall be tested rising using the following:

(1) A tensile testing machine as described in Method 5100, Strength and Elongation, Breaking of Woven Cloth; Grab Method, of Federal Test Method Standard 191A, Textile Test Methods, with the modification that all machine attachments for determining maximum load shall be disengaged and the speed of the pulling clamp shall be 510 mm/min (20 in./min)

(2) Five 50-mm × 100-mm (2-in. × 4-in.) steel plates conforming to Class 301 of Federal Specification QQ-S-766, Steel Plate, Sheet, and Strip-Corrosion Resisting, which have been polished to a No. 4 finish

(3) A 38-mm (1 1/2-in.) wide steel roller weighing 4.53 kg, ±0.06 kg (10 lb, ±2 oz)

8.55.4 [1976: 6-32.3.1] Before each test, the steel plates shall be thoroughly cleaned with diacetone alcohol, methyl alcohol, or methyl ethyl ketone, using a clean piece of lint-free wiping tissue. The tape shall be applied to the clean surface of the plate so that it covers the

entire length of the plate and extends 100 mm (4 in.) beyond one end of the plate.

8.55.5 [1976: 6-32.3.2] The tape shall be pressed down by passing the roller over it six times, three times in each direction. The free end of the tape shall be doubled back and 25 mm (1 in.) of the tape peeled off the plate. The plate shall be inserted and clamped in the bottom jaw of the tensile testing machine with the free end of the tape downward. The free end of the tape shall be looped upward and inserted and clamped in the upper jaw so as to peel the tape from the plate when the jaw motion is started. The minimum tension required to remove the remainder of the tape, except for the final 25 mm (1 in.), shall be the adhesion value and shall be determined by means of the autographic recording device.

8.55.6 [1976: 6-32.4] Five 25-mm × 200-mm (1-in. × 8-in.) specimens of similar tape, taken from a lot of material that has passed the test as specified in Section 8.? [1976: 6-15], shall be used for testing the adhesion of the coating or laminate.

8.55.7 [1976: 6-32.5] The apparatus and procedure shall be as specified in 6-32.3, but instead of the steel plates specified in 6-32.3(2), the test specimens used in Section 8.? [1976: 6-15] shall be used for this test.

8.55.8 [1976: 6-32.6] A moderate amount of specks on the tape of coating shall not constitute failure; however, exposure of adhesive beneath a laminate shall constitute failure. The failure of one specimen shall constitute failure of the unit of product.

8.56 [1976: 6-33] Flex at Low Temperature Test.

8.56.1 [1976: 6-33.1] The test samples shall be five specimens, 25 mm × 100 mm (1 in. × 4 in.), with the long dimension in the warp or wale direction, and shall be from the fabric lot used in the construction of the garment.

8.56.2 [1976: 6-33.2] Specimens shall be tested after being subjected to the procedure specified in 8.1.? [1976: 6-1.3.

8.56.3 [1976: 6-33.3] The test samples and jig as shown in Figure 8.56.3 [1976: 6-33.3] shall be conditioned for 4 hours at a temperature of -32°C (-25°F).

8.56.4 [1976: 6-33.4] At the end of the conditioning period, with the jig and the test specimens still in the test atmosphere, the sample shall be placed in the open jig with the rod in the center of the fabric. The face of the fabric shall be positioned away from the rod. The jig shall be closed in less than 3 seconds so that the specimen is bent face out around the rod until the back of the specimen touches itself. The tested fabric shall be examined without magnification.

8.56.5 [1976: 6-33.5] Failure of any one specimen shall constitute failure of sample unit of production.

8.57 [1976: 6-34] Resistance to High-Temperature Blocking Test.

8.57.1 [1976: 6-34.1] Specimens shall be tested after being subjected to the procedure specified in [1976: 6-1.3].

8.57.2 [1976: 6-34.2] Blocking test procedure shall be as stated in Method 5872, Temperature, High, Effect on Cloth Blocking, of Federal Test Method Standard 191A, *Textile Test Methods.*

8.57.3 [1976: 6-34.3] The test specimen shall be examined to determine pass or fall performance. Failure to any one specimen shall constitute failure of the unit of product.

8.58 Drag Rescue Device (DRD) Materials Strength Test.

8.58.1 Application.

8.58.1.1 This test shall apply to DRD materials and DRD seams.

8.58.1.2 Modifications to this test method for testing DRD seams shall be as specified in 8.58.7.

8.58.3 Samples.

8.58.3.1 Five samples shall be taken from each different DRD material.

8.58.3.2 Five samples shall be taken from each different type of DRD seam.

8.58.3.3 Samples for conditioning shall be at least 1 m (1 yd) lengths of material including seams for seam testing.

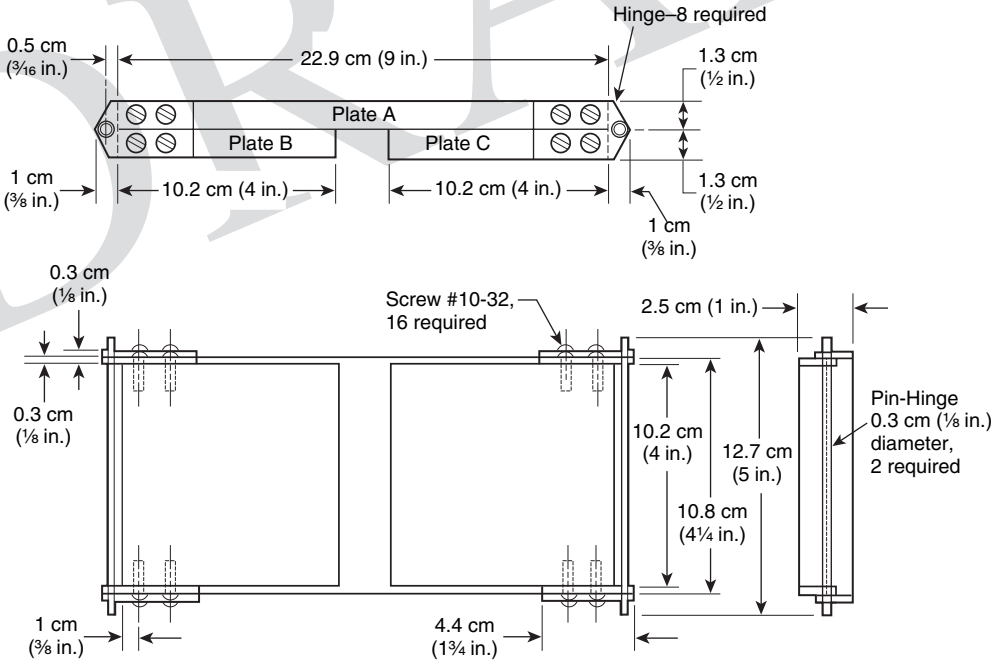

Figure 8.56.3 [1976: 6-33.3] **Jig assembly — resistance to low temperature test**.

8.58.2 Specimens.

8.58.3.1 Specimens shall be tested after being subjected to the conditioning specified in 8.1.2.

8.58.2.1 A total of five material specimens representative of the DRD materials shall be tested for each material type shall be tested.

8.58.2.2 A minimum of five seam specimens representative of the DRD seams shall be tested for each seam type.

8.58.4 Procedure. Specimens shall be tested for breaking strength only as specified in ASTM D 6775 *Standard Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material*.

8.58.5 Report.

8.58.5.1 The breaking strength of each specimen shall be recorded and reported.

8.58.5.2 The average breaking strength of all specimens shall be calculated, recorded, and reported.

8.58.6 Interpretation. The average breaking strength shall be used to determine pass or fail performance.

8.58.7 Specific Requirements for Testing DRD Seams.

8.58.7.1 The test specimen shall be as specified in ASTM D 6775 *Standard Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material,* and shall include the seam in the middle of the test specimen.

8.58.7.2 Testing shall be performed as specified in 8.58.4.

8.59 Drag Rescue Device Function Test.

8.59.1 Application. This test shall apply to protective coats and coverall elements.

8.59.2 Samples.

8.59.2.1 Samples shall consist of individual coats or coveralls.

8.59.2.2 Samples shall be conditioned as specified in 8.1.3.

8.59.3 Specimens.

8.59.3.1 A minimum of three garment specimens shall be tested. Each garment shall have in place all layers that are required for the garment to be compliant.

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

8.59.3.3 The size of the garment comprising the specimen shall be the same size as the mannequin in terms of chest circumference.

8.59.4 Apparatus.

8.59.4.1 The apparatus required for this testing shall include the following:

(1) One pair of gloves that are compliant with NFPA 1971 of the size required to fit the test subject.

(2) The mannequin used for the test shall be the IAFF Rescue Randy model no. 1475.

8.59.5 Procedure.

8.59.5.1 The test specimen shall be donned on the test mannequin in accordance with the manufacturer's instructions for proper wearing.

8.59.5.2 The test mannequin shall be placed on a concrete surface on it's back.

8.59.5.3 With the mannequin in position, the test subject shall don the gloves specified in 8.59.4.1.

8.59.5.4 The test subject shall then deploy the DRD and pull the mannequin using the DRD per the manufacturer's instructions for use for a minimum of 2.5 m (5 ft).

8.59.6 Report. The ability to drag the mannequin a minimum of 2.5 m (5 feet) with a gloved hand shall be recorded and reported.

8.59.7 Interpretation. The inability to drag the mannequin a minimum of 2.5 m (5 ft) feet with a gloved hand shall constitute failing performance.

8.60 Stored Thermal Energy Test.

8.60.1 Application. This test method shall apply to multilayer protective garment composites with and without attached reflective trim.

8.60.2 Samples.

8.60.2.1 Samples shall consist of outer shell, moisture barrier, and thermal barrier.

8.60.2.2 Samples shall be tested both with and without reflective trim. Samples shall not include seams.

8.60.2.3 All samples shall first be preconditioned as specified in 8.1.3

8.60.3 Specimen Preparation.

8.60.3.1 A minimum of three specimens shall be tested.

8.60.3.2 Specimens shall measure 150 mm × 150 mm, ± 6 mm (6 in. × 6 in., ± ¼ in.), and shall consist of all layers representative of the clothing item to be tested. Specimens shall not be stitched to hold individual layers together during testing. When tested with reflective trim, the trim specimen shall be sewn to the center of outer shell of the composite so that it will be directly positioned over the thermal sensor of the test apparatus.

8.60.3.3 For dry condition testing only, no further preconditioning shall be conducted.

8.60.3.4 For wet condition testing only, the following preconditioning procedure shall be used:

1. The samples shall be placed in a room environment, of 21°C, ±3°C, and 65 percent ±5 percent, relative humidity for 24 hours.
2. The samples will then be weighed using a precision scale and the weight of the specimen shall be recorded.
3. A sufficient amount of water shall then be sprayed onto the innermost layer of the composite specimen to increase the weight of the specimen (thermal liner, moisture barrier, shell fabric) by.
4. The wetted specimen shall then be placed in a plastic bag, sealed and allowed to condition for a period of twelve hours.
5. Specimens shall be removed from the plastic bag and tested. Testing shall be performed within one hour from the time specimens are removed from the sealed plastic bag.

8.60.4 Apparatus.

8.60.4.1 The thermal sensor shall be a water-cooled type thermal sensor, such as Medtherm Sensor, Model 64-2-20.

8.60.4.2 Only the quartz tubes of the apparatus described in 8.60.4.4.3 shall be used as the heat source.

8.60.4.3 The TPP apparatus shall be modified by adding a device that permits compression of the test specimen with the thermal sensor housed in an insulated block.

8.60.4.4 (6-10.4.1) The test apparatus shall consist of a specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder. The apparatus shall also have a gas supply, gas rotameter, burners, and sensor.

