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COMMONWEALTH OF MASSACHUSETTS

NORFOLK, SS

SUPERIOR COURT DEPARTMENT
OF THE TRIAL COURT

INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS, Plaintiff. v. NATIONAL FIRE PROTECTION ASSOCIATION, INC., Defendant.	CIVIL ACTION NO. 2382CV00235

DEFENDANT NATIONAL FIRE PROTECTION ASSOCIATION, INC.'S MOTION TO DISMISS

Defendant National Fire Protection Association, Inc. ("NFPA") hereby moves, pursuant to Mass. R. Civ. P. 12(b)(6) and 12(b)(7), to dismiss the Complaint filed by Plaintiff International Association of Fire Fighters ("Plaintiff" or "IAFF"). Plaintiff alleges that the development and implementation of a non-binding standard, NFPA 1971, *Standard of Protective Ensemble for Structural Fire Fighting and Proximity to Fire Fighting*, Section No. 8.62 ("Standard 1971") has caused it harm. Specifically, Plaintiff alleges three causes of action against NFPA: (1) unlawful conspiratorial conduct; (2) negligence; and (3) violation of M.G.L. c. 93A § 11 ("93A"). Each claim in the three-count Complaint is improperly and insufficiently pled, including because Plaintiff, a union, has no cognizable theory of liability against NFPA, an independent, nonprofit standards organization that neither dictates the terms of nor enforces the standard.

Plaintiff's Complaint should be dismissed for failure to state a claim pursuant to Mass. R. Civ. P. 12(b)(6). Plaintiff's civil conspiracy claim must be dismissed because IAFF fails to allege either a specific agreement between the alleged "conspirators" or any specific wrongful means or

purpose with respect to NFPA's conduct. Plaintiff's negligence claim similarly fails as NFPA owes no duty to IAFF and, even if it did, the only alleged harm is purely financial and thus not recoverable under the economic loss doctrine. With respect to 93A, Plaintiff has not alleged or identified any commercial transaction between the parties which could possibly give rise to a 93A claim, nor has it alleged any actual coercive, intimidating, unfair, or deceptive conduct by NFPA.

Moreover, all of Plaintiff's claims are deficient as a result of the Complaint's failure to allege the required causation between NFPA and the alleged financial harm incurred by the union. Indeed, the Plaintiff claims it has been harmed through its own financial expenditures. That harm has been either self-inflicted or caused by others. The public record makes clear that IAFF voted in support of Standard 1971 and continued to support the standard for more than a decade, and during that time, received financial contributions directly from the manufacturers of the gear about which it now complains. As Plaintiff's Complaint concedes, IAFF's position on the standard did not change until it elected a new president in 2021, and under his leadership, reversed course on its support of Standard 1971, submitting a proposed amendment to the standard. Compl. ¶¶ 66-67. But even so, IAFF's own collective bargaining agreements with agencies, municipalities, and others through 2022 (after submission of the proposed amendment) have continued to require compliance with Standard 1971.

Plaintiff offers no specific conduct by NFPA that could causally link NFPA to the alleged harm because it cannot. NFPA is the neutral facilitator during the standards development process and plays no role in requiring the use of or otherwise enforcing the standards once they are developed by technical committees comprised of interested parties, including union representatives from IAFF.

The Complaint should also be dismissed for failure to join the alleged and identified co-conspirators pursuant to Mass. R. Civ. P. 12(b)(7). To the extent Plaintiff believes it has suffered harm as a result of the use by its members of certain bunker gear, its dispute is with the entities that actually require the gear to be used and worn (which, as noted above, includes IAFF through requirements in its collective bargaining agreements), and/or the actual manufacturers of that gear. IAFF dedicates nearly 24 paragraphs to describing and referencing the role of the manufacturers in causing the alleged harm, yet has failed to join them in this suit. Even if the Plaintiff could prove liability, complete relief cannot be awarded absent the various municipal, government, union, and manufacturers who interpret, implement, and require compliance with Standard 1971.

Plaintiff's Complaint relies on irrelevant background history and threadbare legal conclusions that do not raise a right to relief. The boilerplate assertions set forth under each cause of action cannot remedy the deficiencies in a Complaint that is otherwise devoid of specific allegations against NFPA that actually could give rise to liability. For these reasons, and those set forth in NFPA's accompanying Memorandum in Support of its Motion to Dismiss, NFPA respectfully requests that the Court grant its Motion and dismiss the Complaint with prejudice pursuant to Mass. R. Civ. P. 12(b)(6) and 12(b)(7).

REQUEST FOR HEARING

NFPA hereby requests a hearing on this Motion pursuant to Massachusetts Superior Court Rule 9A(c)(3).

Respectfully submitted,

National Fire Protection Association, Inc.

By its attorneys,

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Dated: July 14, 2023

CERTIFICATE OF SERVICE

I, Anthony Fuller, hereby certify that on July 14, 2023, I caused a true and accurate copy of the foregoing document to be served by email upon all counsel of record.

Anthony Fuller

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INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS, Plaintiff. v. NATIONAL FIRE PROTECTION ASSOCIATION, INC., Defendant.	CIVIL ACTION NO. 2382CV00235

MEMORANDUM OF LAW IN SUPPORT OF DEFENDANT'S MOTION TO DISMISS

Date: July 14, 2023

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I. INTRODUCTION

Plaintiff International Association of Fire Fighters ("Plaintiff," "IAFF," or the "Union") alleges that Defendant National Fire Protection Association, Inc. ("NFPA") has, through the development of a non-binding standards for firefighters' protective clothing known as "bunker gear," engaged in unlawful conspiratorial conduct, negligence, and unfair and deceptive practices that have caused "direct" losses to the Plaintiff. Each of Plaintiff's three claims is improperly and insufficiently pled, including because Plaintiff, a union, has no cognizable theory of liability against NFPA, an independent, nonprofit standards organization.

At the core of Plaintiff's Complaint is the assertion that the use of bunker gear compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* Section No. 8.62 ("Standard 1971") has caused harm to Plaintiff's members and to the Union itself. But NFPA does not manufacture or even require the use of any particular bunker gear. Indeed, it is the Plaintiff—not NFPA—who requires its members and contracting organizations to wear gear that complies with Standard 1971. As such, the Complaint necessarily fails to allege the type of direct relationship between the parties that could give rise to liability, and Plaintiff alleges no specific wrongful, coercive, intimidating, unfair, or deceptive conduct by NFPA to sustain its claims.

Union representatives voted for Standard 1971 and continued to support it until 2021 when the Union submitted a proposed amendment to eliminate certain portions of the standard. Compl. ¶¶ 66-67. Thus, the Union's own role in voting for, promoting, supporting, and implementing Standard 1971 between 2006 and June 2021 eviscerates its ability to now attribute any alleged harm to NFPA. Moreover, even if the Union could establish the requisite causation, under Massachusetts law, the purely economic harm claimed by the Union is not recoverable by the

Plaintiff in this case. All of these failures are fatal to Plaintiff's claims, and as such, Counts I-III of the Complaint should be dismissed for failure to state a claim pursuant to Mass. R. Civ. P. 12(b)(6). Alternatively, the Complaint should be dismissed because Plaintiff has failed to join indispensable parties, including the alleged and identified co-conspirators, as is required pursuant to Mass. R. Civ. P. 12(b)(7).

II. BACKGROUND[1]

NFPA is a self-funded nonprofit organization, established in 1896, devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards.[2] NFPA is widely known as a standards development organization; its 300 codes and standards help eliminate fire, electrical, and related hazards.[3] NFPA does not write the standards itself; rather, it convenes balanced Technical Committees of subject matter experts to develop and maintain the fire safety standards it publishes.

The standards developed by these committees and published by NFPA are "voluntary consensus standards," created through policies and procedures that are themselves documented and accredited for their consensus decision-making, openness, balance of interests requirements, and fairness by the American National Standards Institute ("ANSI").[4] The development and/or

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[1] The Court may take judicial notice of the facts set forth herein as they are publicly available on NFPA's website, which the Plaintiff cites in the Complaint. *See* Compl. ¶ 19 n.2; *see also Piper v. Talbots, Inc.*, 507 F. Supp. 3d 339, 343 (D. Mass. 2020) (taking judicial notice of websites in deciding a motion to dismiss when information was "publicly accessible" and "readily verified through an internet search," the plaintiffs did not contest the authenticity); *Charlie's Project LLC v. T2B LLC*, No. 1784CV03350-BLS2, 2018 WL 1413771, at *3 n.1 (Mass. Super. Ct. Mar. 8, 2018) (judicial notice taken of an American Arbitration Association rule on website in deciding motions to compel arbitration and to dismiss).

[2] *See NFPA Overview*, Nat'l Fire Prot. Ass'n, https://www.nfpa.org/overview (last visited July 14, 2023).

[3] *Id.*

[4] *See The value of Standards Dev. Orgs.*, Nat'l Fire Prot. Ass'n, https://www.nfpa.org/Codes-and-Standards/Standards-Development/The-value-of-Standards-Development-Organizations (last

revision of NFPA standards (they are updated every three to five years) includes four steps: (1) public input; (2) public comment; (3) NFPA Technical Meeting; and (4) Standards Council action.[5] Each Technical Committee is balanced in accordance with the committee members' interests in the standard as required by NFPA policy, which provides that, "no more than one third of the voting members shall represent any one interest," such as manufacturer, user, installer/maintainer, labor representative/employee, testing laboratory, consumer, enforcing authority, or insurer, among other types.[6] Per ANSI requirements, balance on the Technical Committee mitigates the risk that any one party or interest group is able to hijack the standards development process for its own business or financial gain.[7] An NFPA staff liaison assigned to each NFPA Technical Committee facilitates the Technical Committee meeting and the standards development process.[8] Each staff liaison is responsible for monitoring the activities of their assigned Technical Committees to ensure the process and procedures move forward in accordance with NFPA policy.[9]

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visited July 14, 2023); *see also Reguls. Governing the Dev. of NFPA Standards*, Nat' Fire Prot. Ass'n, https://www.nfpa.org/-/media/Files/Codes-and-standards/Regulations-directory-and-forms/RegsGovDevStds_2022.ashx (last visited July 14, 2023).

[5] *See How the NFPA standards dev. process works*, Nat'l Fire Prot. Ass'n, https://www.nfpa.org/Codes-and-Standards/Standards-Development/How-the-process-works (last visited July 14, 2023).

[6] *See* Regul. 3.2.5.1, *Reguls. Governing the Dev. of NFPA Standards* Nat' Fire Prot. Ass'n, https://www.nfpa.org/-/media/Files/Codes-and-standards/Regulations-directory-and-forms/RegsGovDevStds_2022.ashx (last visited July 14, 2023); *see also Classification of Comm. Members*, Nat'l Fire Prot. Ass'n, https://www.nfpa.org/Codes-and-Standards/Standards-Development/Technical-Committees/Classification-of-Committee-members (last visited July 14, 2023).

[7] *See ANSI Essential Requirements: Due process requirements for Am. Nat'l Standards*, Am. Nat'l Standards Inst., https://www.ansi.org/american-national-standards/ans-introduction/essential-requirements (last visited July 14, 2023).

[8] *See A primer on how NFPA standards are dev. and revised, and by whom*, Nat'l Fire Prot. Ass'n (Oct. 27, 2021), https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2021/10/27/A-primer-on-how-NFPA-standards-are-developed-and-revised-and-by-whom.

[9] *Id.*

NFPA staff are not permitted to propose changes to any standard and cannot serve as members on Technical Committees.[10]

A. Standard 1971

NFPA's Standard 1971 specifies the minimum design, performance, testing and certification requirements for structural and proximity firefighting bunker gear including coats, trousers, coveralls, helmets, gloves, footwear, and interface components.[11] The purpose of the standard is to establish minimum levels of protection from thermal, physical, environmental, and blood-borne pathogen hazards encountered during firefighting operations.[12] Standard 1971 ***does not dictate*** what materials or chemicals are used to create the bunker gear or how the manufacturer complies with the performance requirements of the standard.[13] Those decisions are left up to the manufacturer.[14] In fact, Standard 1971 explicitly states that it "shall not be construed as addressing all of the safety concerns associated with the use of compliant protective ensembles or ensemble elements. ***It shall be the responsibility of the persons and organizations that use compliant protective ensembles or ensemble elements to establish safety and health practices and determine the applicability of regulatory limitations prior to use.***"[15]

The ultraviolet ("UV") light degradation test that is the focus of Plaintiff's claims was added to Standard 1971 in 2007 after the Plaintiff and others, identified the degradation and failure

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[10] *Id.*

[11] *See* **Ex. A**, *1971 Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, Nat'l Fire Prot. Ass'n 1971-10 (2018).