8.60.4.4.1 (6-10.4.1.1) The specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder mounting plates shall be 152 mm × 152 mm, ±2 mm, × 6mm, ±1 mm (6 in. × 6 in., $\pm^{1}/_{16}$ in., × $^{1}/_{4}$ in., $\pm^{5}/_{16}$ in.). The lower specimen mounting plate shall have a centered 102 mm × 102 mm, ±2 mm (4 in. × 4 in., $\pm^{1}/_{16}$ in.) hole. The upper specimen mounting plate shall have a centered 133.4 mm × 133.4 mm, ±1.6 mm ($5^{1}/_{4}$ in. × $5^{1}/_{4}$ in., $\pm^{1}/_{16}$ in.) hole. The lower specimen mounting plate shall have a 25 mm, ±2 mm high, × 3 mm, ±1 mm (1 in, $\pm^{1}/_{16}$ in. high, × 0.13 in., ±0.0315 in.) thick steel post welded to each corner 6.4 mm, ±1.6 mm ($^{1}/_{4}$ in., $\pm^{1}/_{16}$ in.) from each side and perpendicular to the plane of the plate, or some other method for aligning the specimen shall be provided. The upper sample mounting plate shall have a corresponding hole in each corner so that the upper specimen mounting plate fits over the lower specimen mounting plate. Specifications for the specimen holder assembly shall be as shown in Figure 8.60.4.1.1 (6-10.4.1.1).

FIGURE 8.60.4.4.1 (6-10.4.1.1) Lower specimen mounting plate.
[Existing Figure 6-10.4.1.1, 2000 ed., (no change)]

8.60.4.4.2 (6-10.4.1.2) The specimen holder assembly support shall consist of a steel frame that rigidly holds and positions in a reproducible manner the specimen holder assembly and specimen relative to the thermal flux.

8.60.4.4.3 (6-10.4.1.3) The thermal flux source shall consist of a convective thermal flux source and a radiant thermal flux source. The convective thermal flux source shall consist of two Meker or Fisher burners that are affixed beneath the specimen holder assembly opening, and are subtended at a nominal 45-degree angle from the

vertical so that the flames converge at a point immediately beneath the specimen. The radiant thermal flux source shall consist of nine quartz T-150 infrared tubes affixed beneath and centered between the burners as shown in Figure 8.60.4.4.3 (6-10.4.1.3).

FIGURE 8.60.4.4.3 (6-10.4.1.3) Specifications for TPP tester thermal flux source. [Existing Figure 6-10.4.1.3, 2000 ed., (no change)]

8.60.4.4.4 (6-10.4.1.4) A protective shutter shall be placed between the thermal flux source and the specimen. The protective shutter shall be capable of completely dissipating thermal load from the thermal flux source of the time periods before and after specimen exposure.

8.60.4.4.5 (6-10.4.1.5) The sensor assembly shall be fitted into the opening in the top plate of the specimen holder and be in contact with the surface of the thermal barrier normally facing the wearer as detailed in Figure 8.60.4.4.1 (6-10.4.1.10). The sensor assembly shall consist of 133.4 mm × 133.4 mm × 13 mm ($5^1/_4$ in. × $5^1/_4$ in. × $^1/_2$ in.) heat-resistant block that fits without binding into the hole of the upper specimen mounting plate and shall be uniformly weighted such that the complete sensor assembly, including copper calorimeter, weighs 1000 g, ±10 g (2.2 lb, ± 0.022 lb).

8.60.4.4.6 (6-10.4.1.6) The recorder shall be any strip chart recorder with full-scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ± 0.1 second. Alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

8.60.4.4.7 (6-10.4.1.7) The gas supply shall be propane, methane, or natural gas with appropriate reducer and valving arrangements to control the gas supply pressure at 8 psig, ± 0.1 psig, and capable of providing flow equivalent to 2 L/min (0.07 ft^3/min) air at standard conditions.

8.60.4.4.8 (6-10.4.1.8) The gas rotameter shall be any gas rotameter with range to give flow equivalent to 2 L (0.07 ft^3/min) air at standard conditions.

8.60.4.4.9 (6-10.4.1.9) The burners shall be Meker or Fisher burners with 38 mm, ±2 mm ($^1/_2$ in., ± 0.1 in.) diameter top and with orifice size of 1 mm (0.05 in.).

8.60.4.4.10 (6-10.4.1.10) The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 8.60.4.5.1 (6-10.4.1.10). The sensor shall be coated with a flat black paint.

8.60.4.5 (6-10.4.2) A radiometer shall be used in the calibration of the test apparatus.

8.60.4.5.1 (6-10.4.2.1) The radiometer shall be a Gardon-type radiation transducer with a diameter of 25 mm (1 in.). The heat flux operating range shall be from 0 kW/m^2 to 60 kW/ m^2 (0 cal/cm^2/s to 1.4 cal/cm^2/s or 0 Btu/ft^2/ s to 5 Btu/ft^2/s).

FIGURE 8.60.4.5.1 (6-10.4.1.10) Sensor assembly. [Existing Figure 6-10.4.1.10, 2000 ed., (no change)]

8.60.4.5.2 (6-10.4.2.2) The radiometer shall be water cooled and the cooling water temperature shall be above the ambient dew point temperature.

8.60.5 Procedures.

8.60.5.1 General Procedures.

8.60.5.1.1 (6-10.5.1.1) All testing and calibration shall be performed in a hood or ventilated area to carry away combustion products, smoke, or fumes. If air currents disturb the flame, the apparatus shall be shielded. Procedures for testing and calibration shall be performed using the same hood and ventilation conditions.

8.60.5.1.2 (6-10.5.1.2) Care shall be exercised in handling the burner with open flame. Adequate separation shall be maintained between flame and combustible materials. Because the specimen holder and sensor assembly become heated during prolonged testing, protective gloves shall be used when handling these hot objects. Because some test specimens become hazardous when exposed to direct flame, care shall be used when the specimen ignites or releases combustible gases. If specimens ignite, the gas supply at the cylinder shall be shut off and the flame shall be allowed to burn the gas.

8.60.5.2 Calibration Procedure.

8.60.5.2.1 Specimens shall be exposed to a thermal flux of 10 kW/m^2, ±0.5 kW/m^2 (.25 cal/cm^2·s, ±0.01 cal/cm^2·s) as measured with the water-cooled thermal sensor. The water-cooled thermal sensor shall be used to set the heat flux of the exposure. The total heat flux shall be calculated directly from the voltage output of the sensor.

8.60.5.2.2 Heat flux measurements shall be made with the sensor placed on top of the specimen holder with the sensor facing down. The thermal sensor shall be directly exposed to the heat source. Readings from the sensor be recorded for a period of at least 50 seconds.

8.60.5.3 Test Procedure.

8.60.5.3.1 (6-10.5.3.3) Specimens shall be mounted by placing the surface of the material to be used as the outside of the garment face down on the mounting plate. The subsequent layers shall be placed on top in the order used in the garment, with the surface to be worn toward the skin facing up. With the protective shutter engaged, the specimens shall be placed on the specimen holder.

8.60.5.3.2 The thermal sensor shall be positioned so that a 0.25 in air space exists between the thermal sensor/insulating block assembly and the innermost layer of the test specimen.

8.60.5.3.5 The protective shutter shall be retracted to start data acquisition. The starting time of the thermal exposure shall be indicated. The exposure shall be continued for 60 seconds. The protective shutter shall be then engaged (closed), and the data acquisition shall continue.

8.60.5.3.5 One hundred-thirty (130) seconds after the start of data acquisition, the test specimen shall be compressed at a pressure of 6 kPa (1.0 psi). Data acquisition shall be continued for 20 seconds after the test sample has been compressed.

8.60.5.3.6 If the testing calorimeter is in error by more than 0.5 kW/m^2 (+0.01 cal/cm^2·s), all electrical connections and points where thermocouples are secured to the testing calorimeter shall be checked. Two more calibration runs shall be conducted. The average error shall be calculated. If the average error of the testing calorimeter is more than 0.5 kW/m^2 (+0.01 cal/cm^2·s), then the testing calorimeter shall be repaired and recalibrated or the testing calorimeter shall be replaced.

8.60.5.4 Prediction of Second Degree Burn.

8.60.5.4.1 Processing of the Data. Procedures described in ASTM 1930 A1.1 – A1.3 shall be used to estimate skin burn damage. The skin heat transfer model shall use following physical properties.

8.60.5.5 Determination of Test Results.

8.60.5.5.1 The time to the second-degree burn shall be determined using criteria described in ASTM 1930 A1.1 – A1.3.

8.60.6 Report.

Table 8.60.5.4.2. Physical Properties for Skin Heat Transfer Model

Parameter	Epidermis	Dermis	Subcutaneous Tissue
Thickness of layer (m)	8.0×10^{-5}	2.0×10^{-3}	1×10^{-2}
Thermal conductivity, k (W/m · K)	0.255	0.523	0.167
Volumetric heat capacity, cp ($J/m^3 \cdot K$)	4.32×10^6	3.87×10^6	2.76×10^6

8.60.6.1 The individual Time to Burn of each specimen shall be recorded and reported.

8.60.6.2 The average Time to Burn for dry and the average Time to Burn for wet shall be separately calculated, recorded, and reported.

8.60.6.3 Where no burn injury occurs, the Time to Burn shall be recorded and reported as "no burn."

8.60.7 Interpretation.

8.60.7.1 Pass or fail determination for the wet condition test specimens shall be based on the average reported Time to Burn of all wet specimens tested.

8.60.7.2 Pass or fail determination for the dry condition test specimens shall be based on the average reported Time to Burn of all dry specimens tested. Failure of either the wet condition test set or the dry condition test shall constitute failing performance.

8.60.7.3 Where no burn is achieved, this shall constitute passing performance.

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

8.61 Heat Momentum Test.

8.61.1 Application. This test method shall apply to multilayer protective garment composites.

8.61.2 Samples.

8.61.2.1 Samples shall consist of outer shell, moisture barrier, and thermal barrier. Winter liners shall not be included in the test composite. Samples shall not include seams.

8.61.2.2 All samples shall first be preconditioned as specified in 8.1.3

8.61.3 Specimen Preparation.

8.61.3.1 A minimum of six specimens shall be tested.

8.61.3.2 The specimens shall measure 150 mm × 150 mm, +/- 6 mm (6 in × 6 in, +/- ¼ in), and shall consist of the three base layers representative of the clothing item to be tested. Specimens shall not be stitched to hold individual layers together during testing.

8.61.3.3 For dry condition testing only, no further preconditioning shall be conducted.

8.61.3.4 For wet condition testing only, the innermost layer of the composite specimen shall then be further conditioned as follows prior to testing:

(1) Blotter paper measuring 225 mm x 225 mm (9 in x 9 in) shall be saturated in distilled water.

(2) Two sheets of the saturated blotter paper shall be run together through a wringer that meets the requirements of 10.2 of AATCC 70, *Test Method for Water Repellency: Tumble Jar Dynamic Absorption Test*.

(3) The innermost layer of the composite specimen shall be placed between the two sheets of blotting paper.

(4) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be placed into a 4-L (1-gal) size air- and liquid tight bag and the bag shall be sealed closed.

(5) The innermost layer of the composite specimen, between the two sheets of blotting paper, shall be conditioned in the air- and liquid tight bag at room temperature for at least 24 hours, and shall not be removed from conditioning more than 5 minutes prior to testing.

(6) After removal from conditioning, the innermost layer shall be removed from the blotting paper, and the composite specimen shall be reassembled with all layers arranged in the same order and orientation as intended to be worn.

8.61.4 Apparatus.

8.61.4.1 (6-10.4.1) The test apparatus shall consist of a specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder. The apparatus shall also have a gas supply, gas rotameter, burners, and sensor.

8.61.4.1.1 (6-10.4.1.1) The specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder mounting plates shall be 152 mm × 152 mm, ±2 mm, × 6mm, ±1 mm (6 in. × 6 in., $\pm^{1}/_{16}$ in., × $^{1}/_{4}$ in., $\pm^{5}/_{16}$ in.). The lower specimen mounting plate shall have a centered 102 mm × 102 mm, ±2 mm (4 in. × 4 in., $\pm^{1}/_{16}$ in.) hole. The upper specimen mounting plate shall have a centered 133.4 mm × 133.4 mm, ±1.6 mm ($5^{1}/_{4}$ in. × $5^{1}/_{4}$ in., $\pm^{1}/_{16}$ in.) hole. The lower specimen mounting plate shall have a 25 mm, ±2 mm high, × 3 mm, ±1 mm (1 in, $\pm^{1}/_{16}$ in. high, × 0.13 in., ±0.0315 in.) thick steel post welded to each corner 6.4 mm, ±1.6 mm ($^{1}/_{4}$ in., $\pm^{1}/_{16}$ in.) from each side and perpendicular to the plane of the plate, or some other method for aligning the specimen shall be provided. The upper sample mounting plate shall have a corresponding hole in each corner so that the upper specimen mounting plate fits over the lower specimen mounting plate. Specifications for the specimen holder assembly shall be as shown in Figure 8.61.4.1.1 (6-10.4.1.1).

FIGURE 8.61.4.1.1 (6-10.4.1.1) Lower specimen mounting plate. [Existing Figure 6-10.4.1.1, 2000 ed., (no change)]

8.61.4.1.2 (6-10.4.1.2) The specimen holder assembly support shall consist of a steel frame that rigidly holds and positions in a reproducible manner the specimen holder assembly and specimen relative to the thermal flux.

8.61.4.1.3 (6-10.4.1.3) The thermal flux source shall consist of a convective thermal flux source and a radiant thermal flux source. The convective thermal flux source shall consist of two Meker or Fisher burners that are affixed beneath the specimen holder assembly opening, and are subtended at a nominal 45-degree angle from the vertical so that the flames converge at a point immediately beneath the specimen. The radiant thermal flux source shall consist of nine quartz T-150 infrared tubes affixed beneath and centered between the burners as shown in Figure 8.61.4.1.3 (6-10.4.1.3).

FIGURE 8.61.4.1.3 (6-10.4.1.3) Specifications for TPP tester thermal flux source. [Existing Figure 6-10.4.1.3, 2000 ed., (no change)]

8.61.4.1.4 (6-10.4.1.4) A protective shutter shall be placed between the thermal flux source and the specimen. The protective shutter shall be capable of completely dissipating thermal load from the thermal flux source of the time periods before and after specimen exposure.

8.61.4.1.5 (6-10.4.1.5) The sensor assembly shall be fitted into the opening in the top plate of the specimen holder and be in contact with the surface of the thermal barrier normally facing the wearer as detailed in Figure 8.61.4.1.10 (6-10.4.1.10). The sensor assembly shall consist of 133.4 mm × 133.4 mm × 13 mm ($5^{1}/_{4}$ in. × $5^{1}/_{4}$ in. × $^{1}/_{2}$ in.) heat-resistant block that fits without binding into the hole of the upper specimen mounting plate and shall be uniformly weighted such that the complete sensor assembly, including copper calorimeter, weighs 1000 g, ±10 g (2.2 lb, ±0.022 lb).

8.61.4.1.6 (6-10.4.1.6) The recorder shall be any strip chart recorder with full-scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ±0.1 second. Alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

8.61.4.1.7 (6-10.4.1.7) The gas supply shall be propane, methane, or natural gas with appropriate reducer and valving arrangements to control the gas supply pressure at 8 psig, ±0.1 psig, and capable of providing flow equivalent to 2 L/min (0.07 ft^3/min) air at standard conditions.

8.61.4.1.8 (6-10.4.1.8) The gas rotameter shall be any gas rotameter with range to give flow equivalent to 2 L (0.07 ft^3/min) air at standard conditions.

8.61.4.1.9 (6-10.4.1.9) The burners shall be Meker or Fisher burners with 38 mm, ±2 mm ($^{1}/_{2}$ in., ±0.1 in.) diameter top and with orifice size of 1 mm (0.05 in.).

8.61.4.1.10 (6-10.4.1.10) The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 8.61.4.1.10 (6-10.4.1.10). The sensor shall be coated with a flat black paint.

8.61.4.2 (6-10.4.2) A radiometer shall be used in the calibration of the test apparatus.

8.61.4.2.1 (6-10.4.2.1) The radiometer shall be a Gardon-type radiation transducer with a diameter of 25 mm (1 in.). The heat flux operating range shall be from 0 kW/m^2 to 60 kW/ m^2 (0 cal/cm^2/s to 1.4 cal/cm^2/s or 0 Btu/ft^2/ s to 5 Btu/ft^2/s).

FIGURE 8.61.4.1.10 (6-10.4.1.10) Sensor assembly. [Existing Figure 6-10.4.1.10, 2000 ed., (no change)]

8.61.4.2.2 (6-10.4.2.2) The radiometer shall be water cooled and the cooling water temperature shall be above the ambient dew point temperature.

8.61.5 Procedure.

8.61.5.1 General Procedures.

8.61.5.1.1 (6-10.5.1.1) All testing and calibration shall be performed in a hood or ventilated area to carry away combustion products, smoke, or fumes. If air currents disturb the flame, the apparatus shall be shielded. Procedures for testing and calibration shall be performed using the same hood and ventilation conditions.

8.61.5.1.2 (6-10.5.1.2) Care shall be exercised in handling the burner with open flame. Adequate separation shall be maintained between flame and combustible materials. Because the specimen holder and sensor assembly become heated during prolonged testing, protective gloves shall be used when handling these hot objects. Because some test specimens become hazardous when exposed to direct flame, care shall be used when the specimen ignites or releases combustible gases. If specimens ignite, the gas supply at the cylinder shall be shut off and the flame shall be allowed to burn the gas.

8.61.5.2 Calibration Procedure.

8.61.5.2.1 (6-10.5.2.1) Specimens shall be exposed to a thermal flux of 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/s, ±0.1 cal/cm^2/s) as measured with the copper calorimeter. The copper calorimeter shall be the only heat sensor used in setting the total 83 kW/m^2 (2 cal/ cm^2/s) exposure condition. The total heat flux shall be calculated directly and only from the voltage output of the thermocouples, using the measured temperature rise of the testing copper calorimeter, the area and mass of the calorimeter, and the heat capacity of copper to calibrate the heat flux. Other heat-sensing devices shall not be used to reference or adjust the total heat flux read by the copper calorimeter.

8.61.5.2.2 (6-10.5.2.2) The total heat flux and the 50/50 percent, ±5 percent radiant/convective balance of the energy sources shall be set in accordance with the procedures in 8.61.5.2.3 (6-10.5.2.3) through 8.61.5.2.6 (6-10.5.2.6). The level of the radiant heat flux shall be determined using a radiometer and the level of the total heat flux shall be determined by using a calibration copper calorimeter designated and used only to set the total exposure level.

8.61.5.2.3 (6-10.5.2.3) Once an initial setting of 12 kW/m^2, ±1.2 kW/m^2 (0.3 cal/cm^2/s, ±0.03 cal/cm^2/s) has been made to the array of new quartz lamps, the operating voltage shall be recorded and permanently retained for test purposes. During all future calibration procedures, the voltage setting of the quartz lamps shall be compared to the current voltage setting of the new quartz lamps, and if the voltage increase is 5 V or greater from the initial setting, the lamps shall be replaced.

8.61.5.2.4* (6-10.5.2.4) The two Meker or Fisher burners shall be initially adjusted so that the flames converge upon each other just below the center of the radiometer. The color of the flame shall primarily be blue.

8.61.5.2.5 (6-10.5.2.5) The radiant thermal flux source of nine quartz infrared tubes alone shall be set to an incoming radiant heat flux of 12 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^2/s, ±0.1 cal/cm^2/s) using a commercial radiometer meeting the specifications of 8.10.4.2 (6-10.4.2). The radiometer window shall be positioned at the geometric center of the sample holder and at the same plane as a test specimen. The radiometer shall be mounted in a holder of the same overall size, shape, and material as the one used for the copper calorimeter to ensure similar heat and flame patterns across the faces of the radiometer and calorimeters. The radiant quartz tubes shall be turned to the on position for a minimum of 2 minutes prior to measuring the radiant heat flux.

8.61.5.2.6 (6-10.5.2.6) The total heat flux shall be set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/ cm^2/s, ±0.1 cal/cm^2/s) using the calibration copper calorimeter, defined in 8.10.4.1.10 (6-10.4.1.10), by adjusting only the gas supply to the Meker or Fisher burners. Without a mounted specimen, the calibration copper calorimeter shall be placed on top of the specimen holder with the blackened copper calorimeter facing down, and then exposed directly to the flame of the burner. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall also be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±4°C (267°F, ±7°F) equivalent to 7.86 mV, ±0.20 mV for an iron–constantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2.0 cal/cm^2/s, ±0.05 cal/cm^2/s).

8.61.5.3 Test Procedure.

8.61.5.3.1 (6-10.5.3.1) After the total thermal heat flux has been set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/s, ±0.1 cal/cm^2/s) using the calibration procedure in 8.10.5.2.4 (6-10.5.2.4) through 8.10.5.2.6 (6-10.5.2.6), the testing copper calorimeter shall be used to measure the total heat flux. Prior to testing, the testing copper calorimeter shall be used to measure the total heat flux by placing the calorimeter face down, and then exposing it directly to the total heat source. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±4°C (267°F, ±7°F) equivalent to 7.86 mV, ±0.20 mV for an iron– constantan thermocouple for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2.0 cal/ cm^2/s, ±0.05 cal/cm^2/s).

8.61.5.3.2 (6-10.5.3.2) If the measurement from the testing copper calorimeter is within +4/-0 kW/m^2 (+0.1/-0 cal/cm^2/s), then testing shall be done. If the measurement from the testing copper calorimeter does not agree within +4 kW/m^2 (+0.1 cal/cm^2/s) of the measurement of the calibration calorimeter, the testing copper calorimeter shall be repaired, reconditioned, or replaced to achieve agreement.

8.61.5.3.3 (6-10.5.3.3) Specimens shall be mounted by placing the surface of the material to be used as the outside of the garment face down on the mounting plate. The subsequent layers shall be placed on top in the order used in the garment, with the surface to be worn toward the skin facing up. With the protective shutter engaged, the specimens shall be placed on the specimen holder.

8.61.5.3.4 (6-10.5.3.4) The testing copper calorimeter shall be placed directly on the specimen in contact with the surface to be worn toward the skin.

8.61.5.3.5 The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 8.10.5.4.1. The start time of the exposure shall be indicated and the exposure shall be continued for 10 seconds. The protective shutter shall be engaged (closed), and the data acquisition shall continue for an additional 45 seconds.

8.61.5.3.6 (6-10.5.3.6) After each exposure, the calorimeter shall be cooled to 33°C, ±1°C (91°F, ±2°F) before the next heat flux determination. The sensor shall be cooled after exposure with a jet of air or by contact with a cold surface.

8.61.5.3.7 (6-10.5.3.7) The sensor face shall be wiped immediately after each run, while hot, to remove any decomposition products that condense and could be a source of error. If a deposit collects and appears to be thicker than a thin layer of paint, or is irregular, the sensor surface shall be reconditioned. The cooled sensor shall be carefully cleaned with acetone or petroleum solvent, making certain there is no ignition source nearby.

8.61.5.3.7.1* (6-10.5.3.7.1) If copper is showing on the testing copper calorimeter, the surface shall be completely repainted with a thin layer of flat black spray paint. At least one calibration run shall be performed comparing the testing copper calorimeter with the calibration copper calorimeter.

8.61.5.3.7.2 (6-10.5.3.7.2) If the testing calorimeter is in error by more than +4/-0 kW/m^2 (+0.1/-0 cal/cm^2/s), all electrical connections and points where thermocouples are secured to the testing calorimeter shall be checked. Two more calibration runs shall be conducted by comparing the testing copper calorimeter with the calibration grade copper calorimeter. The average error shall be calculated. If the average error of the testing calorimeter is more than +4 kW/m^2 (+0.1 cal/ cm^2/s), then the testing calorimeter shall be repaired and recalibrated or the testing calorimeter shall be replaced.