[12] *Id.*

[13] *See NFPA releases Standards Council TIA decision on NFPA 1971*, Nat'l Fire Prot. Ass'n (Sept. 16, 2021), https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2021/09/16/NFPA-releases-Standards-Council-TIA-decision-on-NFPA-1971.

[14] *Id.*

[15] *See* **Ex. A** at 1971-10 (emphasis added).

of the moisture barrier component of firefighter bunker gear.[16] The Plaintiff, citing the critical function of the moisture barrier in providing primary protection from a range of hazards encountered during fire fighting operations, such as protection from common liquids, chemicals, bloodborne pathogens, scald-type injuries, steam jet exposure and cold injuries, stated in 2000 that it "continues to believe that this situation may pose a significant safety hazard to fire fighters."[17] Following research done by a third party to try to identify the cause of gear failure, the UV light degradation test was added to Standard 1971 in the 2007 edition following a 30-1 vote in the Technical Committee and 21-0 vote in the Technical Correlating Committee.[18] Members of the Union served on both these committees which voted in support of this requirement as a way to test for degradation and address the problem in the field.[19]

Plaintiff's support of the standard continued until June 21, 2021, when it submitted a Temporary Interim Amendment ("TIA") 1594, which called for eliminating Section No. 8.62's UV light degradation test. Compl. ¶ 67. On August 12, 2021, the Technical Committee and its Correlating Committee rejected the proposed amendment. *Id.* ¶ 69. Plaintiff appealed the denial of the Technical Committee's vote to reject the amendment on August 26, 2021, based in large part

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[16] *See* **Ex. B**, *Fire Fighters Protective Clothing: Moisture Barrier Alert and Recall*, Int'l Ass'n of Fire Fighters, https://www.iaff.org/safety-alerts/fire-fighters-protective-clothing-moisture-barrier-alert-and-recall/ (last visited July 14, 2023).

[17] *Id.*

[18] *See Latest action on firefighting PPE standard underscores the need to better understand and to participate in the standards process*, Nat'l Fire Prot. Ass'n (Nov. 5, 2021), https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2021/11/05/Latest-action-on-firefighting-PPE-standard-underscores-the-need-to-better-understand.

[19] *See Report of the Committee on Fire and Emergency Services Protective Clothing and Equipment*, Nat'l Fire Prot. Ass'n, https://www.nfpa.org/assets/files/AboutTheCodes/1971/1971-A2006-ROP.pdf (last visited July 14, 2023) (stating 30 Technical Committee members, including IAFF members, voted affirmatively).

on testimony of a fire service representative that it was unclear what impact to personal safety removal of the UV light degradation test would have on fire fighters. *Id.* ¶ 78.

Notwithstanding Plaintiff's recently altered position concerning Standard 1971, many of the IAFF's own collective bargaining agreements ("CBAs") with various municipalities across the United States continue to mandate compliance with Standard 1971, some of which were executed *after* the current IAFF leadership took office. *See* **Ex. C** (Town of Avon Memorandum of Agreement, dated April 29, 2022, requiring "[a]ll protective clothing shall be to the NFPA 1971 or latest standard when issued.") at 4.[20]

III. STANDARD OF REVIEW

To survive a motion to dismiss under Mass. R. Civ. P. 12(b)(6), the complaint's "[f]actual allegations must be enough to raise a right to relief above the speculative level[.]" *Iannacchino v. Ford Motor Co.*, 888 N.E.2d 879, 890 (Mass. 2008) (citation omitted). Allegations must contain "more than labels and conclusions" and must "plausibly suggest . . . an entitlement to relief." *Id.* (internal quotations omitted). "Threadbare recitals of a cause of action, supported by mere conclusory statements, do not suffice." *Commonwealth ex rel. Riedel v. Quest Diagnostics, Inc.*, No. SUCV2007-05416-E, 2012 Mass. Super. LEXIS 263, at *4 (Mass. Super. Ct. Aug. 24, 2012) (quoting *Ashcroft v. Iqbal*, 556 U.S. 662, 678 (2009)). In considering a Rule 12(b)(6) motion, the court will not accept "legal conclusions cast in the form of factual allegations." *Iannacchino*, 888 N.E.2d at 888.

Additionally, under Rule 12(b)(7) of the Massachusetts Rules of Civil Procedure, a motion to dismiss may be filed where the plaintiff has failed to join an indispensable party under Rule 19. *Brooks Pond Conservation Ass'n, Inc. v. Starr*, No. 10-P-1116, 2011 WL 2802994, at *2 (Mass.

[20] *See also infra* n.28.

App. Ct. July 19, 2011). A party is deemed indispensable under Rule 19(a) when either: (1) the party's absence would prevent complete relief from being afforded those already parties, or (2) the party "claims an interest relating to the subject of the action" such that disposition in his absence may "impair or impede his ability to protect that interest or . . . leave any of the persons already parties subject to . . . double, multiple, or otherwise inconsistent obligations." *Id.* "[W]hen the absentee is regarded as indispensable under Rule 19(b), dismissal will be necessary." *Hamilton v. Conservation Comm'n of Orleans*, 425 N.E.2d 358, 366-67 (Mass. App. Ct. 1981).

IV. ARGUMENT

A. Plaintiff's Civil Conspiracy Theory of Liability is Not Cognizable

Massachusetts law recognizes two distinct theories of liability under the umbrella term of civil conspiracy: (1) "concerted action" conspiracy; and (2) a "true conspiracy" based on coconspirators exerting "some peculiar power of coercion." *Greene v. Philip Morris USA Inc.*, No. SJC-13330, 2023 WL 3311415, at *3 (Mass. May 9, 2023) (citing *Gurney v. Tenney*, 84 N.E. 428, 430 (Mass. 1908) and *Fleming v. Dane*, 22 N.E.2d 609, 611 (Mass. 1939)). Here, Plaintiff specifically alleges a true conspiracy of "peculiar power of coercion." Compl. ¶¶ 88-98.[21]

To prevail on a true conspiracy claim, IAFF must allege that the co-conspirators, NFPA, Lion, and Gore, agreed to accomplish an unlawful purpose, or a lawful purpose by unlawful means,

[21] To the extent Plaintiff seeks to allege a concerted action theory of conspiratorial liability, it has failed to do so. First, this theory is akin to theory of common law joint liability in tort. *Greene*, 2023 WL 3311415, at *3. Yet Plaintiff alleges no underlying tort on which to base such liability. Second, the only tort alleged by the Plaintiff, negligence, cannot—by its very own definition—be a concerted action, which requires the requisite intent associated with a "common plan to commit a tortious act where the participants know of the plan and its purpose and take affirmative steps to encourage the achievement of the result." *Id.; see also Bartle v. Berry*, 983 N.E.2d 243, 253, *rev. denied*, 957 N.E.2d 241 (Table) (Mass. 2011) ("To prove [its] claims for civil conspiracy, [a] plaintiff[ ] must show an underlying tortious act in which two or more persons acted in concert and in furtherance of a common design or agreement.").

and then caused harm to IAFF via some "peculiar power of coercion" that would not have existed if they had been acting alone. *Greene*, 2023 WL 3311415, at *6 n.10. Yet none of these elements have been alleged beyond generalized, conclusory statements.

Historically used by private business against organized labor, *see Burnham v. Dowd*, 104 N.E. 841, 841 (Mass. 1914), the "peculiar power of coercion" conspiracy has long since fallen out of favor. Indeed, the SJC has repeatedly noted, including as recently as May 2023, that "instances of conspiracy which is in itself an independent tort are rare and should be added to with caution." *Greene*, 2023 WL 3311415, at *6 n.10 (noting the limited guiding authority for the application of the true conspiracy theory in the context of cigarette litigation and deciding not to reach the issue). Thus, a "true conspiracy" continues to be recognized by Massachusetts courts only in "rare" circumstances and not at all when not based on any evidence of an agreement to accomplish an unlawful purpose. *See Fleming*, 22 N.E.2d at 611.

Where a true conspiracy does exist, "[t]he most common illustration of such a 'conspiracy' is to be found in the combined action of groups of employers or employees, where through the power of combination[,] pressure is created and results [are] brought about different in kind from anything that could have been accomplished by separate individuals." *Id.* The SJC long ago noted that with respect to these actions, "there will be no tort if the means pursued resulting in the damage are not unlawful." *Neustadt v. Emps. Liab. Assur. Corp.*, 21 N.E.2d 538, 540-41 (Mass. 1939) (affirming dismissal of complaint, noting lack of allegations concerning unlawful purpose, threats or coercion, fiduciary relationship, or any other inference of malice attributed to defendants).

Here, Plaintiff's claim fails for all of the reasons noted by the SJC in *Neustadt*: the Complaint is devoid of any facts alleging actual unlawful conduct, malice, coercion, or even a breach of a fiduciary duty by NFPA. Instead, Plaintiff relies on general and conclusory allegations

that prior and subsequent to the adoption of Standard 1971, NFPA, Lion, and Gore "entered into a combination to accomplish an unlawful purpose and/or to accomplish a lawful purpose through unlawful means." Compl. ¶¶ 92-93. But, the Complaint does not detail any actual agreement among the "conspirators" or identify the alleged "unlawful purpose". Instead, it simply repeats—without any supporting facts—that NFPA acted "via combination" with Lion and Gore to adopt and preserve the UV light degradation test required by Standard 1971.[22] Compl. ¶¶ 91-97.

Moreover, despite repeatedly using the term "unlawful" to describe the purpose and means of the supposed conspiracy, Plaintiff fails to identify any unlawful actions or conduct. Compl. ¶¶ 92-97. Plaintiff states that the conspiracy was intended to allow Lion, Gore, and others to continue to profit from manufacture, use, and distribution of moisture barriers in bunker gear, Complaint ¶ 93, but there are no allegations as to NFPA's purpose and motive for engaging in such supposed conspiratorial agreement. The Complaint does not set forth any alleged benefit to NFPA for its supposed role in the conspiracy. Nor could it since NFPA has no role in, nor does it profit or benefit from, the manufacturing of bunker gear. Bunker gear manufacturers made such gear prior to the development and adoption of Standard 1971, and any decision to modify their gear after the development of the standard in order to prevent gear-failures, burns, or other injuries to fire fighters is entirely the decision of those manufacturers. Plaintiff does not and cannot allege that NFPA has any control over decisions made by manufacturers with respect to the bunker gear they make and which is worn by Plaintiff's members.

Unable to allege that NFPA benefited from the alleged conspiracy the only reference in the Complaint to anyone receiving anything of value from a co-conspirator is the Union's admission

[22] Notably, no individual associated with Gore was even on the Technical Committee and had no ability to vote.

that until January 2021, it had accepted "sponsorships" from the chemical industry, textile manufacturers, and personal protective equipment manufacturers.[23] Thus, under its own conspiracy theory, the Union would have necessarily been a participant in the alleged conspiracy, if there were one, from the development of the standard in 2007 through January 2021 when it opted to seek a change.

As detailed herein, NFPA's ANSI-certified standards require that the Technical Committees that develop and vote on the actual language of the standard be balanced, and not dominated by any single interest category. Although Plaintiff alleges influence by specific manufacturers in the standards-development and revision processes, it does not allege that NFPA ever violated Regulation 3.2.5.1 or otherwise allowed manufacturers—or any other single interest group—to dominate its Technical Committee such that that group represented more than one third of the voting members.

Finally, and perhaps most importantly, the Plaintiff has failed to allege any specific act of coercion by NFPA, the defining element of the claim. *See Copperbeech Partnership, Ltd. v. Seegel, LipShutz and Wilchins, P.C.*, No. 02044A, 2004 WL 1431052, at *3 (Mass. Super. Ct. May 5, 2004) (citation omitted) (The plaintiff must allege and prove that by "mere force of numbers acting in unison" the defendants exercised "some peculiar power of coercion of the plaintiff which any individual standing in a like relation to the plaintiff would not have had."). There is no allegation that NFPA ever required or enforced Standard 1971, nor is there any allegation that

[23] Indeed, publicly available records show that the Union accepted nearly $480,000 in donations from bunker gear manufacturers over the course of three years. *See* **Ex. D**, Andrew Wallender, *Firefighters Want Halt on Money From Makers of PFAS-Laden Gear*, Bloomberg (Jan. 19, 2021), https://news.bloomberglaw.com/pfas-project/firefighters-want-halt-on-money-from-makers-of-pfas-laden-gear ("The IAFF reported at least $476,161 in transactions with companies and individuals tied to the manufacturing of turnout gear or firefighting foam between 2016 to 2019, according to the union's financial disclosures.").

NFPA has ever had direct interaction with the Plaintiff that could be construed as "coercive" beyond simply publishing publicly available standards. In fact, the standard itself states "the NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of NFPA Standards. Nor does the NFPA list, certify, test, or inspect products, designs, or installations . . . . Any certification or other statement of compliance . . . shall not be attributable to the NFPA."[24] Absent allegations that NFPA ever enforced, required, or coerced the Union with respect to the standard, or otherwise acted with malice, or illegality, Plaintiff's conspiracy claim must be dismissed. *See Comerford v. Meier, et al.*, 19 N.E.2d 711, 714 (Mass. 1939) (finding that plaintiff failed to allege that the defendants (or non-parties) performed such listed activities maliciously, arbitrarily, unreasonably, or illegally).

B. Plaintiff Fails to State a Claim for Negligence

Plaintiff's negligence claim fails for at least two reasons: (1) NFPA owes no duty of care to the Union; and (2) the economic loss rule bars the claim. To establish a claim of negligence, the Plaintiff must allege that NFPA owed it a duty of reasonable care, that NFPA committed a breach of that duty, that damage resulted, and that there was a causal relation between the breach of duty and the damage. *Leavitt v. Brockton Hosp., Inc.*, 907 N.E.2d 213, 215 (Mass. 2009). Plaintiff has failed to sufficiently allege facts with respect to each of these elements.

1. NFPA Owes No Duty to the Plaintiff

As a general principle of tort law, "[t]here is no duty so to control the conduct of a third person as to prevent him from causing physical harm to another . . . ." *Lev v. Beverly Enters.-Mass., Inc.*, 929 N.E.2d 303, 311 (Mass. 2010) (quoting Restatement (Second) of Torts § 315 (1965)). Although "[court]s have recognized such a duty, albeit in narrowly prescribed

[24] *See* **Ex. A.**

circumstances, where a special relationship exists between the person posing the risk and the one who can prevent the harm." *Id.* This special relationship is based either on responsibilities imposed by statute or common law (or both). *Luoni v. Berude*, 729 N.E.2d 1108, 1111 (Mass. 2000). In deciding whether a special relationship exists between a particular plaintiff and defendant, the foremost consideration is whether "a defendant reasonably could foresee that he would be expected to take affirmative action to protect the plaintiff and could anticipate harm to the plaintiff from the failure to do so." *Adams v. Cong. Auto Ins. Agency, Inc.*, 65 N.E.3d 1229, 1235 (Mass. App. Ct. 2016), *rev. denied*, 86 N.E.3d 243 (Table) (Mass. 2017). However, this "special relationship" does not typically exist between organizations that develop standards and consumers of products manufactured by their members. *Meyers v. Donnatacci*, 531 A.2d 398, 402 (N.J. Super. Ct. Law Div. 1987).

In *Meyers*, a New Jersey court examined whether an organization developing standards owed a duty of care, or assumed a duty not otherwise owed, to a user of a swimming pool manufactured by members of the defendant organization. *Id.* at 399-400. In finding that the organization owed no duty to the general public who may use products manufactured by its members, the court noted that the "crucial element of foreseeability" was lacking. *Id.* at 402-03. The court recognized that a consensus-process was used to compile suggested standards for pool construction and design and that the organization had no power to enforce compliance with the standards, thus lacking the control necessary to establish liability. *Id.* The court also found that the organization had not undertaken the duty to warn consumers or its membership of the danger of shallow water diving or of certain pool liners. *Id.* at 405-06.

Courts in other jurisdictions have found in various contexts that organizations developing standards owe no duty for injuries caused by the product of a member manufacturer. *See DeLong*

v. Am. Home Furnishing All., 464 F. Supp. 3d 727, 731 (E.D. Pa. 2020) (Rule 12(b)(6) dismissal where organizations developing standards had no legal duty to furniture users because the organizations created no new risk, and "[a]t most . . . urged inadequate measures to reduce the risk already posed by household furniture"); *Beasock v. Dioguardi Enters., Inc.*, 494 N.Y.S.2d 974, 975 (1985) (tire and rim organization developing standards had no duty or authority to control tire manufacturers); *Howard v. Poseidon Pools, Inc.*, 506 N.Y.S.2d 523, 527 (1986) (organization developing pool standards had no duty or authority to control manufacturers), *aff'd*, 134 A.D.2d 926 (N.Y. App. Div. 4th Dep't 1987), *aff'd*, 530 N.E.2d 1280 (N.Y. 1988); *In re Johnson & Johnson Talcum Powder Prods. Mktg., Sales Pracs., and Prods. Liab. Litig.*, 553 F. Supp. 3d 211, 230 (D.N.J. 2021) (organization developing standards had no legal duty to ensure manufacturer products were safe for consumer use); *Sizemore v. Georgia-Pacific Corp.*, No. 94-2894, 1996 WL 498410, at *4-5, *8 (D.S.C. Mar. 8, 1996) (Hardwood Plywood & Veneer Association owed no duty of care to plaintiffs with respect to products manufactured by one of its members), *aff'g j.*, 114 F.3d 1177 (Table) (4th Cir. 1997); *Bailey v. Edward Hines Lumber Co.*, 719 N.E.2d 178, 180, 184 (Ill. App. Ct. 1999) (citation omitted) (organization developing standards, Truss Plate Institute, owed no duty of care to plaintiff end user where organization had no ability "to oversee or control access to the recommendations"), *denying appeal*, 724 N.E.2d 1266 (Table) (Ill. 2000).

The common denominator in the aforementioned cases is the inability of the standards organizations to control the use of or to enforce its safety standards. *See, e.g., In re Johnson & Johnson,* 553 F. Supp. 2d at 228. Here, Plaintiff does not allege (because it cannot) that NFPA has any enforcement powers. *First*, the Union is not a "member" of NFPA over which it has control. NFPA simply publishes standards developed by a consensus committee process. *Second*, as explained above, the standard explicitly states that "NFPA has no power, nor does it undertake, to

police or enforce compliance with the contents of NFPA Standards."[25] In addition, NFPA's website and the front matter of the standard itself goes even further, containing a public notice and disclaimer of liability concerning the use of NFPA standards, cited *infra*.[26] Furthermore, the disclaimer states: "[i]n issuing and making NFPA Standards available, the NFPA is not undertaking to render professional or other services . . . nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else.[27]

Without any elaboration, Plaintiff alleges that "by virtue of its role in the fire safety industry" and due to its "special relationship" with the Union, NFPA "owed a duty of care to promulgate and maintain standards which promote the health, safety, and welfare of firefighters." Compl. ¶ 113. Plaintiff does not provide any specifics detailing this conclusory "special relationship" between NFPA and the Union—nor can it, as there is no transactional relationship between these two entities and no control over the Union by NFPA. There is no formal contract or relationship alleged between the Union and NFPA, and NFPA does not require the Union to abide by or otherwise implement its standards. Quite the opposite, NFPA's website and the text of the standard itself specifically disavows the perception that any duty could or would be created by clearly stating that its standards are consensus-based, and NFPA **does not** independently test the information in the standards, make any guaranty or warranty as to their accuracy, accept liability for reliance on or use of them, or seek to enforce them.[28] Accordingly, Plaintiff has not alleged any facts on which this Court could find a duty of care owed by NFPA to the Union.

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[25] *See* **Ex. A**.
[26] *See* **Ex. E**, *Notice and disclaimer of liab. concerning the use of NFPA standards*, Nat'l Fire Prot. Ass'n, https://www.nfpa.org/Codes-and-Standards/Standards-Development/Disclaimers (last visited July 14, 2023).
[27] *Id.*
[28] *See* **Exs. A, E**.

2. Plaintiff Fails to Allege that NFPA Has Caused the Type of Harm Recoverable Under the Law

Plaintiff alleges that NFPA's development of Standard 1971 has harmed its members as well as the Union itself because it has been forced to redirect its time and resources. Compl. ¶¶ 119-121. Plaintiff only seeks to recover the Union's "costs and expenses" allegedly incurred in seeking to amend Standard 1971, alleging that it has had to redirect its time and "expend significant resources in order to make its members aware of the risks," "to develop recommended policies and procedures," and "to advocate for the repeal" of Standard 1971. Compl. ¶¶ 96, 119-121. Yet, such expenditures are purely discretionary by the Union and entirely self-imposed. Plaintiff fails to plead any facts detailing how NFPA caused such expenditures, particularly since NFPA neither obligates the Union, or anyone else, to comply with its standards and has no power to enforce them.

Although causation is generally left to a jury to decide, it may be determined as a question of law where there is no set of facts that could support a conclusion that plaintiff's injuries were within the scope of liability. *Leavitt*, 454 Mass. at 44. The law does not impose liability for all harm factually caused by tortious conduct; liability obtains only where the conduct is both a cause in fact of the injury and where the resulting injury is within the scope of the foreseeable risk arising from the negligent conduct. *Id.* at 45.

Publicly available documents show that IAFF's own CBAs actually require compliance with Standard 1971, **not** NFPA. A cursory online search reveals that Plaintiff's CBAs with various municipalities across the nation, some of which were executed after the current IAFF leadership took office, **mandate** compliance with Standard 1971, the very standard the Union claims in its

Complaint was foisted upon it.[29] *See* **Ex. C** (Town of Avon Memorandum of Agreement executed on April 29, 2022) at 4. As indicated below, other agencies, such as the Federal Emergency Management Agency ("FEMA"), also require implementation of Standard 1971 by any fire department that accepts FEMA funding. Because NFPA cannot "require" adherence to its standards, there is simply no causal link between any alleged harm caused by the implementation of Standard 1971 and NFPA.

Finally, as indicated above, Plaintiff asserts not only economic loss, but also unspecified property damage, presumably in order to circumvent the economic loss doctrine. As this Court knows, "the economic loss doctrine bars recovery [for negligence claims] unless the plaintiff[] can establish that the injuries [] suffered due to the defendant['s] negligence involved physical harm or property damage, and not solely economic loss." *Cumis Ins. Soc'y, Inc. v. BJ's Wholesale Club, Inc.*, 918 N.E.2d 36, 46 (Mas. 2009). The Union has not alleged any such property losses (nor can it). Any damages the Plaintiff has explicitly set forth in the Complaint are the discretionary spending expenses that the Union voluntarily chose to undertake. Furthermore, although Plaintiff seeks an injunction, as explained above, NFPA does not enforce the standards, and as such, there is no action that NFPA must be prohibited from doing. Accordingly, Plaintiff's negligence claim must be dismissed.

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[29] *See, e.g., Collective Bargaining Agreement between The City of Belleville and Belleville Firefighters Local No. 53, IAFF*, https://www.belleville.net/DocumentCenter/View/2273/Belleville-Fire-Contract-Final-2019-2024?bidId= (requiring adherence to NFPA Standard 1971) (Aug. 23, 2022); *Agreement between the County of Clark State of Nevada and Clark County Fire Fighters Local 1908*, https://emrb.nv.gov/uploadedFiles/emrbnvgov/content/Resources/FF/IAFF%201908%20Clark%20County.pdf (same); *Agreement between the City of Middletown, Connecticut and Local Union #1073 – International Association of Firefighters, AFL-CIO*, https://www.middletownct.gov/DocumentCenter/View/16289/Fire-Local-1073-IAFF-AFL-CIO---2019-2024-PDF (Aug. 2, 2019) (same).