8.61.5.4 Preparation of Human Tissue Burn Tolerance Overlay.

8.61.5.4.1 (6-10.5.4.1) Tolerance Overlay. The thermal end point shall be determined with a plot of energy versus the time to cause a second-degree burn in human tissue as shown in Table 8.61.5.4.1 (6-10.5.4.1). The calorimeter equivalent from Table 8.61.5.4.1 (6-10.5.4.1) that corresponds to the recorder scale shall be plotted on recorder chart paper. The columns DT°F, DT°C, and DmV (columns 6, 7, and 8) shall be plotted on the vertical axis and the corresponding exposure time (column 1) shall be plotted on the horizontal axis. Chart units based on the recorder full-scale deflection and the chart speed for a graph directly comparable to the recorder sensor trace shall be used. If pen deflection is from left to right and paper movement is down, the plot shall be from right to left with origin at lower right. If recorder trace differs, the graph shall be adjusted accordingly. An exact transparent duplicate shall be made for the overlay. The overlay shall be compared with the original to ensure change in the overlay size.

Table 8.61.5.4.1 (6-10.5.4.1) Human Tissue Tolerance to Second-Degree Burn

Exposure Time(s)	Heat Flux		Total Heat		Calorimeter* Equivalent		
	cal/cm^2/ s	kW/m^2	cal/cm^2/ s	kW/m^2	DT°F	DT°C	DmV
1	1.2	50	1.20	50	16.0	8.9	0.46
2	0.73	31	1.46	61	19.5	10.8	0.57
3	0.55	23	1.65	69	22.0	12.2	0.63
4	0.45	19	1.80	75	24.0	13.3	0.69
5	0.38	16	1.90	80	25.3	14.1	0.72
6	0.34	14	2.04	85	27.2	15.1	0.78
7	0.30	13	2.10	88	28.0	15.5	0.80
8	0.274	11.5	2.19	92	29.2	16.2	0.83
9	0.252	10.6	2.27	95	30.2	16.8	0.86
10	0.233	9.8	2.33	98	31.1	17.3	0.89
11	0.219	9.2	2.41	101	32.1	17.8	0.92
12	0.205	8.6	2.46	103	32.8	18.2	0.94
13	0.194	8.1	2.52	106	33.6	18.7	0.97
14	0.184	7.7	2.58	108	34.3	19.1	0.99
15	0.177	7.4	2.66	111	35.4	19.7	1.02
16	0.168	7.0	2.69	113	35.8	19.8	1.03
17	0.160	6.7	2.72	114	36.3	20.2	1.04
18	0.154	6.4	2.77	116	37.0	20.6	1.06
19	0.148	6.2	2.81	118	37.5	20.8	1.08
20	0.143	6.0	2.86	120	38.1	21.2	1.10
25	0.122	5.1	3.05	128	40.7	22.6	1.17
3[1,2]	0.107	4.5	3.21	134	42.8	23.8	1.23

[1]Stoll, A. M. and M. A. Chianta, "Method and Rating System for Evaluation of Ther mal Protection," *Aerospace Medicine*, vol. 40, 1968, pp. 12321238.

[2]Ironconstantan thermocouple.

8.61.5.4.2 Computer Processing of the Data. The information provided in Table 8.61.5.4.1 shall be permitted to be used as the criteria of performance in the software of a computer program. In this case, the sensor response shall be compared with the thermal response, either pain sensation or second-degree burn in human tissue to determine the thermal end points.

8.61.5.5 Determination of Test Results.

8.61.5.5.1 (6-10.5.5.1) The time to the second-degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 8.61.5.4.1 (6-10.5.4.1). The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the exposure start time resulting from heat transfer. The horizontal axis (time) shall be placed in line with the initial trace of the pen, keeping the overlay square with the recorder chart. The time to the second-degree burn shall be read to the nearest 0.1 second from the overlay chart at the point when the sensor response curve and the tissue tolerance curve cross. If the sensor response curve and the tissue tolerance curves do not cross, ">30" shall be recorded as the test result.

8.61.5.5.1.1 (6-10.5.5.1.1) If a computer software program is used, the sensor response shall be compared with the data describing the human tissue heat tolerance to determine like values. The time from the start of the exposure to the time when these values are the same shall be taken at the exposure time.

8.61.6 Report.

8.61.6.1 The individual Time to Burn of each specimen shall be recorded and reported.

8.61.6.2 The average Time to Burn for dry and average Time to Burn for wet shall be separately calculated, recorded, and reported.

8.61.6.3 Where no burn injury occurs, then the Time to Burn shall be recorded and reported as "no burn."

8.61.7 Interpretation.

8.61.7.1 Pass or fail determination for the wet condition test specimens shall be based on the average reported Time to Burn of all wet specimens tested. Pass or fail determination for the dry condition test specimens shall be based on the average reported Time to Burn of all dry specimens tested. Failure of either the wet condition test set or the dry condition test set shall constitute failing performance.

8.61.7.2 Where no burn is achieved, this shall constitute passing performance.

8.61.7.3 Where an individual result from any test set varies more than +/- 8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

8.62 Light Degradation Resistance Test.

8.62.1 Application. This test shall apply to moisture barrier materials.

8.62.2 Samples.

8.62.2.1 Samples for conditioning shall be at least 380-mm (15-in.) square and shall consist of a composite constructed using a layer of 7.5-oz natural Nomex®, the moisture barrier, a layer of Q9 thermal barrier material, and another layer of 7.5-oz. Natural Nomex®. The four-layer composite sample shall be stitched around the entire periphery.

8.62.2.2 Where the layer intended to be the moisture barrier is configured of a composite that includes outer shell, moisture barrier, or thermal barrier combinations, the samples to be preconditioned shall be constructed using those materials.

8.62.2.3 The moisture barrier layer shall be removed from the four layer composite samples after all preconditioning has been completed and shall become the moisture barrier specimen.

8.62.2.4 Where the moisture barrier is configured as indicated in 8.62.2.2, specimens shall be permitted to be a composite of layers provided that the layer intended to be the moisture barrier will face the light source in the test apparatus and provided that the specimen was preconditioned according to 8.62.2.2.

8.62.3 Sample Preparation.

8.62.3.1 Sample composites shall be subjected to two cycles of the following conditioning.

(1) The sample shall first be subjected to the procedure specified in 6-1.2.

(2) The sample shall then be conditioned a specified in 6-1.3.

(3) The sample shall then be conditioned as specified in 6-1.5.

(4) The sample shall then be conditioned at a temperature of 21° C, ±3°C (70°F, ±5°F) and a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8.62.4 Specimen Preparation.

8.62.4.1 The moisture barrier material will be removed from the conditioned sample composite and be cut into specimens at least 15 0mm (6 in.) square.

8.62.4.2 A minimum of four specimens shall be tested.

8.62.5 Procedure.

8.62.5.1 Light resistance testing shall be conducted in accordance with ASTM G-155, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, using Cycle 8 Exposure Conditions. Both inner and outer filters shall be Borosilicate. Exposure duration shall not include dark cycles.

8.62.5.2* For each specimen, cut a piece of cardstock equal in dimensions to the specimen. Staple the specimen to the cardstock at each corner with the film side of the specimen away from the cardstock. Clip the card stock-backed specimen into the test apparatus, insuring clips do not contact the specimen and the film side of the specimen is oriented toward the light source.

8.62.5.3 Specimens shall be subjected to 40 hours of continuous light exposure.

8.62.5.4 Specimens shall be removed from the test apparatus and conditioned in a dark environment at a temperature of 21° C, ±3°C (70°F, ± 5°F) and a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8.62.5.5 Specimens shall be tested in accordance with ASTM D 751, Standard Methods for Testing Coated Fabrics, Hydrostatic Resistance, Procedure B – Rising Column Water Method, Procedure 2, Sections 46-49, with the following modifications:

(a) Alternative test apparatus shall be permitted provided that the exposed area of the specimen is at least 108 mm (4 ¼ in.) in diameter and the pressure can be applied uniformly over the exposure period at a precision of ± 0.1 kPa (± 0.2 psi).

(b) The applied pressure shall be 13.8 kPa (2 psi) for an exposure period of 1 minute.

(c) Restraining materials shall not be used.

8.62.5.5.1 The moisture barrier specimen shall be placed in the apparatus with the film side facing away from the water source.

8.62.6 Reports. The pass or fail performance for each specimen shall be recorded and reported.

8.62.7 Interpretation.

8.62.7.1 Failing performance shall be if any water appears on the surface of the specimen during the exposure period as discerned by a person with 20/20 vision, or vision corrected to 20/20, at a nominal distance of 305 mm (12 in.) with standard room illumination.

8.62.7.2 One or more test failures of any specimen shall constitute failure of material.

8.63 Liner Retention Test.

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

8.63.2 Samples. Samples for conditioning shall be whole gloves.

8.63.3 Specimens

8.63.3.1 A minimum of three whole gloves with each liner type shall be tested.

8.63.3.2 Each digit of the glove shall be tested.

8.63.3.3 Specimens shall be conditioned as specified in 8.1.2, and then conditioned as specified in 8.1.3.

8.63.4 Apparatus. Liner retention shall be evaluated with the use of locking forceps and a force-measuring gauge.

8.63.5 Procedure.

8.63.5.1 The locking forceps shall be attached to the inner liner of the digit to be tested ensuring that an unattached liner or the outer shell is not grabbed.

8.63.5.2 The hook of the force gauge shall be looped around the locking bridge of the forceps.

8.63.5.3 The digit of the glove shell shall be gripped ensuring that the inner liner is not impeded.

8.63.5.4 The force gauge shall be pulled until 6 lbf registers on the dial and then released.

8.63.5.5 Each digit shall be inspected for indication of detachment of inner liner and/or moisture barrier.

8.63.6 Report. Results shall be recorded and reported as pass or fail.

8.63.7 Interpretation.

8.63.7.1 Failure of any digit of any glove shall constitute failure.

8.63.7.2 Glove shall be permitted to be cut open to verify detachment.

8.64 Shear Strength Test for Hook and Loop Fasteners.

8.64.1 Application. This test method shall apply to hook and pile fastener tapes used in garments.

8.64.2 Samples. Specimens shall be conditioned as specified in 8.1.12.

8.64.3 Specimens. Specimens shall be as specified in ASTM D 5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners.* A minimum of 5 specimens shall be tested.

8.64.4 Procedure. Specimens shall be evaluated in accordance with ASTM D 5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners.*

8.64.5 Report. The average shear strength shall be recorded and reported for all specimens tested.

8.64.6 Interpretation. The average shear strength shall be used to determine pass or fail performance.

8.65 Peel Strength Test for Hook and Loop Fasteners.

8.65.1 Application. This test method shall apply to Hook and Pile Fastener Tapes used in garments.

8.65.2 Samples. Specimens shall be conditioned as specified in 6-1.12.

8.65.2 Specimens. Specimens shall be as specified in ASTM D 5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners.* A minimum of 5 specimens shall be tested.

8.65.4 Procedure. Specimens shall be evaluated in accordance with ASTM D 5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners.*

8.65.5 Report. The average peel strength shall be recorded reported for all specimens tested.

8.65.6 Interpretation. The average peel strength shall be used to determine pass or fail performance.

8.66 Overall Ensemble Inward Leakage Test.

8.66.1 Application. This test method shall apply to CBR protective ensembles and ensemble elements.

8.66.2 Samples.

8.66.2.1 Samples shall consist of CBR protective ensembles and the ensemble garment, helmet, glove, and footwear elements, and the SCBA specified for the ensemble by the ensemble manufacturer. The hood interface component shall also be tested where the hood is not part of the CBR ensemble garment elements..

8.66.2.2 A total of three different ensemble specimens shall be evaluated.

8.66.3 Specimens.

8.66.3.1 Garment, glove, and hood elements shall be conditioned as specified in 8.1.11.

8.66.3.2 Where the ensemble garment element does not include booties and the chemical/ biological/particulate barrier layer is incorporated into footwear, the footwear shall be conditioned by flexing for 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*.

8.66.3.3 Specimens shall be provided to fit or be adjustable to fit the selected test subjects in accordance with the sizing provisions specific to each element.