C. Plaintiff Fails to Allege Bad Faith or Unfair Conduct in Violation of Chapter 93A

Plaintiff does not state a claim for violation of Chapter 93A because the Complaint has no allegations of unfair or deceptive conduct by NFPA, an essential element of any Chapter 93A claim. *See Equip. & Sys. for Indus. v. Northmeadows Constr. Co.*, 798 N.E.2d 571, 575 (Mass. App. Ct. 2003) (affirming dismissal of Chapter 93A claim where the "allegations, and the inferences that might be drawn from them, fall far short of anything that might qualify as an unfair or deceptive practice under that statute."). An appropriately pled Chapter 93A claim must demonstrate that NFPA's conduct was "immoral, unethical, oppressive or unscrupulous" or within "the penumbra of some common-law, statutory, or other established concept of unfairness." *Mass. Farm Bureau Fed'n, Inc. v. Blue Cross of Mass., Inc.*, N.E.2d 660, 664 (Mass. 1989). Plaintiff's pleading falls woefully short of that required showing.

Plaintiff's Chapter 93A claim asserts that NFPA, through conduct generally set forth in the Complaint, "engag[ed] in unfair methods of competition and/or unfair and deceptive acts and practices." Compl. ¶ 100. Yet, the only allegedly wrongful conduct charged against NFPA is the allegation that NFPA promulgated a standard with which the Plaintiff now disagrees, changing course after many years in which it did agree. This conduct in no way rises to "objectionable conduct [that] attain[s] a level of rascality that would raise an eyebrow of someone inured to the rough and tumble of the world of commerce." *Levings v. Forbes & Wallace, Inc.*, 396 N.E.2d 149, 153 (Mass. App. Ct. 1979).

Furthermore, the SJC has clearly stated that Chapter 93A, §11 requires the existence of a commercial transaction between two persons engaged in trade or commerce in connection with the alleged misbehavior. *Szalla v. Locke,* 657 N.E.2d 1267, 1269 (Mass. 1995); *see also Manning v. Zuckerman*, 444 N.E.2d 1262, 1263 (Mass. 1983) (Chapter 93A "was intended to refer to

individuals acting in a business context in their dealings with other business persons and not to every commercial transaction whatsoever"). Though the Complaint contains the boilerplate assertion that NFPA "has been engaged in trade and commerce within the Commonwealth of Massachusetts," Compl. ¶ 19, the Union does not allege any commercial relationship or transaction between it and NFPA. In sum, there are simply no facts alleged to support any allegation that there was a commercial transaction between Plaintiff and NFPA that could give rise to Chapter 93A, Section 11 liability and Plaintiff's claim should be dismissed.

V. Dismissal Pursuant to Rule 12(b)(7)

Presented with a motion to dismiss under Mass. R. Civ. P. 12(b)(7), a court must refer to the procedure set out in Mass. R. Civ. P. 19 ("Rule 19") to determine whether the claim must be dismissed. *Nw. Farm Credit Servs., FLCA v. Miller*, No. 14-CV-4487-F, 2014 WL 3728116, at *2 (Mass. Super. Ct. July 10, 2014) (citing *Hamilton*, 425 N.E.2d at 365-67). "The first inquiry under Rule 19 is whether a person, or entity, that is not a party should be joined in the action if possible." *Id.* When conducting this inquiry, a court must ask whether "complete relief" can be awarded despite the non-party's absence, and whether any relief granted may "as a practical matter impair or impede [the non-party's] ability to protect [its] interest" in the subject matter of the lawsuit. *Id.* (quoting Mass. R. Civ. P. 19(a)).

Here, the Plaintiff seeks relief in the form of damages and an injunction "[e]njoining NFPA from maintaining or enforcing NFPA 1971 (2018), Section No. 8.62." Compl. ¶ 25. As noted above, NFPA has no powers of enforcement. Thus, complete relief cannot be awarded absent joining in this lawsuit the various municipal, government, and in some cases, even unions who **do require** compliance with Standard 1971 as a condition of operation and/or funding. However, with respect to at least some of these legally-necessary entities, joining them to this lawsuit is a legal

impossibility. For example, FEMA requires that fire departments comply with NFPA standards as a condition of funding,[30] yet, as a federal agency, cannot be sued in state court. *See, e.g.*, *Dreamweaver Andalusians, LLC v. Prudential Ins. Co. of Am.*, 184 Cal. Rptr. 3d 735, 741-43 (2015) (affirming on appeal a motion to dismiss complaint because federal agency, who was a necessary and an indispensable party, could not be sued in a state court).

Under a Rule 19 analysis, Plaintiff has failed to join the parties necessary for the "complete relief" it seeks. This case is comparable to *Service Employees International Union, Local 509 v. Department of Mental Health*, where the plaintiff union similarly failed to name the appropriate entities in its complaint. 14 N.E.3d 216, 228-29 (Mass. 2014) (SJC determining that lower court had not erred in its Rule 19 analysis dismissing case because union failed to name vendors who had contracted with defendant and who were necessary parties to suit). In *Service Employees*, the unnamed vendors had an interest in the resolution of the union's claim and a right to contest those claims. *Id.* Here, the various entities requiring and/or enforcing compliance with Standard 1971 are necessary parties to this action. As in *Service Employees*, the Union's failure to name all of these necessary parties renders its Complaint legally insufficient, and it must be dismissed.

Similarly, Plaintiff has not joined the alleged co-conspirators, Lion and Gore, as Defendants despite identifying them by name in the Complaint and alleging that they, unlike NFPA, gained financially from the alleged conduct. By failing to join the co-conspirators who are necessary parties, Plaintiff has prejudiced NFPA and the alleged co-conspirators. *See Picciotto v.*

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[30] *See The Department of Homeland Security Notice of Funding Opportunity Fiscal Year 2022 Assistance to Firefighters Grant Program*, FEMA, https://www.fema.gov/sites/default/files/documents/fema_fy-22-afg-nofo.pdf (last visited July 14, 2023) ("AFG Program funds used to acquire PPE may only be used to acquire compliant PPE for firefighting and nonaffiliated EMS personnel. Only the acquisition of PPE compliant with the most current edition of NFPA 1971, 1977, 1981 and/or 1999 are eligible activities.").

Cont'l Cas. Co., No. 05-10901, 2006 WL 8445727, at *8 (D. Mass. Sept. 29, 2006) (granting 12(b)(7) motion for failure to join alleged co-conspirators), *aff'd*, 512 F.3d 9, 16-17 (1st Cir. 2008).

VI. Conclusion

For the reasons set forth above, the Court should dismiss IAFF's claims against NFPA with prejudice.

Respectfully submitted,

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Dated: July 14, 2023

CERTIFICATE OF SERVICE

I, Anthony Fuller, hereby certify that on July 14, 2023, I caused a true and accurate copy of the foregoing document to be served by email upon all counsel of record.

Anthony Fuller

Exhibit A

NFPA®

Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

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NFPA® 1971

Standard on

Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

2018 Edition

This edition of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, was prepared by the Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment and released by the Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on August 1, 2017, with an effective date of August 21, 2017, and supersedes all previous editions.

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

This edition of NFPA 1971 was approved as an American National Standard on August 21, 2017.

Origin and Development of NFPA 1971

The original work on this project was done by the Sectional Committee on Protective Equipment for Fire Fighters that was a part of the Committee on Fire Department Equipment. In 1973, the Sectional Committee released a tentative standard, NFPA 19A-T, *Tentative Standard on Protective Clothing for Fire Fighters*. The Sectional Committee continued its work, and with the cooperation of the Program for Fire Services Technology of the National Bureau of Standards, developed NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighting*. NFPA 1971 was adopted as a standard at the Fall Meeting in Pittsburgh, PA, on November 18, 1975.

Since that time, the Sectional Committee has been removed from the Committee on Fire Department Equipment and made a full Technical Committee.

The 1981 edition of NFPA 1971 represented a complete editorial reworking of the 1975 edition to make the document more usable by both the fire service and protective clothing manufacturers. The 1981 edition was acted on at the Annual Meeting in Dallas, TX, on May 19, 1981.

The 1986 edition incorporated a complete revision of the document to include more performance requirements and fewer specifications. Separate performance and testing chapters were written. The 1986 edition was acted on at the Annual Meeting in Atlanta, GA, on May 19–22, 1986.

Following the 1986 edition, the committee was renamed from the Technical Committee on Protective Equipment for Fire Fighters to the Technical Committee on Fire Service Protective Clothing and Equipment.

The 1991 edition incorporated third-party certification, labeling, and listing for the protective clothing. A new chapter was added to address interface items, specifically the protective hood and protective wristlets. Appendix material was developed on cleaning of garments and evaluating how materials can affect heat stress. The 1991 edition, the fourth edition, was presented to the NFPA membership at the Annual Meeting in Boston, MA, on May 19–23, 1991, and was issued with an effective date of August 16, 1991.

In October 1994, the NFPA Standards Council reorganized the Technical Committee on Fire Service Protective Clothing and Equipment as the Project on Fire and Emergency Services Protective Clothing and Equipment operating with seven technical committees and a technical correlating committee. NFPA 1971 was now the responsibility of the Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment.

The 1997 edition of NFPA 1971, the fifth edition, combined four former standards on structural fire fighting protective clothing: 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*, into a single document entitled NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*.

The 2000 edition was the sixth edition and represented a complete revision to the fifth (1997) edition. Among other changes, the edition introduced new requirements for evaporative heat transfer through garments through a total heat loss test, for evaluating thermal insulation in areas of garments that are most likely to become compressed through a conductive and compressive heat resistance test, for evaluating hand dexterity with gloves through a new hand function test, and for evaluating the durability of barrier materials through additional preconditioning prior to selected physical tests of the barrier materials.

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

The 2007 edition of NFPA 1971, the seventh edition, represented a complete revision. The requirements of two former standards, the 2000 (sixth) edition of NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*, and the 2000 (second) edition of NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, were combined into a single document entitled NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

Other than combining the two documents, the major changes represented in the 2007 edition were the optional requirements for protection from CBRN terrorism agents (specified chemicals, biological agents, and radiological particulate) that could be released as a result of a terrorism attack. These optional requirements could be selected by fire departments that were concerned about first response of their personnel to such WMD incidents where "normal" fire fighting protective ensembles offer little or no protection from CBRN terrorism agents, and where supplementary protective ensembles that are certified as compliant with NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*, for protection from CBRN terrorism agents are unlikely to be provided to the vast majority of fire fighting first responders.

The CBRN optional protection can be applied only to an entire ensemble, including the specified CBRN SCBA for that ensemble, and cannot be applied to individual ensemble elements. The design and performance of the entire ensemble including the CBRN SCBA provides the CBRN protection for the wearer and depends on the proper use of the entire ensemble to accomplish this protection. No combination of individual ensemble elements short of the entire assembled ensemble will give CBRN protection.

These optional CBRN requirements that apply to both structural fire fighting protective ensembles and proximity fire fighting protective ensembles were built into the construction of the "basic" fire fighting protective ensemble elements so that nothing had to be added to or subtracted from the basic fire fighting protective clothing in order to achieve the protection from CBRN terrorism agents. The optional CBRN requirements did not decrease any of the protection for the fire fighting environments in which these ensembles are used.

The 2007 edition was presented to the Association membership at the 2006 Association Annual Meeting in Orlando, Florida, on June 7, 2006, and issued by the Standards Council with an effective date of August 17, 2006.

The 2013 edition of NFPA 1971 represented a complete revision of the document, incorporating many technical and editorial changes. In addition to several new definitions and revised labeling requirements, changes were made to the performance requirements in Chapter 7, including those for garment zippers, fastener tape, and helmets. Performance requirements for the radiant reflective protective areas of proximity fire fighting protective glove elements also were added. A number of tests in Chapter 8 were revised, including glove test areas, the flame resistance test procedure, the glove hand function test procedure, and the slip resistance test. The chemical permeation test and the man-in-simulant test (MIST) also were completely revised. New tests were added to Chapter 8, including a torque test, transmitted and stored thermal energy test, fastener tape strength test, and a glove tool test.

For the 2018 edition of the standard, CBRN was removed from NFPA 1971 and put into NFPA 1994, including definitions, design and performance requirements, and test methods related to CBRN. There is a new definition for *protective barrier hood*, the optional interface element of the protective ensemble that provides limited thermal, physical, and barrier protection to the coat/helmet/SCBA facepiece interface area. Both the Particulate Filtration Efficiency Test and Total Heat Loss Test are required for the new optional interface element. Current design requirements for hoods are left in as well (hood size opening, what it must cover, etc.). A new glove sizing system is an evenly graded system that readily lends itself to the use of a Brannock-style measuring device for estimating correct sizing (similar to footwear).

A new test method, Water Vapor Resistance Test (R_{et}), was created at First Draft but removed during Second Draft after lengthy discussion and presentation. The Technical Committee agrees that while this test may provide valuable information, there has only been limited data to support including this test in the standard during this revision cycle. The Technical Committee does want to encourage continued research on this test method and established a task group for work during the intervening years on this issue.

In Memoriam, 11 September 2001

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

Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment

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

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

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

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

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

Committee Scope: This committee shall have primary responsibility for documents on 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.

Contents

NFPA 1971

Standard on

Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

2018 Edition

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

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.

N **1.1.2.1** This standard shall also specify optional requirements for particulate barrier protective hood interface components.

1.1.3* This standard shall also specify additional optional requirements for structural fire fighting protective ensembles and proximity fire fighting protective ensembles that will provide limited protection from liquid and particulate hazards.

1.1.3.1 This standard shall not specify requirements for protection against CBRN 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 Other than for the certification of structural or proximity protective ensembles to the optional complete ensemble liquid and particulate hazard protection requirements, this standard shall not specify the respiratory protection that is necessary for proper protection with structural or fire fighting 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 ensemble 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 ensemble elements. It shall be the responsibility of the persons and organizations that use compliant protective ensembles or ensemble 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 ensemble 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.

1.2.2 The purpose of this standard shall also be to establish a minimum level of protection for structural and proximity fire fighting personnel from exposure to liquid and particulate contaminants 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.

Δ **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 additional optional protection from liquid and particulate contaminants.

1.3.3 This standard shall not apply to any protective ensembles, ensemble elements, or protective clothing for any other types of fire fighting operations.

Δ **1.3.4** This standard shall not apply to structural fire fighting protective ensembles manufactured according to previous editions of NFPA 1971.

Δ **1.3.5** This standard shall not apply to structural fire fighting protective clothing and equipment manufactured according to past editions of NFPA 1971, NFPA 1972, NFPA 1973, and NFPA 1974.

Δ **1.3.6** This standard shall not apply to proximity fire fighting protective ensembles manufactured according to previous editions of NFPA 1976.

Δ **1.3.7** This standard shall not apply to proximity fire fighting protective clothing and equipment manufactured according to past editions of NFPA 1976.

1.3.8* 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.

Δ **1.3.9** 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.

1.4 Units.

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

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

Chapter 2 Referenced Publications

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

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

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

NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2014 edition.

NFPA 1972, *Helmets for Structural Fire Fighting*, 1992 edition. (withdrawn)

NFPA 1973, *Gloves for Structural Fire Fighting*, 1993 edition. (withdrawn)

NFPA 1974, *Protective Footwear for Structural Fire Fighting*, 1992 edition. (withdrawn)

NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, 2000 edition. (withdrawn)

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

NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, 2017 edition.

2.3 Other Publications.

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

AATCC 35, *Water Resistance: Rain Test*, 2013.

AATCC 42, *Water Resistance: Impact Penetration Test*, 2013.

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

AATCC 70, *Water Repellency — Tumble Jar Dynamic Absorption Test*, 2015.

AATCC 135, *Dimensional Changes of Fabrics after Home Laundering*, 2004.

Δ **2.3.2 ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A666, *Standard Specification for Annealed or Cold Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar*, 2015.

ASTM B152/B152M, *Specification for Copper Sheet, Strip Plate, and Rolled Bar*, 2013.

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

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

ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, 2013.

ASTM D1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, 2011.

ASTM D1776/D1776M, *Standard Practice for Conditioning and Testing Textiles*, 2016.

ASTM D3359, *Standard Test Methods for Measuring Adhesion by Tape Test*, 2009 e2.

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

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

ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Test Method)*, 2012 e1.

ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, 2013.

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

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

ASTM D5587, *Standard Test Method for the Tearing Strength of Fabrics by Trapezoid Procedure*, 2015.

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

ASTM D6775, *Standard Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material*, 2013.

ASTM D6797, *Standard Test Method for Bursting Strength of Fabrics Constant-Rate-of-Extension (CRE) Ball Burst Test*, 2015.

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

ASTM E809, *Standard Practice for Measuring Photometric Characteristics of Retroreflectors*, 2013.

ASTM E991, *Standard Practice for Color Measurement of Fluorescent Specimens Using the One-Monochromator Method*, 2011.

ASTM E1164, *Standard Practice for Obtaining Spectrometric Data for Object -Color Evaluation*, 2012.

ASTM E2152, *Standard Practice for Computing the Colors of Fluorescent Objects from Bispectral Photometric Data*, 2012.

ASTM E2153, *Standard Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color*, 2011.

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

ASTM F1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, 2008.

ASTM F1215, *Test Method for Determining the Initial Efficiency of a Flatsheet Filter Medium in an Airflow Using Latex Spheres*, 1998.

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

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

ASTM F1671/F1671M, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X-174 Bacteriophage Penetration as a Test System*, 2013.

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

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

ASTM F1939, *Standard Test Method for Radiant Heat Resistance of Flame Resistant Clothing Materials with Continuous Heating*, 2015.

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

ASTM F2299/F2299M, *Standard Test Method for Determining the Initial Efficiency of Materials Used in Medical Face Masks to Penetration by Particulates Using Latex Spheres*, 2010.

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

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

ASTM F2731, *Standard Test Method for Measuring the Transmitted and Stored Energy in Fire Fighter Protective Clothing Systems*, 2011.

ASTM F2894, *Standard Test Method for Evaluation of Materials, Protective Clothing and Equipment for Heat Resistance Using a Hot Air Circulating Oven*, 2014.

ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester*, 2011.

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

ASTM G155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*, 2013.

2.3.3 CIE Publications. U.S. National Committee of the Comission Internationale de l'Eclairage CIE, c/o Mr. Thomas M. Lemons, TLA — Lighting Consultants, Inc., 7 Pond Street, Salem, MA 01970-4819.

ISO/CIE 10526, *Calorimetric Illuminants*, 1999.

2.3.4 CSA Publications. Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON, L4W 5N6, Canada.

CSA Z195, *Protective Footwear*, 2014.

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

FIA 1209, *Whole Shoe Flex*, 1984.

2.3.6 GSA Publications. U.S. General Services Administration, 1800 F Street, N.W., Washington, DC 20405.

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

N **2.3.7 ISEA Publications.** International Safety Equipment Association, 1901 North Moore Street, Arlington, VA 22209-1762.

ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel and Accessories*, 2015.

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

Δ **2.3.8 ISO Publications.** International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

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

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

ISO 9001, *Quality management systems — Requirements*, 2008.

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

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

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

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

ISO 17492, *Clothing for protection against heat and flame — Determination of heat transmission on exposure to both flame and radiant heat*, 2003.

ISO/CIE 10526, *Calorimetric Illuminants*, 2007.

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

2.3.9 SAE Publications. SAE International, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J211-1, *Instrumentation for Impact Test, Part 1 – Electronic Instrumentation*, 2014.

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

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

A-A-55634A, *Commercial Item Description, Zippers (Fasteners, Slide, Interlocking)*, March 23, 2004.

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

Title 29, Code of Federal Regulations, Part 1910.132, "Personal Protective Equipment: General Requirements," 1994.

Δ **2.3.12 U.S. Military Publications.** U.S. Army Developmental Test Command, ATTN: CSTE-DTC-TT-S, Aberdeen Proving Ground, MD 21005-5055.

Federal Specification CCC-C-419, *Cloth, Duck, Unbleached, Plied-Yarns, Army and Numbered*, 1985.

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

Test Operations Procedure (TOP) 10-2-022, *Chemical Vapor and Aerosol System-Level Testing of Chemical/Biological Protective Suits*, 2013.

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. *(See also definition 3.3.88, Product Label.)*

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

3.2.5 Shall. Indicates a mandatory requirement.

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

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

"standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

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

N **3.3.2 Barrier Hood.** See 3.3.136, Structural Fire Fighting Protective Hood.

3.3.3 Barrier Material. The part of the composite that limits transfer from the face of the layer to the other side.

3.3.4 Basic Plane. The anatomical plane 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.

3.3.5 Belt. An equipment item configured as a device that fastens around the waist only and is designated as a ladder belt or an escape belt.

3.3.6 Biological Terrorism Agents. Liquid or particulate agents that can consist of biologically derived toxin or pathogen to inflict lethal or incapacitating casualties.

3.3.7* 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.

3.3.8* Bitragion Inion Arc. The arc between tragion as measured over the inion.

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

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

3.3.11 Bootie. A sock-like extension of the garment or suit leg that covers the entire foot.

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

3.3.13 Brim Line. A horizontal plane intersecting the point of the front opening of the helmet at the midsagittal plane.

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

3.3.15 CBRN. An abbreviation for chemicals, biological agents, and radiological particulates hazards. *(See also 3.3.16, CBRN Terrorism Agents.)*

• **3.3.16* CBRN Terrorism Agents.** Chemicals, biological agents, and radiological particulates that could be released as the result of a terrorist attack. *(See also 3.3.20, Chemical Terrorism Agents; 3.3.6, Biological Terrorism Agents; and 3.3.112, Radiological Particulate Terrorism Agents.)*

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

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

3.3.19 Char. The formation of a brittle residue when material is exposed to thermal energy.

3.3.20 Chemical Terrorism Agents. Liquid, solid, gaseous, and vapor chemical warfare agents and toxic industrial chemicals used to inflict lethal or incapacitating casualties, generally on a civilian population, as a result of a terrorist attack. *(See also 3.3.21, Chemical Warfare (CW) Agents, and 3.3.146, Toxic Industrial Chemicals.)*

3.3.21 Chemical Warfare (CW) Agents. Liquid, solid, and gaseous chemical agents (most are liquids) traditionally used during warfare or armed conflict to kill or incapacitate an enemy.

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

3.3.23 Coat. See 3.3.128, Structural Fire Fighting Protective Coat, and 3.3.102, Proximity Fire Fighting Protective Coat.

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

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

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

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

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

3.3.29 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.

3.3.30 Coverall. See 3.3.129, Structural Fire Fighting Protective Coverall, and 3.3.103, Proximity Fire Fighting Protective Coverall.

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

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

3.3.33 Dielectric Test Plane. A plane that runs diagonally through the headform from the intersection of the test line and midsagittal plane in the front of the headform to the intersection of the reference plane and midsagittal plane in the rear of the headform.

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

3.3.35 Ear Covers. An interface component of the protective helmet element that provides limited protection to the helmet/coat interface area.

3.3.36 Element(s). See 3.3.39, Ensemble Elements.

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

3.3.38 Ensemble. See 3.3.130, Structural Fire Fighting Protective Ensemble, and 3.3.104, Proximity Fire Fighting Protective Ensemble.

3.3.39 Ensemble Elements. The compliant products that provide protection to the upper and lower torso, arms, legs, head, hands, and feet.

3.3.40* 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.

3.3.41* Faceshield. The component of the helmet that provides limited protection to a portion of the wearer's face.

3.3.42 Faceshield/Goggle. The term that applies to the helmet component that is a faceshield, or goggle, or both.

3.3.43 Facial Feature Headform. The medium size reference headform specified in ANSI/ISEA Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices.*

3.3.44 Flame Resistance. The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or nonflaming source of ignition, with or without subsequent removal of the ignition source. Flame resistance can be an inherent property of a material, or it can be imparted by specific treatment. *(See also 3.3.67, Inherent Flame Resistance.)*

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

3.3.46 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 labeled and listed products that are being produced by the manufacturer to the requirements of this standard.

3.3.47* Footwear. See 3.3.132, Structural Fire Fighting Protective Footwear, and 3.3.106, Proximity Fire Fighting Protective Footwear.

3.3.48 Functional. The ability of an element or component of an element to continue to be utilized for its intended purpose.

3.3.49 Garment(s). See 3.3.133, Structural Fire Fighting Protective Garments, and 3.3.107, Proximity Fire Fighting Protective Garments.