8.66.4 Apparatus. The test chamber, test equipment, and test supplies shall be as specified in Test Operations Procedure (TOP 10-2-022), *Man-In-Simulant Test (MIST) - Chemical Vapor Testing of Chemical/Biological Protective Suits.*

8.66.5 Procedure. Procedures used for the evaluation of ensembles shall be as specified in Test Operations Procedure (TOP 10-2-022), *Man-In-Simulant Test (MIST) - Chemical Vapor Testing of Chemical/ Biological Protective Suits.*

8.66.6 Report.

8.66.6.1 The mass of methyl salicyate found at each sample location within the ensemble shall be recorded and reported.

8.66.6.2 The percent inward leakage for the overall ensemble as determined in Appendix F of Test Operations Procedure (TOP 10-2-022), *Man-In-Simulant Test (MIST) - Chemical Vapor Testing of Chemical/Biological Protective Suits*, shall be recorded and reported..

8.66.7 Interpretation. The percent inward leakage for the overall ensemble shall be used to determine pass or fail performance.

8.67 Chemical Permeation Resistance Test.

8.67.1 Application.

8.67.1.1 This method shall apply to the CBR barrier layer and seams used in elements and ensembles for CBR terrorism agent protection.

8.67.1.2 Specific requirements for testing the garment, glove, hood, and bootie CBR barrier layer shall be as specified in 8.67.7.

8.67.1.3 Specific requirements for testing footwear CBR barrier layer shall be as specified in 8.67.8.

8.67.2 Samples.

8.67.2.1 A minimum of three samples of each material shall be tested against each chemical.

8.67.2.2 Only the CBR barrier layer shall be tested for chemical permeation resistance.

8.67.3 Specimens. Specimens shall be conditioned as specified in 8.1.3 prior to testing.

8.67.4 Procedures.

8.67.4.1 Specimens shall be tested for permeation resistance for not less than 60 minutes against the chemicals specified in 8.67.4.2 and 8.67.4.3 in accordance with ASTM F 739, *Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact,* with the following modifications:

(1) The test cells shall be designed to accommodate the introduction of liquid chemicals in a safe manner.

(2) The collection media shall be filtered air flowed through the bottom of the test cell at a rate of 1 lpm ± 0.1 lpm.

(3) Analytical methods used shall be sensitive to concentrations of at least two orders of magnitude lower than the required end points.

(4) Where cumulative permeation end points are not specified in this standard, a permeation rate of 0.1 $\mu g/cm^2$/minute, as defined by ASTM F 739, *Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact,* shall be used.

8.67.4.2 The following liquid chemicals shall be tested:

(1) Liquid chemical warfare agents

(a) Distilled sulfur mustard: [HD; bis (2-chloroethyl) sulfide] 505-60-2; at 32°C ±1°C (90°F ±2°F)

(b) Sarin: (GB; isopropyl methanefluorophosphonate) 107-44-8; at 32°C ±1°C (90°F ±2°F)

(2) Liquid industrial chemical

(a) Dimethyl sulfate (DMA, sulfuric acid dimethyl ester), 77-78-1; at 32°C ±1°C (90°F ±2°F)

8.67.4.3 The following gases shall be tested:

(1) Ammonia (7664-41-7); at 32°C ±1°C (90°F ±2°F)

(2) Chlorine (Cl2; 7782-50-5); at 32°C ±1°C (90°F ±2°F)

(3) Cyanogen chloride (CK; 508.77-4); at 32°C ±1°C (90°F ±2°F)

(4) Carbonyl chloride (CG; 75-44-5); at 32°C ±1°C (90°F ±2°F)

(5) Hydrogen cyanide (AC, HCN, CAS; 74-90-8); at 32°C ±1°C (90°F ±2°F)

8.67.4.4 Permeation Test Configuration.

8.67.4.5.1 The gas concentration shall be 1000 ppm +100/-0 ppm, and the cell shall be assembled in closed-top configuration.

8.67.4.4.2 The liquid concentration density shall be 10 g/m^2 +1/-0 g/m2, applied as nominal 1 μl drops. Drops shall be applied uniformly over the sample surface. Where a seam, closure, or fixture is included, at least one drop shall be applied to each critical juncture, such as the seam edge.

8.67.4.4.3 The test cell shall be assembled in the closed-top configuration.

8.67.5 Report.

8.67.5.1 For permeation testing of chemical warfare agents, the cumulative permeation in 1 hour shall be recorded and reported in $\mu g/cm^2$ for each specimen. The average cumulative permeation in 1 hour for all specimens shall be calculated, recorded, and reported. The report shall include the pass or fail results for each chemical tested.

8.67.5.2 For permeation testing of liquid and gaseous industrial chemicals, the normalized breakthrough time shall be recorded and reported in minutes for each specimen. The average normalized breakthrough time shall also be calculated, recorded, and reported.

8.67.6 Interpretation.

8.67.6.1 For permeation testing of chemical warfare agents specified in 8.67.4.2(1), the average cumulative permeation shall be used to determine pass or fail performance.

8.67.6.2* For permeation testing of liquid and gaseous industrial chemicals specified in 8.67.4.2(2), the average normalized breakthrough time shall be used to determine pass or fail performance.

8.67.7 Specific Requirements for Testing Garment, Hood, Glove, and Bootie Materials and Seams.

8.67.7.1 Samples for conditioning shall be at least 380-mm (15-in.) square and shall consist of all layers of the composite arranged in the order used in the construction of the garment. Where the sample includes the seam, the chemical/biological/particulate barrier layer shall be constructed with a center seam that shall extend across the entire 380 mm (15 in.) width of the specimen. The multi-layer composite shall be stitched around the entire periphery.

8.67.7.2 Chemical/biological/particulate barrier layer and seam specimens prepared as describe in 8.67.7.1 shall be tested after being twice subjected to the following conditioning.

(1) Specimens shall first be subjected to the procedure specified in 8.1.2.

(2) Specimens shall then be conditioned as specified in 8.1.3.

(3) Specimens shall then be conditioned as specified in 8.1.5.

(4) Specimens shall then be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and at a relative humidity of 65 percent, ±5 percent, for at least 4 hours.

8.67.7.3 The chemical/biological/particulate barrier layer shall be removed from the four-layer composite samples after all

preconditioning specified 8.67.7.2 has been completed and shall be conditioned by flexing as specified in 8.1.Y. Samples shall be 200 mm × 280 mm (8 in. × 11 in.). Following flexing, one specimen shall be taken from the center of each sample subjected to flexing and the specimen become the chemical/biological/particulate barrier layer specimen for permeation testing for 8.67.2 through 8.67.6.

8.67.7.4 Where the chemical/biological/particulate barrier layer as the outer layer of the composite, samples shall be also conditioned by abrading as specified in 8.1.Z. Samples shall be 45 mm × 230 mm (1 7/8 in. × 9 in.). Following abrading, one specimen shall be taken from the center of each sample subjected to abrading and the specimen become the chemical/biological/particulate barrier layer specimen for permeation testing for 8.67.2 through 8.67.6.

8.67.10 Specific Requirements for Testing Footwear Materials After Flexing and Abrading.

8.67.10.1 This test shall apply to all types of footwear configurations.

8.67.10.2 Samples for conditioning shall be whole footwear items.

8.67.10.3 Footwear samples shall be subjected to the following sequence a total of three time prior to permeation testing.

(1) Samples shall first be conditioned as specified in 8.1.5.

(2) Samples shall then be conditioned by flexing 33,300 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*.

8.67.10.4 Following flexing, new samples shall be taken in areas from the footwear upper where the greatest flexing occurred, usually at the footwear quarter or vamp, measuring 45 mm × 225 mm (1 7/8 in. × 9 in.).

8.67.10.5 The new samples shall then be conditioned by abrading as specified in 8.1.Z.

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

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

8.68 Puncture Propagation Tear Resistance Test.

8.68.1 Application. This test shall apply to the CBR barrier layer.

8.68.2 Sample Preparation.

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

8.68.2.2 Samples shall be conditioned as specified in 8.1.3.

8.68.3 Specimens.

8.68.3.1 Specimens shall be the size specified in ASTM D 2582.

8.68.3.2 A minimum of five specimens in each of the warp, machine or coarse, and filling, cross-machine or wales, directions shall be tested.

8.68.3.3 If the material is nonanisotropic, then ten specimens shall be tested.

8.68.4 Procedure. Specimens shall be tested in accordance with ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting.*

8.68.5 Report.

8.68.5.1 The puncture propagation tear resistance of each specimen shall be recorded and reported to the nearest 1 N (0.1 lbf).

8.68.5.2 An average puncture propagation tear resistance shall be calculated for warp and filling directions. The average puncture propagation tear resistance calculations shall be recorded and reported.

8.68.6 Interpretation.

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

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

8.69 Cold Temperature Performance Test 1.

8.69.1 Application. This test method shall apply to the CBR barrier layer.

8.69.2 Sample Preparation.

8.69.2.1 Samples for conitioning shall be at least 50 cm (18 in.) squares of material.

8.69.2.2 Samples shall be conditioned a specified in 8.1.3.

8.69.3 Specimens.

8.69.3.1 Specimens shall be the size specified in ASTM D 747.

8.69.3.2 A minimum of five specimens consisting of all layers in each of the warp, machine or coarse, and filling, cross-machine or wales, directions shall be tested.

8.69.3.3 If the material is nonanisotropic, then ten specimens shall be tested.

8.69.3 Preparation.

8.69.3.1 Samples for conditioning shall be at least 1 m (1 yd) squares of material.

8.69.3.2 Samples shall be conditioned as specified in 8.1.3.

8.69.4 Procedure.

8.69.4.1 Specimens shall be tested in accordance with ASTM D 747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*, with the following modifications:

(1) The test temperature shall be -25°C (-13°F).

(2) The bending moment shall be that applied when the specimen is bent to a 60 degree angular deflection and shall be calculated in inch-pounds as follows:

Bending moment = [(load scale reading) x (moment weight)] x 100

Bending moment (N) = Bending moment (in-lb_f) x 0.113

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

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

8.70 Abrasion Resistance Test 2.

8.70.1 Application. This test method shall apply to the CBR barrier layer where configured as an exterior layer in protective footwear covers.

8.70.2 Sample Preparation.

8.70.2.1 Samples for conitioning shall be at least 50 cm (18 in.) squares of material.

8.70.2.2 Samples shall be conditioned a specified in 8.1.3.

8.70.3 Specimens.

8.70.3.1 Specimens shall be the size specified in ASTM D 3884.

8.70.3.2 A minimum of five specimens shall be tested.

8.70.4 Preparation.

8.70.4.1 Samples for conditioning shall be at least 50 cm (18 in.) squares of material.

8.70.4.2 Samples shall be conditioned as specified in 8.1.3.

8.70.5 Procedure.

8.70.5.1 Specimens shall be tested in accordance with ASTM D 3884, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)*, with the following modifications:

(1) The H-18 Calibrase wheels shall be used with a 1000 gram load.

(2) The abrasion shall be continued until a hole, wear-through or rupture in the film portion of the material is observed.

8.70.6 Report. The number of cycles required for the formation of a hole, wear-through or rupture in the film portion of the material shall be recorded and reported.

8.70.7 Interpretation. The number of cycles required for the formation of a hole, wear-through or rupture in the film portion of the material shall be used to determine pass or fail performance.

8.71 (1976: 6.39) Overall Liquid Integrity Test 2.

8.71.1 Application. This test shall apply to protective footwear.

8.71.2 Samples.

8.71.2.1 Samples for conditioning shall be whole footwear.

8.71.2.2 Samples shall be conditioned as specified in 8.1.3.

8.71.3 Specimens. A minimum of three footwear elements shall be tested.

8.71.4 Procedure.

8.71.4.1 Protective footwear shall be tested in accordance with Appendix B of Footwear Industries of America Standard 1209, *Whole Shoe Flex.*

8.71.4.2 The level of the water shall be no less than 25 mm (1 in.) from the lowest point of the throat.

8.71.4.3 The test shall consist of 100,000 flexes.

8.71.4.4 After flexing, the footwear specimen shall be placed in a container that allows its immersion in tap water to a height not less than 25 mm (1 in.) from the lowest point of the throat.

8.71.4.5 The tap water shall be treated with a dye and surfactant that achieves a surface tension of 34 dynes/cm, ±5 dynes/cm.

8.71.4.6 The paper toweling required in FIA 1209, *Whole Shoe Flex*, shall be placed inside the footwear specimen such that the paper toweling intimately contacts all areas inside the footwear specimen to a height not less than 25 mm (1 in.) from the lowest point of the thorat.