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

3.3.51 Glove. See 3.3.134, Structural Fire Fighting Protective Gloves, and 3.3.108, Proximity Fire Fighting Protective Gloves.

3.3.52 Glove Body. The part of the glove that extends from the tip of the fingers to the wrist crease or to a specified distance beyond the wrist crease.

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

3.3.54 Glove Wristlet. See 3.3.153, Wristlet.

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

3.3.56 Grading. The process of proportioning components for construction of an element.

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

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

3.3.59 Harness. An equipment item; an arrangement of materials secured about the body used to support a person.

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

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

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

3.3.63 Helmet. See 3.3.135, Structural Fire Fighting Protective Helmet, and 3.3.109, Proximity Fire Fighting Protective Helmet.

3.3.64 Helmet Cover. A removable helmet component that offers radiant reflective protection to the exterior of the helmet shell.

3.3.65 Helmet Shroud. The component element of the helmet that provides limited protection to the helmet/coat SCBA interface area.

3.3.66 Hood. See 3.3.136, Structural Fire Fighting Protective Hood.

3.3.67 Inherent Flame Resistance. Flame resistance that is derived from the essential characteristic of the fiber or polymer.

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

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

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

3.3.71 Ladder Shank. See 3.3.122, Shank.

3.3.72 Liquid Borne Pathogen. See 3.3.9, Body Fluid-Borne Pathogen.

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

3.3.74 Major A Seam. See 3.3.119.2.

3.3.75 Major B Seam. See 3.3.119.3.

Δ **3.3.76 Manufacturer.** The entity that assumes the liability for the compliant product.

N **3.3.77 Manufacturing Facility.** A facility that is involved in the production, assembly, final inspection, or labeling of the compliant end product.

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

3.3.79 Midsagittal Plane. The plane, perpendicular to the basic and coronal planes, that bisects the head symmetrically.

3.3.80 Minor Seam. See 3.3.119.4.

3.3.81 Model. The collective term used to identify a group of elements or items 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.

3.3.82 Moisture Barrier. The component of an element or item that principally prevents the transfer of liquids.

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

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

N **3.3.85* Particulate Blocking Layer.** The layer(s) of an element or item that principally inhibits the ingress of particles.

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

3.3.87 Percent Inward Leakage. The ratio of vapor concentration inside the ensemble versus the vapor concentration outside the ensemble expressed as a percentage.

3.3.88 Product Label. A marking provided by the manufacturer for each compliant product containing compliant statements, certification statements, manufacturer or model information, 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 is attached to or part of the product label.

3.3.89 Protective Clothing. See 3.3.130, Structural Fire Fighting Protective Ensembles, and 3.3.104, Proximity Fire Fighting Protective Ensemble.

Δ **3.3.90 Protective Coat.** See 3.3.128, Structural Fire Fighting Protective Coat, and 3.3.101, Proximity Fire Fighting Protective Coat.

3.3.91 Protective Coverall. See 3.3.129, Structural Fire Fighting Protective Coverall, and 3.3.103, Proximity Fire Fighting Protective Coverall.

3.3.92 Protective Ensemble. See 3.3.130, Structural Fire Fighting Protective Ensemble, and 3.3.104, Proximity Fire Fighting Protective Ensemble.

3.3.93 Protective Footwear. See 3.3.132, Structural Fire Fighting Protective Footwear, and 3.3.106, Proximity Fire Fighting Protective Footwear.

3.3.94 Protective Garment. See 3.3.133, Structural Fire Fighting Protective Garments, and 3.3.107, Proximity Fire Fighting Protective Garments.

3.3.95 Protective Gloves. See 3.3.134, Structural Fire Fighting Protective Glove, and 3.3.108, Proximity Fire Fighting Protective Glove.

3.3.96 Protective Helmet. See 3.3.135, Structural Fire Fighting Protective Helmet, and 3.3.109, Proximity Fire Fighting Protective Helmet.

3.3.97 Protective Hood. See 3.3.136, Structural Fire Fighting Protective Hood.

3.3.98 Protective Trousers. See 3.3.137, Structural Fire Fighting Protective Trousers, and 3.3.110, Proximity Fire Fighting Protective Trousers.

3.3.99 Protective Wristlet. See 3.3.153, Wristlet.

3.3.100* 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.

3.3.101 Proximity Fire Fighting Protective Clothing. See 3.3.104, Proximity Fire Fighting Protective Ensemble.

3.3.102 Proximity Fire Fighting Protective Coat. The element of the protective ensemble that provides protection to upper torso and arms, excluding the hands and head.

3.3.103 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.

3.3.104 Proximity 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.

3.3.105 Proximity Fire Fighting Protective Ensemble with Optional Liquid and Particulate Contaminant Protection. A compliant proximity fire fighting protective ensemble that is also certified as an entire ensemble to meet the optional requirements for protection from liquid and particulate contaminants.

3.3.106 Proximity Fire Fighting Protective Footwear. The element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.107 Proximity Fire Fighting Protective Garment. The coat, trouser, and coverall elements of the protective ensemble.

3.3.108 Proximity Fire Fighting Protective Glove. The element of the protective ensemble that provides protection to the hand and wrist.

3.3.109 Proximity Fire Fighting Protective Helmet. The element of the protective ensemble that provides protection to the head.

3.3.110 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.

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

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

3.3.113 Recall System. Procedures by which a manufacturer identifies a product, provides notice or safety alert, and repairs or withdraws the product as the corrective action.

3.3.114 Reference Plane. A dimensionally defined plane parallel to the basic plane that is measured from the top of the applicable headform or the basic plane.

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

3.3.116 Retroreflection/Retroflective. 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.

3.3.117 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.

3.3.118 Sample. (1) The ensemble, element, component, or composite that is conditioned for testing. (2) Ensembles, elements, items, or components that are randomly selected from the manufacturing facility's production line, from the manufacturer's or manufacturing facility's inventory, or from the open market.

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

3.3.119.1 ***Major Seam.*** Seam assemblies where rupture exposes the wearer to immediate danger.

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

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

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

3.3.120 Seam Assembly. The structure obtained when materials are joined by means of a seam.

3.3.121 Separate/Separation. A material response evidenced by splitting or delaminating.

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

3.3.123 Shell. See 3.3.84, Outer Shell.

3.3.124 Specimen. The conditioned ensemble, element, item, or component that is tested. Specimens are taken from samples. *(See also 3.3.118, Sample.)*

3.3.125 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.

N **3.3.126 Structural Fire Fighting Protective Barrier Hood.** The optional interface element of the protective ensemble that provides limited thermal, physical, and barrier protection to the coat/helmet/SCBA facepiece interface area.

3.3.127 Structural Fire Fighting Protective Clothing. See 3.3.130, Structural Fire Fighting Protective Ensemble.

3.3.128 Structural Fire Fighting Protective Coat. The element of the protective ensemble that provides protection to the upper torso and arms, excluding the hands and head.

3.3.129 Structural 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.

3.3.130* 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.

3.3.131 Structural Fire Fighting Protective Ensemble with Optional Liquid and Particulate Contaminant Protection. A compliant structural fire fighting protective ensemble that is also certified as an entire ensemble to meet the optional requirements for protection from liquid and particulate contaminants.

3.3.132 Structural Fire Fighting Protective Footwear. The element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.133 Structural Fire Fighting Protective Garment(s). The coat, trouser, and coverall elements of the protective ensemble.

3.3.134 Structural Fire Fighting Protective Glove. The element of the protective ensemble that provides protection to the hand and wrist.

3.3.135 Structural Fire Fighting Protective Helmet. The element of the protective ensemble that provides protection to the head.

3.3.136 Structural Fire Fighting Protective Hood. The interface element of the protective ensemble that provides limited protection to the coat/helmet/SCBA facepiece interface area.

3.3.137 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.

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

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

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

3.3.141 Thermal Barrier. The component of an element or item that principally provides thermal protection.

3.3.142 Toe Cap. A reinforcement to the toe area of footwear designed to protect the toes from impact and compression.

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

3.3.144 Top. The intersection between the midsagittal plane and the coronal plane extended to the helmet surface.

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

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

3.3.147 Trim. Retroreflective and fluorescent materials attached to the outermost surface of the protective ensemble for visibility enhancement. Retroreflective materials enhance nighttime visibility, and fluorescent materials enhance daytime visibility. "Trim" is also known as "visibility markings."

3.3.148 Trouser. See 3.3.137, Structural Fire Fighting Protective Trousers, and 3.3.110, Proximity Fire Fighting Protective Trousers.

3.3.149* 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.

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

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

3.3.152 Winter Liner. An optional component layer that provides added insulation against cold.

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

Chapter 4 Certification

4.1 General.

Δ **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 products 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, which include protective garments, protective helmet, protective gloves, protective footwear, interface components where necessary for certification, and protective hood where the hood is not part of the protective garments, to the optional requirements for protection against liquid and particulate contaminants.

4.1.2.2 The certification organization shall further require that the protective ensemble manufacturer specify the respiratory protection component of the ensemble by manufacturer, type, and model in order for the ensembles to be certified to the optional requirements for protection against liquid and particulate contaminants.

Δ **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.

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

Δ **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.

Δ **4.1.8** The certification organization shall not issue any new certifications to the 2013 edition of NFPA 1971 on or after the NFPA effective date for the 2018 edition, which is August 21, 2017.

Δ **4.1.9** The certification organization shall not permit any manufacturer to continue to label any products that are certified as compliant with the 2013 edition of NFPA 1971 on or after August 21, 2018.

Δ **4.1.10** The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2013 edition of NFPA 1971 from all products that are under the control of the manufacturer on August 21, 2018, 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.

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

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

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

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

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

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

4.2.6.1 The certification organization laboratory facilities shall have 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 manufacturing facilities of the compliant product with at least two random and unannounced visits per 12-month period to verify the product's continued compliance. Where portions of the production process are carried out by multiple facilities, the certification organization shall determine the appropriate follow-up program according to which facility or facilities most closely meet the definition provided in 3.3.77 (Manufacturing Facility).

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

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

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

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

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

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

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

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

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

4.3.4.1* For certification of structural fire fighting helmet elements, a test series shall consist of 14 helmets.

4.3.4.1.1 A minimum of three test series shall be required for certification.

4.3.4.1.2 Each helmet shall be subjected to the specified environmental conditioning and test or tests.

4.3.4.2* For certification of proximity fire fighting helmet elements, a test series shall consist of 14 helmets.

4.3.4.2.1 A minimum of three test series shall be required for certification.

4.3.4.2.2 Each helmet shall be subjected to the specified environmental conditioning and test or tests.

4.3.4.3 For certification of any ensembles with the optional liquid and particulate contaminant protection requirements, the ensembles and components shall be subjected to the specified environmental conditioning and test or tests.

4.3.5 Inspection and evaluation 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 products identified in Section 5.1, Product Label Requirements for Both Ensembles, Section 5.2, Additional Product Label Requirements for Structural Fire Fighting Ensemble Elements Only, and Section 5.3, Additional Product Label Requirements for Proximity Fire Fighting Ensemble Elements Only.

4.3.6 Inspection and evaluation 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 in 5.1.5 to ensure that the symbols are clearly explained in the product's user information package.

4.3.7 Inspection and evaluation by the certification organization shall include a review of the user information required by Section 5.4, User Information Requirements for Both Ensembles, to ensure that the information has been developed and is available.

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

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

4.3.9.1 Testing shall be performed on specimens representative of materials and components used in the actual construction of the compliant product.

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

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

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

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

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

4.3.14 The certification organization shall test an ensemble element with the specific ensemble(s) with which it is to be certified.

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

4.3.16 The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the certification of the manufacturer's

compliant product. The manufacturer shall provide such data, upon request, to the purchaser or authority having jurisdiction.

4.4 Recertification.

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

(1) Inspection and evaluation to all design requirements as required by this standard on all manufacturer models and components.
(2) Testing to all performance requirements as required by this standard on all manufacturer models and components with the following protocol:
   (a) Where a test method incorporates testing both before and after laundering conditioning specified in 8.1.2 and the test generates quantitative results, recertification testing shall be limited to the conditioning that yielded the worst-case test result during the initial certification for the model or component.
   (b) Where a test method incorporates testing both before and after laundering conditioning specified in 8.1.2 and the test generates non-quantitative results (e.g., pass/fail for melt/drip), recertification shall be limited to a single conditioning procedure in any given year. Subsequent annual recertifications shall cycle through the remaining conditioning procedures to ensure that all required conditionings are included over time.
   (c) Where a test method requires the testing of three specimens, a minimum of one specimen shall be tested for annual recertification.
   (d) Where a test method requires the testing of five or more specimens, a minimum of two specimens shall be tested for annual recertification.