8.71.5 Report. The appearance of any water mark on the toweling after testing any of the three footwear shall be recorded and reported.

8.71.6 Interpretation. The appearance of any water mark on the toweling after testing any footwear element shall be considered leakage and shall constitute failing performance.

Annex A Explanatory Material

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

A.1.1 Organizations responsible for specialized functions including, but not limited to, wildland fire fighting, proximity and other specialized fire fighting, emergency medical service, special operations, and hazardous materials response should use appropriate protective clothing and protective equipment specifically designed for those activities.

A.1.1.5 Fire and emergency response organizations are cautioned that accessories are not a part of the certified product, but could be attached to the certified product by a means not engineered, manufactured, or authorized by the manufacturer.

Fire and emergency response organizations are cautioned that if the accessory or its means of attachment causes the structural integrity of the certified product to be compromised, the certified product might not comply with the standard for which it was designed, manufactured, and marketed. Additionally, if the accessory or its attachment means are not designed and manufactured from materials suitable for the hazardous environments of emergency incidents, the failure of the accessory or its attachment means could cause injury to the emergency responder.

Because the aftermarket for certified product accessories is so broad, fire and emergency response organizations are advised to contact both the manufacturer of the accessory and the manufacturer of the certified product and verify that the accessory and its means of attachment are suitable for use in the intended emergency response environment. Fire and emergency response organizations should seek and receive written documentation from both the accessory manufacturer and the manufacturer of the certified product to validate the following information:

1) The accessory for a certified product, and its attachment method, will not degrade the designed protection or performance of the certified product below the requirements of the product standard to which it was designed, manufactured, tested and certified.

2) The accessory, when properly attached to the certified product, shall not interfere with the operation or function of the certified product, or with the operation or function of any of the certified product's component parts.

Users are also cautioned that the means of attachment of the accessory that fail to safely and securely attach the accessory to the certified product can cause the accessory to be inadvertently dislodged from the certified product and create a risk to the wearer, or other personnel in the vicinity.

A.1.2 This standard is not designed to be utilized as a purchase specification. It is prepared, as far as practicable, with regard to required performance, avoiding restriction of design wherever possible. Purchasers should specify departmental requirements for items such as color, markings, closures, pockets, and trim patterns. Tests specified in this standard should not be deemed as defining or establishing performance levels for protection from all structural fire-fighting environments.

A.1.2.1 The testing requirements in Chapter 8 (6) of this standard are not intended to establish the limitations of the working environment for fire fighting but are intended to establish material performance. Users should be advised that when a continual increase of heat is felt through the protective ensemble, the protective ensemble could be nearing its maximum capability and injury could be imminent.

Users should be advised that if unusual conditions prevail, or if there are signs of abuse or mutilation of the protective ensemble or any element or component thereof, or if modifications or replacements are made or accessories are added without authorization of the protective ensemble element manufacturer, the margin of protection might be reduced.

Users should be advised that the protective properties in new structural fire-fighting protective ensemble elements, as required by this standard, can diminish as the product is worn and ages.

A.1.3.9 See A.1.1.5.

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

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

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

A.3.3.5 Bitragion Coronal Arc. See Figure A.3.3.5 (A-3.3.XX).

FIGURE A.3.3.5 (A-1-3.9) Bitragion coronal arc. [Existing Figure A-1-3.9, 2000 ed., (no change)]

A.3.3.6 Bitragion Inion Arc. See Figure A.3.3.6 (A-1-3.10).

FIGURE A.3.3.6 (A-1-3.10) Bitragion inion arc. [Existing Figure A-1-3.10, 2000 ed., (no change)]

A.3.3.38 Entry Fire Fighting. Examples of fires that commonly produce extreme levels of convective, conductive, and radiant heat and could result in incidents incorporating entry fire fighting operations include, but are not limited to, bulk flammable liquid fires, bulk flammable gas fires, bulk flammable metals, and aircraft fires. Highly specialized thermal protection is necessary for persons involved in such extraordinarily specialized operations due to the scope of these operations and because direct entry into flames is

made. Usually these operations are exterior operations, as in outside of structures. Entry fire fighting is *not* structural fire fighting.

A3.3.44 Footwear. See Figure A.3.3.44 (A-1-3.42).

FIGURE A.3.3.44 (A-1-3.42) Identification of footwear terms.
[Existing Figure A-1-3.42, 2000 ed., (no change)]

A.3.3.97 Proximity Fire Fighting. Examples of fires that commonly produce high levels of radiant heat, as well as convective and conductive heat, and could result in incidents incorporating proximity fire fighting operations include, but are not limited to, bulk flammable liquid fires, bulk flammable gas fires, bulk flammable metal fires, and aircraft fires. These operations usually are exterior operations but might be combined with interior operations. Proximity fire fighting is not structural fire fighting but might be combined with structural fire-fighting operations. Proximity fire fighting also is not entry fire fighting. The fire fighting activities differ from "entry fire fighting" as proximity fire fighting does not include direct entry of fire fighters into flames. Proximity operations are performed close to the actual fire where the high levels of radiant heat as well as the convective and conductive heat would overcome the thermal protection provided by structural fire fighting protective ensembles and the proximity fire fighting protective ensembles provide enhanced protection from these thermal exposures. After the fire and heat have been controlled at a proximity fire fighting incident, entry into structures or enclosures by fire fighters protected by proximity fire fighting protective ensembleds could be made where the incident requires additional operations for control of the incident.

A.3.3.124 Upper. See Figure A.3.3.44.

A.3.3.129 Structural Fire-Fighting Protective Ensemble. Structural fire-fighting protective ensembles include but are not limited to garments, helmets, hoods, gloves, and footwear.

A.4.1.4 The NFPA, from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment might be carrying labels falsely identifying them as compliant with an NFPA standard.

NFPA advises those purchasing protective ensembles or protective ensemble elements to be aware of the following:

For protective ensembles or protective ensemble elements to meet the requirements of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, they must be certified by an independent third-party certification organization. In addition, the item must carry the label, symbol, or other identifying mark of that certification organization.

A protective ensemble or element that does not bear the mark of an independent third-party certification organization is not compliant with NFPA 1971 even if the product label states that the protective ensemble or element is compliant.

For further information about certification and product labeling, Chapters 2 and 3 of NFPA 1971 should be referenced. Also, the definitions for *Certification*/*Certified* (1-3.15), *Labeled* (1-3.64), and *Listed* (1-3.67) in Section 3.3 (1-3) should be reviewed.

Third-party certification is an important means of ensuring the quality of fire and emergency services protective clothing and equipment. To be certain that an item is properly certified, labeled, and listed, the NFPA recommends that prospective purchasers require appropriate evidence of certification for the specific product and model from the manufacturer before purchasing. Prospective purchasers also should contact the certification organizations and request copies of the certification organization's list of certified products to the appropriate NFPA standard. This listing is a requirement of third-party certification by this standard and is a service performed by the certification organization.

All NFPA standards on fire and emergency services protective clothing and equipment require that the item be certified by an independent third-party certification organization and, as with NFPA 1971 protective ensembles or protective ensemble elements, all items of fire and emergency services protective clothing and equipment must carry the label, symbol, or other identifying mark of that certification organization.

Any item of protective clothing or protective equipment covered by an NFPA standard that does not bear the mark of an independent third-party certification organization is not compliant with the appropriate NFPA standard even if the product label states that the item is compliant.

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

A.4.2.5 The contractual provisions covering certification programs should contain clauses advising the manufacturer that, if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently listed products.

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

A.4.2.6 Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the agency before any major testing is undertaken.

A.4.2.7.1 For further information and guidance on recall programs, see 29 *CFR* 7, Subpart C.

A.4.2.9 Such factory inspections should include, in most instances, witnessing of production tests. With certain products, the certification organization inspectors should select samples from the production line and submit them to the main laboratory for countercheck testing. With other products, it might be desirable to purchase samples in the open market for test purposes.

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

A.5.1.3 See (A.4.1.4).

A.5.2.4 A statement should be included in the user information advising that, upon the purchaser's request, the manufacturer is to furnish all documentation required by this standard and the test data showing compliance with this standard. A statement also should be included in the user information advising that, upon the purchaser's request, the manufacturer is to furnish a complete specification of all materials and components comprising each certified hood.

A.5.2.4(f) Additional general information on care, cleaning, and use of protective clothing and equipment can be obtained from either SAFER, PPE Care and Use Guidelines, 8920 Limonite Ave., #169, Riverside, CA 92509, or F.I.E.R.O., PPE Care and Use Guidelines, 1029 Lansdowne Road, Charlotte, NC 28270.

A.6.1 A protective ensemble consisting of both a protective coat and protective trousers is required to be utilized for structural fire fighting by 5-2.1 and 5-2.6 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, for protection of the fire fighter's torso and limbs. An overlap of coat and trousers by measurement of the garments on the wearer also is required by 5-2.1.1 of NFPA 1500. Utilizing three-quarter-length boots instead of protective trousers leads to increased burn injury for the lower torso, since they significantly reduce leg, groin, and buttock protection. Wearing three-quarter-length boots instead of protective trousers is prohibited by 5-2.1 of NFPA 1500.

Purchasers of protective clothing should realize that fire fighters have to wear many items of protective clothing and equipment. Any interference by one item with the use of another might result in inefficient operations or unsafe situations. Chest girth, sleeve length, and coat length should be required for protective coats; waist girth, inseam length, and crotch rise should be required for protective trousers; and chest girth, sleeve length, waist girth, outseam length from the underarm to the pant cuff, and trunk length from the base of neck to the crotch fold should be required for protective coveralls. Since manufacturers' patterns vary, measurement for sizing should be done by the manufacturer's representative or by a trained person in accordance with the manufacturer's instructions to ensure proper fit.

A.6.1.2 Purchasers might wish to specify additional reinforcement or padding in high-wear or load-bearing areas, such as pockets, cuffs, knees, elbows, and shoulders. Padding could include additional thermal barrier material meeting requirements as specified herein. Reinforcing material could include the outer shell material or leather. Purchasers are cautioned that additional weight caused by excessive reinforcement or padding could lead to fatigue or result in injury.

A.6.1.3 The fastener system should be specified by the purchaser. Fastener system methods can include, but are not limited to the following:

(1) Entirely securing the thermal barrier and moisture barrier to a component part of the outer shell with snap fasteners or fastener tape

(2) Zipping the thermal barrier and moisture barrier to the outer shell

(3) Stitching the thermal barrier and moisture barrier into the coat in the neck and into the trouser in the waist area with snap fasteners or hook and pile fasteners securing the remainder

(4) Entirely stitching the thermal barrier and moisture barrier to the outer shell

It is strongly recommended that the thermal barrier and moisture barrier be detachable to facilitate cleaning the garments.

A.6.1.7 Purchasers should consider specifying requirements for hook and pile fastener service life, for dry and wet operation, and for thermal stability including shrinkage, melt, char, and drip requirements where tested in accordance with Section 8.6 (6-6).

A.6.1.11 Purchasers should specify pockets large enough to hold the items normally carried. Placement should allow for access to the pockets while wearing SCBA. Specifying ballooned pockets can increase capacity but could interfere with maneuverability. Ballooning only the back edges could minimize the maneuverability problem. Divided pockets as well as pockets for specific items such as SCBA facepieces and radios could be desirable.

A.6.1.12 Users of protective clothing should be aware that reflective trims have varying durability under field use conditions. Trim can be damaged by heat, but still appear to be in good condition when it might have lost retroreflective properties. Trim can become soiled and lose fluorescing and retroreflective qualities. Trim can lose retroreflective qualities in rain or in fire-fighting water exposures.

Trim should be checked periodically by using a flashlight to determine retroreflective performance. The trim should be bright. Samples of new trim can be obtained from the manufacturer for comparison, if necessary.

A.6.1.14.2 Purchasers should consider specifying wristlets with a thumb hole or bartack creating a thumb hole for the wearer's thumb in order to ensure protection when arms are in the raised position.

A.6.1.14.5 Use of vertical trim on the front of a protective coat has been shown to be capable of detrimentally affecting the performance of SCBA in high heat exposure conditions, such as flashover heat/flame conditions.