4.4.2 At least one sample of each compliant product and component shall be tested for overall performance as specified in Chapter 7 according to the following protocol:

(1) Where a test method incorporates testing both before and after laundering conditioning specified in 8.1.2 and the test generates quantitative results, recertification testing shall be limited to the conditioning that yielded the worst-case test result during the initial certification for the model or component.
(2) Where a test method incorporates testing both before and after laundering conditioning specified in 8.1.2 and the test generates non-quantitative results (e.g., pass/fail for melt/drip), recertification shall be limited to a single conditioning procedure in any given year. Subsequent annual recertifications shall cycle through the remaining conditioning procedures to ensure that all required conditionings are included over time.
(3) Where a test method requires the testing of less than five specimens, a minimum of one specimen shall be tested for annual recertification.
(4) Where a test method requires the testing of five or more specimens, a minimum of two specimens shall be tested for annual recertification.

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

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

4.4.5 Samples of manufacturer models and components for recertification shall be acquired as part of the follow-up program in accordance with 4.2.7 and shall be permitted to be used toward annual recertification.

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

4.5 Manufacturers' Quality Assurance Program.

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

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

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

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

Δ **4.5.3.1** Registration to the requirements of ISO 9001, *Quality management systems — Requirements*, shall be conducted by a registrar that is accredited for personal protective equipment in accordance with ISO 17021, *Conformity assessment – Requirements for bodies providing audit and certification of management systems*. 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*** Where the manufacturer uses subcontractors in the construction or assembly of the compliant product, the locations and names of all subcontractor facilities shall be documented and the documentation shall be provided to the manufacturer's ISO registrar and the certification organization.

4.5.5 Where manufacturers construct custom sized or special fitting gloves for accommodating the special needs of individual fire fighters, the manufacturer shall employ the same manufacturing methods as used in the construction of required glove sizes.

4.5.5.1 The manufacturer shall notify the certification organization as required in 4.2.8 and shall obtain written approval from the certification organization prior to proceeding with any modifications to an existing certified glove design.

4.5.5.2 Custom fitting gloves shall be individually evaluated to verify the integrity of the glove moisture barrier using air or other similar method to ensure that the glove is constructed in a leak-free manner.

4.6 Hazards Involving Compliant Product.

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

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

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

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

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

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

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

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

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

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

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

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

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

4.6.13* Where a change to an NFPA standard(s) is felt to be necessary, the certification organization shall also provide a copy of the report and corrective actions indicated to the NFPA and shall also submit either a Public Input 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 manufacturer safety alert and product recall system shall provide the following:

(1) The establishment of a coordinator and responsibilities by the manufacturer for the handling of safety alerts and product recalls
(2) A method of notifying all dealers, distributors, purchasers, users, and the NFPA about the safety alert or product recall that can be initiated within a 1 week period following the manufacturer 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 Labeling and Information

5.1 Product Label Requirements for Both Ensembles.

5.1.1* 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 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label. However, all label pieces comprising the product label shall be located adjacent to each other.

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

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

5.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

5.1.6 The compliance statements specified in Section 5.2 for structural fire fighting protective ensemble elements and in Section 5.3 for proximity fire fighting protective ensemble elements shall be printed legibly on the product label.

Δ **5.1.7** The following information shall also be printed legibly on 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) Principal material(s) of construction
(9) Cleaning precautions

N **5.1.7.1** For garments only, where the principal material of construction is a component that is listed, the component name under which it is listed shall be identified.

N **5.1.7.2** For garments only, where the thermal liner, moisture barrier, and outer shell are separable, each separable layer shall also have a label containing the information required in 5.1.7(4) through 5.1.7(8).

N **5.1.7.3*** For principal materials of construction of footwear, at least the outer shell, moisture barrier, and thermal liner shall be listed. Generic names of materials shall be permitted to be used. Additional materials that are used throughout the majority of the footwear shall also be listed on the label.

N **5.1.7.4*** For principal materials of construction of helmets, the shell material shall be listed.

5.1.7.5* For principal materials of construction of gloves, at least the outer shell, moisture barrier, thermal liner, and glove interface component (wristlet) shall be listed. Generic names of materials shall be permitted to be used. If used, the type of leather shall be listed. Any additional materials that are used throughout the significant portion of the glove's construction shall also be listed on the label.

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5.2 Additional Product Label Requirements for Structural Fire Fighting Ensemble Elements Only.

5.2.1 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 STRUCTURAL FIRE FIGHTING PROTECTIVE (insert appropriate element term here) MEETS THE (insert appropriate element term here) REQUIREMENTS OF NFPA 1971, 2018 EDITION.

DO NOT REMOVE THIS LABEL."

Δ **5.2.1.1** Where an entire ensemble is also certified as compliant with the optional requirements for protection against liquid and particulate contaminants, 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.

"LIQUID AND PARTICULATE PROTECTIVE ENSEMBLE

THIS ELEMENT IS NOT INTENDED AS PART OF A HAZARDOUS MATERIALS PROTECTIVE ENSEMBLE.

THIS STRUCTURAL FIRE FIGHTING PROTECTIVE (insert appropriate element term here) MEETS THE (insert appropriate element term here) REQUIREMENTS OF NFPA 1971, 2018 EDITION, AND THE OPTIONAL REQUIREMENTS FOR LIQUID AND PARTICULATE

CONTAMINANT PROTECTION WHEN WORN TOGETHER WITH THE OTHER SPECIFIED ELEMENTS AND INTERFACE COMPONENTS 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 liquid and particulate contaminants shall list those items of the certified ensemble by manufacturer name and model number on the product label.

5.2.2 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.)

DO NOT REMOVE THIS LABEL."

Δ **5.2.3** 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, 2018 ED."** permanently on each replaceable performance critical part of the goggle lens or faceshield.

5.2.4 For hoods only, where the hood is designed to interface with a specific SCBA facepiece(s), the hood manufacturer shall add an item to the items specified in 5.1.7.

5.2.4.1 The hood manufacturer shall designate the specific SCBA facepiece(s), model(s) and size(s) in the new item of 5.1.7.

5.2.4.2 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:

"FOR COMPLIANCE WITH THE STRUCTURAL FIRE FIGHTING REQUIREMENTS OF NFPA 1971, THIS HOOD CAN ONLY BE USED WITH THE FOLLOWING NOTED SCBA FACEPIECE(S) [insert SCBA facepieces(s), model(s), and size(s) here]."

Δ **5.2.5** For garments only, the garment manufacturer shall place a manufacturer's identification number, lot number or serial number, the size or size range, the symbol of the certification organization, and the words **"NFPA 1971, 2018 ED."** on the drag rescue device (DRD).

N **5.2.6** For particulate blocking hoods only, the following additional language shall be provided on the product label:

"THIS HOOD PROVIDES LIMITED PARTICULATE BLOCKING PROTECTION."

5.3 Additional Product Label Requirements for Proximity Fire Fighting Ensemble Elements Only.

5.3.1 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 — 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 PROXIMITY FIRE FIGHTING PROTECTIVE [insert appropriate element term here] MEETS THE [insert appropriate element term here] REQUIREMENTS OF NFPA 1971, 2018 EDITION.

DO NOT REMOVE THIS LABEL."

Δ **5.3.1.1** Where an entire ensemble is also certified as compliant with the optional requirements for protection against liquid and particulate contaminants, 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 5.3.1. The appropriate term for the element type — garment, helmet, glove, footwear — 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.

"LIQUID AND PARTICULATE CONTAMINANT PROTECTIVE ENSEMBLE

THIS ELEMENT IS NOT INTENDED AS PART OF A HAZARDOUS MATERIALS PROTECTIVE ENSEMBLE.

THIS PROXIMITY FIRE FIGHTING PROTECTIVE [insert appropriate element term here] MEETS THE [insert appropriate element term here] REQUIREMENTS OF NFPA 1971, 2018 EDITION, AND THE OPTIONAL REQUIREMENTS FOR LIQUID AND PARTICULATE CONTAMINANT PROTECTION, WHEN WORN TOGETHER WITH THE OTHER SPECIFIED ELEMENTS AND INTERFACE COMPONENTS OF THE ENSEMBLE.

DO NOT REMOVE THIS LABEL."

5.3.1.2 The garment element of the ensemble meeting the optional requirements for protection against liquid and particulate contaminants shall list those items of the certified ensemble by manufacturer name and model number on the product label.

Δ **5.3.2** 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 — shall be inserted in the statement text where indicated. Following this statement, the additional protective items or detachable components shall be listed by item/ component

identification or part number, and where applicable, how properly assembled.

"FOR COMPLIANCE WITH THE PROXIMITY 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.]

DO NOT REMOVE THIS LABEL."

5.3.2.1 For proximity fire fighting helmets, the list of additional items or detachable components shall include, as a minimum, the shroud, cover (except where the helmet cover is part of the shroud), and faceshield.

Δ **5.3.3** 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, 2018 ED."** permanently on each replaceable performance critical part of the faceshield.

Δ **5.3.4*** For the helmet shroud and cover (except where the helmet cover is part of the shroud), the manufacturer shall place a label on the shroud and cover (except where the helmet cover is part of the shroud) with a unique manufacturer's part number or identification and the following statement. The appropriate term for the item, shroud or cover, shall be inserted in the statement text where indicated.

"FOR COMPLIANCE WITH THE PROXIMITY FIRE FIGHTING REQUIREMENTS OF NFPA 1971-2018, THIS [insert appropriate item term here] CAN ONLY BE USED WITH THE FOLLOWING NOTED HELMET(S) AND ADDITIONAL ITEM(S): [insert helmet manufacturer's name and specific helmet model; and item name (shroud or cover) and shroud or cover part number, or identification where applicable]."

5.3.5 For garments only, the garment manufacturer shall place a manufacturer's identification number, lot number or serial number, the size or size range, the symbol of the certification organization, and the words **"NFPA 1971, 2018 ED."** on the DRD.

5.4 User Information Requirements for Both Ensembles.

5.4.1 The manufacturer shall provide at least the user information that is specified in 5.4.4 with each structural and proximity fire fighting element.

5.4.2 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 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* 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 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
(8) A statement that the moisture barrier has not been evaluated for all chemicals that can be encountered during fire fighting operations and information that the effects of chemical exposure on the moisture barrier are to be evaluated per the inspection procedures in NFPA 1851

5.4.5 For the DRD only, the manufacturer shall provide specific information on the use, inspection, maintenance, cleaning, and retirement of the DRD. Additional instructions shall be provided on the removal and reinstallation of the DRD into the garment.

5.4.6 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.

N **5.4.7** For helmets only, the manufacturer shall provide a list of items that are installed on, attached to, or packaged with the compliant helmet that meet the requirements of 6.4.8.

Δ **5.4.8** For protective ensembles certified to the optional liquid and particulate contaminant protection requirements, the manufacturer shall provide the following additional instruction and information with the ensemble:

(1) A statement that only the ensemble and the specific elements with which the ensemble has been certified must be worn together to ensure that the optional liquid and particulate contaminant protection is provided
(2) A list of the specific elements and interface components that must be worn as part of the liquid and particulate contaminant protective ensemble, including each type of CBRN SCBA that the ensemble has been certified with
(3) A list of specific limitations associated with the use of the ensemble for a response involving liquid and particulate contaminant hazards, including but not limited to a statement that the ensemble is not a hazardous materials protective ensemble and that protection will not be provided from vapors or all liquids and particulates

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

N **5.4.9** When the optional requirements for liquid and particulate contaminant protection necessitate a specific action to engage interface areas, the manufacturer shall provide details explaining those procedures.

Chapter 6 Design Requirements

6.1* Protective Garment Element Design Requirements for Both Ensembles.

6.1.1 Protective garment elements shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.1.1.1 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 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* Garments shall consist of a composite of an outer shell, moisture barrier, and thermal barrier.