A basic minimum trim pattern has been established to eliminate CIL requirements and the requirements for minimum square inches for trim. It was decided to use minimum 325-in.^{2} fluorescence on a size 40 coat and for all other coats to have trim established proportionately using a trim pattern instead of actual square-inch requirements.

It is recommended that the circumferential bands on the coat not be aligned. An irregular pattern of bands improves the conspicuousness of the user.

A.6.1.14.6 Coat length is not addressed in this document as it must be determined by the individual donning both coat and trouser and proceeding through the directions contained in NFPA 1500 to ensure adequate overlap between the coat and trouser. Overlap is a significant safety issue and can be best addressed by careful overlap evaluation and ensuring only those coat/trouser combinations are worn that are recommended by the manufacturer of those ensemble items.

A.6.1.15.1 A protective ensemble consisting of both a protective coat and protective trousers is required to be utilized for structural fire fighting by 5-2.1 and 5-2.6 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, for protection of the fire fighter's torso and limbs. An overlap of coat and trousers by measurement of the garments on the wearer also is required by 5-2.1.1 of NFPA 1500. Utilizing three-quarter-length boots instead of protective trousers leads to increased burn injury to the lower torso, since they significantly reduce leg, groin, and buttock protection. Wearing of three-quarter-length boots instead of protective trousers is prohibited by 5-2.1 of NFPA 1500.

A.6.1.15.3 It is recommended that the trim on trousers be positioned at least 75 mm (3 in.) above the leg hem.

A.6.3.5.3 The values contained in the five tables are bare-hand dimensions, not glove pattern dimensions. Guidelines for applying these dimensions to flat glove patterns vary, depending on such factors as the type of pattern being used, the number of layers in the glove, and the type of fit desired for the glove.

The values contained in the five tables are those that apply to the five-size system intended to fit a population defined as the 5th percentile (female) through the 95th percentile (male) in the U.S. Army. These values are not valid if other than a five-size system is being used or if the demographics of the intended population vary.

Caution should be used in determining the specific value to be used in glove patterning from the given range of values for a particular dimension and glove size. The choice of the lowest, middle, or highest value is related to expectations of how the glove will fit.

A.6.1.15 Fire fighters can encounter many common liquids during the normal performance of their duties, such as doing structural fire-fighting operations. The performance requirements of 7.1.14 (5-1.14) should not be interpreted to mean that the protective garments are suitable or are permitted to be used for protection to the wearer during any hazardous materials operation. It is the intent of this standard to provide protection from intrusion throughout the protective garment body by certain liquids, including some common chemicals.

A.6.5.2.1 Many helmet designs expose the faceshield/goggle component(s) to abrasion, heat, flame, and particulate contamination. Purchasers might wish to specify a means of protecting the component(s). This could include, but not be limited to, faceshield/goggle components that retract inside the helmet, coverings for the component(s), and component(s) that are inherently resistant to the fire fighting environment.

The health risks associated with contaminated goggles coming in direct contact with the wearer's face should be considered. Goggles do not have to be attached to the helmet.

A.6.6.3 Many helmet designs expose the faceshield component to abrasion, heat, flame, and particulate contamination. Purchasers might wish to specify a means of protecting the faceshied. This could include, but not be limited to, faceshields that retract inside the helmet, and coverings for the faceshield that are inherently resistant to the fire fighting environment.

A.7.3.9 Fire fighters can encounter biohazards during he normal performance of their duties, including rescue of victims from fires, extrication of victims from vehicles or other entrapment situations, provision of first responder or emergency medical care, or other rescue situations. It is the intent of this standard to provide protection from intrusion throughout the glove body by certain liquids, including some common chemicals and from blood-borne pathogens.

A.7.3.10 Fire fighters can encounter many common liquids during the normal performance of their duties, such as during structural fire-fighting operations. The performance requirement of 7.3.10 (5-3.10) should not be interpreted to mean that gloves for structural fire fighting are suitable or are permitted to be used for protection to the wearer during any hazardous materials operations. It is the intent of this standard to provide protection from intrusion throughout the glove body by certain common liquids and from blood-borne or other liquid-borne pathogens.

Water is also included as a liquid. The inclusion of water in the liquid penetration requirement satisfies essential safety criteria for structural fire-fighter gloves. The glove requirements are largely based on the work of G. C. Coletta, I. J. Arons, L. Ashley, and A. Drennan in NIOSH 77-134-A, *The Development of Criteria for Firefighters' Gloves,* and Arthur D. Little in NIOSH 77-134-B, *Glove Requirements.* This NIOSH report is the landmark study in this field and the merits of its testimony should not be underestimated. It subsequently has been validated by the work of NASA, Project FIRES, the International Association of Fire Fighters, and reports by the fire service. The study identified a set of qualitative and quantitative criteria for fire-fighter gloves. Those criteria form the basis from which recommendations were made for both new glove standards and a prototype glove system that met those standards. The NIOSH survey of hand and wrist injury statistics and fire fighter's task-oriented needs provided the most in-depth identification of structural fire fighter glove requirements to date. That study identified the following critical performance needs:

(1) Resistance to cut

(2) Resistance to puncture

(3) Resistance to heat penetration (radiant and conductive)
(4) Resistance to wet heat penetration (scald-type injury)
(5) Resistance to cold
  a. Dry
  b. Wet
(6) Resistance to electricity
(7) Dexterity
(8) Resistance to liquids
  a. Penetration
  b. Retention
  c. Material degradation
(9) Comfort
  a. Cold and heat
  b. Absorbency
  c. Weight
  d. Stiffness
  e. Fit
(10) Resistance to flame
(11) Durability
(12) Drying
(13) Visibility

Thus, NIOSH developed a comprehensive list of all the design and performance parameters required by fire service gloves. This list addressed documented hazards encountered by structural fire fighters and it served as the foundation for the development of the first and all subsequent editions of the former glove standard, NFPA 1973, *Standard on Gloves for Structural Fire Fighting*, as well as this standard. The following outlines how closely the NIOSH committee has followed the NIOSH guide for design criteria, performance criteria, and test methods for fire-fighter gloves.

Critical Performance Needs as Addressed in NFPA 1971**:**

(1) Resistance to cut: 5-3.11
(2) Resistance to puncture: 5-3.13
(3) Resistance to heat penetration: 5-3.5, conductive heat resistance; and 5-3.1, thermal protective performance
(4) Resistance to wet heat penetration: 5-3.5, conductive heat resistance; 5-3.1, thermal protective performance; and 5-3.10, liquid penetration resistance (as recommended by the NIOSH study)
(5) Resistance to cold: 5-3.10, liquid penetration resistance (as recommended by the NIOSH study)
(6) Resistance to electricity: These criteria were not addressed, as the committee decided that it could convey that the glove was suitable for live electrical use
(7) Dexterity: 5-3.14
(8) Resistance to liquids: 5-3.10 (as recommended by the NIOSH study)
(9) Comfort: 5-3.14, dexterity; and 4-3.5, sizing
(10) Resistance to flame: 5-3.6
(11) Durability: No performance requirements, but durability is addressed in Section 3-2 as part of manufacturer's instructions.
(12) Drying: No performance requirements, but drying is addressed in Section 3-2 as part of manufacturer's instructions.
(13) Visibility: No requirements, but visibility is addressed in other protective clothing standards.

This NIOSH comprehensive listing of all the design and performance parameters required by fire service gloves shows that the water portion of the liquid penetration resistance performance requirement is an integral component for satisfying the following three protective criteria:

(1) Wet heat resistance
(2) Liquid resistance
(3) Cold resistance

The NIOSH study relied on the water penetration requirement to ensure a minimum level of protection in otherwise untested areas and the committee agrees with the NIOSH study. In defense of this requirement, the NIOSH committee has provided the following expanded justifications for each of these three criteria.

Wet Heat Resistance. The wet heat resistance concept encompasses at least the following five types of combined thermal/wet exposures:

(1) Radiant energy on a wet glove
(2) Conductive heat transfer to a wet glove
(3) Wetting of an already heated glove
(4) Steam jet exposure, such as from a broken steam line
(5) Saturated water–vapor atmosphere, such as from scalding water/steam from the hose nozzle during fire-fighting operations

The NIOSH committee addressed the first two types of exposure in 5-3.1 and 5-3.5 (TPP and conductive heat testing) with wet gloves. The last three types of exposures are addressed in 5-3.10 (the water portion of the liquid penetration resistance requirement).

No tests other than those for water penetration have been included in the standard to simulate the last three kinds of exposures. This is because the NFPA committee has relied on the documentation of NIOSH and D. L. Simms and P. L. Hinkley, Part 10, *The Effect of Water on Clothing, Suitable for Clothing Aircraft Fire Crash Rescue Workers* (an early study on the interactive effect of heat and water on thermal transfer in protective clothing) to show that the water penetration requirement satisfies those needs.

The NIOSH study states the following: "Fire fighters' gloves should protect against scald-type injury by meeting the criteria for both resistance to heat penetration and to liquid penetration."

The Simms study states the following: "A sudden rise in temperature sufficient to produce a scald did not occur at all if a moistureproof layer was included in the clothing."

The Simms study concludes that, in the absence of continuous wetting throughout the exposure period, the assemblies with moisture barriers provided more protection and were "recommended." In assemblies without moisture barriers, the wetting of the hot/dry materials caused a sudden rise of temperature and severe scalds, and these assemblies should be "avoided."

The committee believes that the liquid penetration resistance test for water is the best available technique for evaluating a glove's ability to resist these three wet heat assaults until more sophisticated techniques are developed. To the committee's knowledge, no other appropriate procedures for testing these criteria are currently available. The previous literature citations document the liquid penetration resistance test for water as being appropriate and field experience confirms it to be adequate for protection of the fire fighter.

Liquid Resistance. As noted by NIOSH, the liquid resistance concept encompasses three kinds of hazards: liquid penetration, liquid retention, and material degradation. Gloves not meeting the liquid penetration resistance requirement for water produce burn injuries quickly when assaulted by hot or boiling water. The liquid penetration resistance test for water directly evaluates whether water can penetrate through the glove materials. Furthermore, according to NIOSH, if liquid penetration resistance is not required, a fire fighter more readily encounters a wet glove/wet hand situation. This combination reduces working efficiency by degrading a fire fighter's manipulative and gripping abilities. These requirements have been addressed in 5-3.14 and 5-3.17 (dexterity and grip). However, the dexterity and grip testing that is specified necessitates the use of a testing subject and is done only at room temperature and not in conditions of extreme heat or cold. Including a liquid penetration resistance requirement for the glove limits the negative impact that these conditions can have on dexterity and grip.

Liquid retention (i.e., a glove's tendency to soak up liquids) can be hazardous, since it influences both comfort and function. The committee relied on both 5-3.10 (liquid penetration resistance) and 5-3.14 (dexterity) to satisfy this criterion.

Cold Resistance. In addressing the resistance to cold, the NIOSH study states the following: "Fire fighter's gloves used in winter conditions should be constructed with enough insulation to keep the skin above 18°C (65°F) during nonsedentary exposures to ambient temperature of -34°C (-30°F). Gloves should meet the criteria for resistance to liquid penetration as an integral part of these criteria."

Because fire-fighting gloves have to be insulative to high heat exposures, they normally are effectively insulative to cold exposures as well. As a result, no separate cold insulation requirements are included in the standard. Gloves also have to be similarly insulative

under cold/wet exposures. In lieu of an insulative test, the cold/wet condition has been addressed by 5-3.10 (liquid penetration resistance). All the data and experience available to the committee shows that drier insulation is more insulative than wetter insulation under cold exposures.

The committee believes that resistance to cold is a safety issue since, if it is not adequately provided for in the glove, it can lead to cold burn (frostbite) injuries. A lack of resistance to cold also can degrade grip and manipulative performance. Almost every area of the country can experience freezing conditions, although in some southern locales it is not a frequent event. Fire fighters, however, can experience cold exposures from sources other than weather, such as cold storage occupancies. The committee believes it is not necessary to differentiate performance for different areas of the country for any personal protective equipment.

A number of technical papers have been published over the past 50 years that established the following facts:

(1) The insulative value of clothing can be quantitatively measured in clo units.

(2) Moisture in clothing insulation reduces the clo value of protective clothing.

(3) Compression of clothing reduces the clo value of clothing.

(4) Manual dexterity is reduced as the ambient temperature decreases from 18°C to -29°C (65°F to -20°F).

(5) Moisture in clothing accelerates the loss of heat from the hand.

(6) Manual dexterity begins to degrade as hand skin temperature decreases below 18°C (65°F).

Points (1) through (6) show the deleterious effect of water in gloves on manual dexterity and protection, especially in cold exposures.

In summary, the liquid penetration resistance requirement and test for water is the most appropriate test available to measure water penetration resistance in a glove. It is the only currently available method for providing resistance to several kinds of wet heat exposures. Furthermore, it also addresses the necessity for a glove to resist cold/wet exposures, to be dexterous during cold/wet exposures, and to be resistant to excessive absorption of and deterioration by water. Without the liquid penetration resistance requirement for water, a fire fighter would have no protection from hot/cold water, which can produce scald and frostbite injuries, respectively. Without the liquid penetration resistance requirement for water, the standard would fail to address the resistance to wetting of an already heated glove, steam jets, saturated water–vapor atmospheres, and insulation against cold/wet exposures.

A.7.3.14 The glove hand function test referenced in the body of the standard can be supplemented by the following:

(1) Exploration of dexterity tests for all sizes or, since it is typically a greater challenge, exploration of dexterity testing on the extra-small sizes

(2) Exploration of glove interface with other fire-fighting vocational tools used by the purchaser

(3) Wear-testing the gloves being considered with particular attention to use on toggles, switches, and knobs

A.7.3.18 It is the intent of this standard to provide protection from intrusion throughout the glove body by certain common liquids and from blood-borne pathogens. The performance and testing requirements for glove composite materials for liquid penetration are found in 5-3.10 and Section 6-28, respectively, and the performance and testing requirements for glove composite materials for biopenetration are found in 5-3.9 and Section 6-29, respectively. The whole glove performance and testing requirements of 5-3.18 and Section 6-33 use water as a convenient and repeatable medium for evaluating whole glove integrity, since the provisions of Sections 6-28 and 6-29 only allow for testing of glove composites and not the entire glove. A precedent exists in NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*, where water is used to test the integrity of the entire protective suit.

A.7.3.19 The glove donning performance requirement is intended to evaluate the overall design of the glove for repeated use. Many factors can affect the performance, including proper sizing, glove interior design, wrist opening configuration, lining material selection, liner pullout, and integrity of the assembly. The time limits of this test are not necessarily indicative of field use. In particular, purchasers might wish to comparatively test wet (as well as dry) don/doff characteristics before making a final purchase decision.

A.7.10.12 Footwear sole slip resistance measured in wet conditions is conducted with water and is not to be construed as providing the same degree of protection from other wet substances.

A.7.10.14 Fire department personnel should be warned that the electrical hazard-resistant protective properties in new, unworn structural fire fighter boots as required by this standard will diminish or be eliminated as the boot and the soles/heels wear or if they are punctured or cut.

A.8.1.6.8 A radiant heat test for helmets is specified. Under controlled conditions, a radiant heat load of 1 W/cm^2 is applied until a temperature of 260°C (500°F) is reached on a transducer. This temperature alone does not simulate actual field conditions but is a test devised to put extreme heat loads on helmets in an accurate and reproducible manner by testing laboratories. However, the radiant heat load of 1 W/cm^2 was selected as an average value based on studies of fire conditions that relate to field use.

A.8.10 The TPP test method described in Section 6-10 is intended for the measurement of structural fire fighter protective clothing including garment composites, hoods, and gloves. The test method is not recommended for station/work uniforms and wildland fire-fighting protective clothing.

A.8.10.1.1 The specimen mounting configuration in this test that positions the specimen in contact with the sensor is not recommended for station/work uniforms, wildland fire-fighting protective clothing, or industrial protective clothing.

A.8.10.5.2.4 The convergence of the Meker burners can be checked using a colored piece of flame-resistant material and operating the burners for a couple of seconds. The pattern of discoloration on the material should appear to be uniform and in the center of the specimen. Any noncircular or nonuniform discoloration should be cause for adjustment of the Meker burners to achieve convergence.

A.8.10.5.3.7.1 Copper Calorimeter Calibration Procedures. Calibration of the copper calorimeter is based on the following equation:

$$I = 41.84\left(\frac{MC}{KA\varepsilon}\right)\left(\frac{dT}{dt}\right)$$

where:

I =incident heat flux (kW/m^2)

41.84 =conversion factor to kW/m^2 from cal/cm^2/sec

dT/dt =rate of temperature rise for the calorimeter indicated by mV/°C

$MC/KA\varepsilon$ =calorimeter's physical constant, which includes the variables A, ε, and M

M is the finished mass (g) of the calorimeter, which includes the copper disk and flat black paint mass on the sensing surface minus the thermocouple mass.

C is the heat capacity of pure copper, which is 0.0927 cal/g °C.

K is the thermocouple conversion constant (0.053 mv/°C) for the type J, iron–constantan thermocouple at an average test temperature of 65°C.

A is the surface area (1250 mm^2) for the calorimeter's front surface, which is exposed to the test heat flux. e is the emissivity or absorptivity of the black paint used on the calorimeter's front surface, usually a value not less than 0.95.

The physical constant used in calibration calculations with these sensors is sensitive to changes in mass and/or emissivity values.

For the copper disk calorimeter used in the TPP test, the punched out and drilled copper slug mass must be between 17.5 g and 18.0 g to meet the temperature rise over 10-second rate requirement.

The calorimeter's physical constant can be calculated based on the above discussion. Check the repaired calorimeter's performance by substituting it with the calibration calorimeter. After proving equivalence, the test calorimeter can be placed back into service.

Copper Calorimeter Repair Procedures. The copper disk can be removed from its support board and checked to ensure that all thermocouple to disk connections are securely made. Any loose connections should be repaired. To repair loose connections, the thermocouple data transfer wire should be removed, while leaving

the short thermocouple wires extending from the sensor's back side. The sensing surface should be smoothed, cleaned, and repainted with a quality flat black paint of known emissivity with a value of no less than 0.95. It may take two or three light coats to completely and evenly cover the surface. After the paint has thoroughly dried, the finished calorimeter should be carefully weighed and its total mass recorded to an accuracy of 0.01 g. The total mass should include the copper disk mass with the short thermocouple wires attached and also includes the mass of flat black paint applied to the calorimeter's surface. The calorimeter's finished mass should be determined by subtracting the sensor's thermocouple wire mass from the sensor's total mass. This is accomplished by measuring the sensor's thermocouple wire lengths from their ends down to the calorimeter's back surface. Then the total wire mass should be calculated based on the number of wires and their lengths. This value should then be subtracted from the total mass of the calorimeter assembly to obtain the finished mass. After the finished mass is determined, the data transfer wires should be securely reconnected and the sensor repositioned in its support board.

A.8.15.4.9 Calibration Procedures. The following multiple-step procedure is recommended.

Procedure One: Medium and System Calibration. This calibration step should be carried out with an accelerometer, as specified in Section 6-16, mounted in the impactor. The accelerometer should be mounted with its sensitive axis within 5 degrees of vertical.

A calibrating medium should be mounted over the load cell as specified in Section 6-15. The centers of the load cell, medium, impactor, and accelerometer should be colinear within 3 mm ($^1/_8$ in.), T.I.R. The impactor should be dropped from a height that yields a peak force of 9000 N, ±500 N (2000 lbf, ±110 lbf). A means of verifying the impact velocity within 2 percent should be utilized. The measured peak force should equal (within 2.5 percent) the measured peak acceleration (in g's) times the weight of the impactor. This accuracy should be repeatable through at least five impacts.

Procedure Two: System Calibration Only. A calibrating medium that has been tested in accordance with Procedure One can be used without an accelerometer or guided mass. The force value obtained when testing in accordance with Procedure One should be recorded and provided with the calibrating medium. The calibrating medium should be mounted over the load cell. The centers of the load cell, medium, impactor, and accelerometer should be colinear within 3 mm ($^1/_8$ in.), T.I.R. The impactor should be dropped onto the medium and the peak force measured by the load cell should be recorded. The peak force should be within 2.5 percent of that recorded while testing in accordance with Procedure One. The calibrating medium should be retested in accordance with Procedure One at not more than 4-month intervals.

Procedure Three: Electronics Calibration. When in use, electronics calibration of the normally used instrumentation scales should be undertaken at least every 6 months. This calibration should be accomplished by following the procedures recommended by the manufacturer of the instrumentation.

A.8.16.4.9 Calibration Procedures. The following multiple-step calibration should be used.

Procedure One: Medium and System Calibration. This calibration step should be carried out using a guided-fall system with an accelerometer mounted in the drop assembly and a load cell mounted under the reference anvil. The load cell should be mounted in compliance with the requirements of 6-15.4.3 through 6-15.4.8. The drop assembly should be dropped onto the reference anvil from a height that yields a peak acceleration of 400 Gn, ±20 Gn and accelerations above 200 Gn of at least 1 millisecond duration. A means of verifying the impact velocity within 2 percent should be utilized. The measured peak performance should equal (within 2 percent) the measured peak acceleration (in g's) times the weight of the drop assembly. This accuracy should be repeatable through at least five impacts.

Procedure Two: Electronics Verification. When in use, electronics verification of the normally used instrumentation scales should be undertaken at least weekly. This verification should be accomplished by following the procedures recommended by the manufacturer of the instrumentation.

A.8.17.4.1.3 This prevents missile tumble, helps to protect the operator if the tube extends to within a short distance of the device being tested, and allows the exact space necessary for insertion of the missile at the top. Partial shielding of the headform might be advisable to protect the operator's feet.

A.8.17.5.1.1 The steel balls move at dangerous speeds, and other forms of safety devices, such as interlocks and palm switches, might be desirable in a particular setup.

A.8.33.4.1 An example of an inner glove fabric is a lightweight, tightly woven medium- or dark-colored, 100-percent polyester fabric without surface treatment.

A.8.34 Copies of an IAFF report can be obtained from the International Association of Fire Fighters Department of Health and Safety, 1750 New York Avenue, NW, Washington, DC 20006.

Copies of an NFPRF report can be obtained from the National Fire Protection Research Foundation, 1 Batterymarch Park, Quincy, MA 02269.

A.8.38.4.4.2 The test surface specified is identical to the calibration material specified in the cut resistance test found in Section 8.22 (6-22) that references ASTM F 1790, *Standard Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing.*

A.8.45.5 The Gardner pivotal sphere haze meter is described in ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.*

A.8.48.4(2) A heavy, flat metal plate with two upright threaded posts, large slotted metal bar, and heavy-duty metal bolts is a preferred means for mounting the mannequin in the spray chamber to prevent any effects of the mannequin mounting on the clothing specimen.

A.8.48.6 The authority having jurisdiction can request a diagnosis of the mechanism of failure.

A.8.62.5.2 A readily available white cardstock material of 1.29 mm (0.05 in) thickness is suitable for use as a backing material to keep the material flat and unaffected by the air currents created in the test apparatus.

Annex B Referenced Publications

B.1 Referenced Publications. The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

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

NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*, 2000 edition.

NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*, 1997 edition.

B.1.2 Other Publications.

B.1.2.1 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, 1988.

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

B.1.2.2 NIOSH Publications. National Institute for Occupational Health and Safety, 1600 Clifton Road, Atlanta, GA 30333.

NIOSH 77-134-A, *The Development of Criteria for Firefighters' Gloves*, vol. 1, 1976.

NIOSH 77-134-B, *Glove Requirements*, vol. 2, 1976.

B.1.2.3 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 29, *Code of Federal Regulations*, Part 7, Subpart C, 1 April 1997.

B.1.2.4 Simms, D. L. and P. L. Hinkley, Part 10, *The Effect of Water on Clothing, Suitable for Clothing Aircraft Fire Crash Rescue Workers*, F. R. Note 366, Fire Research Station, Boreham Wood, Herts, England, 1959.

B.2 Informational References. Reserved.