6.1.2.1 The composite specified in 6.1.2 shall be permitted to be configured as a single layer or multiple layers.

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

6.1.3* Garments shall have a means of securing the moisture barrier and thermal barrier to the outer shell.

6.1.4 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, unless those barrier layers terminate in a garment-glove interface.

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, unless those barrier layers terminate in booties.

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 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.

6.1.6 All garment hardware finishes shall be free of rough spots, burrs, or sharp edges.

6.1.7 All sewing thread utilized in the construction of garments and the drag rescue devices (DRDs) shall be made of an inherently flame-resistant fiber.

6.1.8* 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 Coats shall be designed to provide protection to the upper torso, neck, arms, and wrists, excluding the hands and head.

6.1.9.1 Each coat element shall have a DRD installed in the upper torso portion of the element.

6.1.9.1.1 The DRD shall be accessible from the exterior of the garment.

6.1.9.1.2 The DRD shall be easily accessible for deployment, shall be designed to minimize the risk of accidental deployment, and shall allow for visual inspection.

6.1.9.1.3 The DRD shall be fully functional and shall not require any subsequent actions in order to be used, other than deploying the DRD, when the garment is donned in accordance with the manufacturer's instructions.

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.

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 pull only the garment.

6.1.9.2* Each coat sleeve shall have a protective wristlet or other interface component permanently attached to the coat sleeve.

6.1.9.2.1 The wristlet or other garment sleeve interface component shall be designed so that it will not permit a gap in thermal protection.

6.1.9.2.2 The wristlet or other garment sleeve interface component shall meet the requirements specified in Section 6.16, Protective Wristlet Interface Component Design Requirements for Both Ensembles.

6.1.9.3 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, Protective Garment Performance Requirements for Both Ensembles.

6.1.9.3.3 Where a hood is permanently attached to the coat, a collar shall not be required.

6.1.9.3.4 Where a hood is permanently attached to the coat, it shall meet the requirement of 6.1.9.3.1 and at least the bottom 75 mm (3 in.) of the hood shall meet the requirement of 6.1.9.3.2.

6.1.9.4 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 Trousers shall be designed to provide protection to the lower torso and legs, excluding the ankles and feet.

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

6.1.10.2 Where trousers incorporate booties, the booties shall be designed as an extension of the trouser leg and shall cover the entire foot and ankle.

6.1.10.3 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* 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.

6.1.11.1 The sizing increments for the ranges specified in Table 6.1.11 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 Men's and women's sizing shall be accomplished by men's and women's individual patterns.

6.1.12* When life safety harnesses, escape belts, and ladder belts penetrate the outer shell, are incorporated as part of a garment closure system, or are temporarily or permanently attached to the garment, the harness or belt components shall meet the applicable requirements of NFPA 1983, and the optional requirements for flame resistant life safety harnesses or optional requirements for flame resistant belts.

N 6.1.13 Liners that consist of a thermal barrier sewn to a moisture barrier shall include an inspection opening that permits the examination of the lining interior, including all moisture barrier seams.

6.2 Additional Design Requirements for Structural Fire Fighting Protective Garment Elements Only.

6.2.1 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 and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.2.2* 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 (⅝ in.) wide.

6.2.2.3 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.

6.2.2.4 The fluorescent and retroreflective areas of trim specified in 6.2.2.2 and 6.2.2.3 shall appear to be continuous at a distance of 30.5 m (100 ft) for the length of the trim, with gaps of not more than 3 mm (⅛ in.).

6.2.2.5 Trim used in excess of that required by the minimum trim pattern requirements specified and illustrated in Figure 6.2.3 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* Coat trim configuration shall be in accordance with Figure 6.2.3. No vertical stripes of trim shall be permitted on the front of the coat.

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 also have at least one band of horizontal trim at the chest level located within 75 mm (3 in.) above or below the sleeve-to-body underarm garment seam.

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.

Table 6.1.11 Available Coat/Trouser Size Ranges

	Men		Women		Increment	
Dimension	mm	in.	mm	in.	mm	in.
Chest	865–1525	34–60	710–1270	28–50	50	2
Sleeve	820–965	32–38	710–865	28–34	25	1
Waist	760–1525	30–60	710–1270	28–50	50	2
Inseam	660–915	26–36	610–865	24–34	50	2

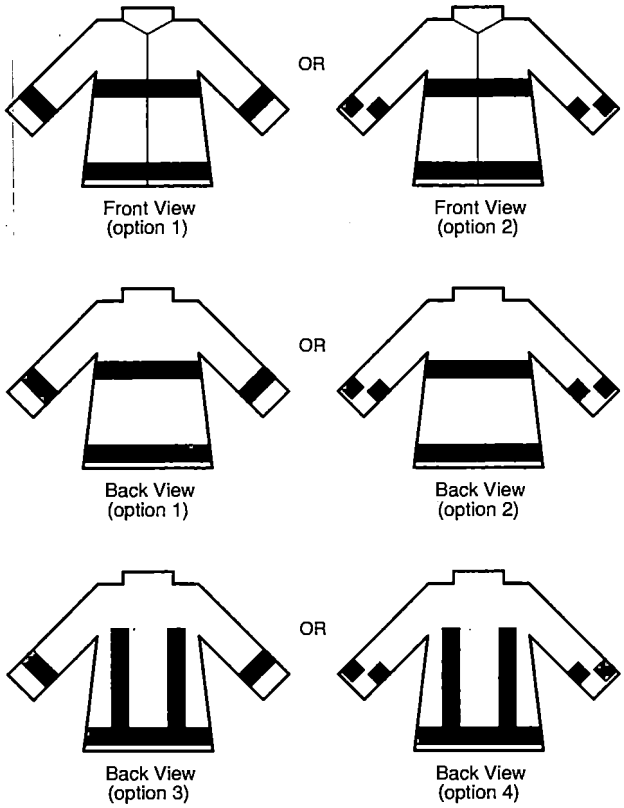


FIGURE 6.2.3 Minimum Required Structural Fire Fighting Coat Trim Patterns.

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 located within 75 mm (3 in.) above or below the sleeve-to-body underarm garment seam.

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.

6.2.3.5.1 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* Trouser trim configuration shall be in accordance with Figure 6.2.4.

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.

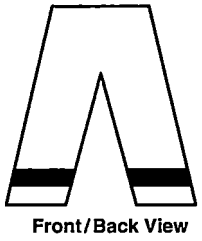


FIGURE 6.2.4 Minimum Required Structural Fire Fighting Trouser Trim Patterns.

6.3 Additional Design Requirements for Proximity Fire Fighting Protective Garment Elements Only.

6.3.1 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 and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.3.2 Garments shall not have materials that do not meet the radiant reflective requirements specified in 7.3.2 affixed to the outer shell radiant reflective surfaces of the garments unless such materials are covered in 6.3.3.

6.3.3 Reinforcing materials that do not meet the radiant reflective requirements specified in 7.3.2 shall be permitted to be affixed only to the garment outer shell radiant reflective surfaces as reinforcement of the sleeve cuffs and trouser leg cuffs where the following requirements are met:

(1) The reinforcing materials shall meet the flame resistant requirements specified in 7.1.3.
(2) The reinforcing materials shall meet the heat resistance requirements specified in 7.1.5.
(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 The collar lining material shall not be reflective material.

6.4 Protective Helmet Element Design Requirements for Both Ensembles.

6.4.1 Protective helmet elements shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.4.2 No openings shall penetrate the helmet shell other than those provided by the manufacturer for mounting energy absorbing systems, retention systems, and accessories.

6.4.3 The helmet retention system shall include a chin strap and a nape device. The chin strap shall have a minimum width of 19 mm (¾ in.).

6.4.4 All sewing thread used in the construction of helmets shall be made of inherently flame-resistant fiber.

6.4.5 The helmet faceshield or the faceshield/goggle component, when deployed, shall provide at least the following field of vision:

(1) Dihedral angle of at least 85 degrees
(2) Upper dihedral angle of at least 10 degrees
(3) 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 helmet with the faceshield or the faceshield/goggle component deployed shall be positioned in accordance with the HPI as described in 8.1.13 on a facial feature headform as defined in 3.3.43. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

6.4.6 The helmet faceshield or the faceshield/goggle component in the stowed position as described in 8.1.16 shall provide peripheral vision clearance of at least 94 degrees to each side.

6.4.6.1 The peripheral vision clearance shall be measured from the center of the eye, with the helmet positioned in accordance with the HPI as described in 8.1.13 on a facial feature headform as defined in 3.3.43. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

6.4.7 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.

N **6.4.8*** For helmets with items installed or attached, the helmet with the items installed/attached shall meet the affected design and performance requirements of this standard.

6.5 Additional Design Requirements for Structural Fire Fighting Protective Helmet Elements Only.

6.5.1 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 and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.5.2* Helmets shall consist of at least all of the following assembled components:

(1) Shell
(2) Energy absorbing system
(3) Retention system
(4) Fluorescent and retroreflective trim
(5) Ear covers
(6) A faceshield or goggles, or both

Δ **6.5.2.1** Where a faceshield is selected in accordance with 6.5.2(6), the faceshield component shall be attached to the helmet.

Δ **6.5.2.2** Where the goggle component is selected in accordance with 6.5.2(6), the goggles shall be permitted to be unattached, not assembled, to the helmet.

N **6.5.2.3** Where the manufacturer provides or intends to provide both a faceshield and goggles with the helmet, whether the faceshield is or is not provided installed or attached to the helmet, both the faceshield and the goggles shall be considered components of the helmet.

6.5.3 Helmets shall have fluorescent and retroreflective trim on the shell exterior.

6.5.3.1 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 as described in 8.1.16, is viewed at the following positions:

(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 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 as described in 8.1.16, 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 The entire surface of the trim shall be permitted to be both fluorescent and retroreflective.

6.5.4 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) 95 mm (3¾ in.) measured 50 mm (2 in.) forward of the coronal plane
(2) 120 mm (4¾ in.) measured 25 mm (1 in.) forward of the coronal plane
(3) 130 mm (5⅛ in.) measured at the coronal plane
(4) 130 mm (5⅛ 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 positioned according to the HPI as described in 8.1.13 on an ISO size J headform as specified in Figure 8.16.4.1. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance.

6.5.4.2 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.

6.5.4.3 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 (½ in.) in any direction around the perimeter of the adjustment device.

6.5.5 Faceshield/goggle components shall meet the respective requirements for goggles or faceshields and be marked "Z87+" in accordance with ANSI/ISEA Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices.*

6.6 Additional Design Requirements for Proximity Fire Fighting Helmet Elements Only.

6.6.1 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 Require-

ments for Both Ensembles, where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.6.2 Helmet elements shall consist of at least the following assembled components:

(1) Shell
(2) Energy absorbing system
(3) Retention system
(4) Faceshield
(5) Shroud
(6) Cover (where separate from the shroud)

6.6.3 Helmet faceshields shall be attached to the helmet.

6.6.4 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.

6.6.4.1 The helmet outer cover shall be permitted to be removable.

6.6.4.2 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.

6.6.4.3 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.

6.6.5 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 or faceshield.

6.6.5.1 Shrouds shall provide at least the following coverage:

(1) 230 mm (9⅛ 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 midsagittal plane
(3) 295 mm (11⅝ 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

N **6.6.5.1.1** The helmet, with the shroud deployed, shall be positioned according to the HPA as described in 8.1.13 on an ISO size J headform as specified in Figure 8.16.4.1. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance.

N **6.6.5.1.2** With the helmet positioned as required by 6.6.5.1.1, the shroud coverage shall be measured downward from the reference plane to the lower edge of the shroud coverage at the specified points to determine the coverage specified in 6.6.5.1.

6.6.5.2 The shroud shall be permitted to be a part of a helmet outer cover, where provided.

6.6.5.3 The shroud shall be designed to interface with a specific helmet.

6.6.5.4 The helmet shroud, when deployed, shall provide at least the following field of vision:

(1) Dihederal angle of at least 85 degrees
(2) Upper dihedral angle of at least 7 degrees
(3) Lower dihederal angle of at least 40 degrees

6.6.5.4.1 The field of vision shall be measured from the center of the eye.

6.6.5.4.2 The helmet with the shroud attached shall be positioned according to the HPI as described in 8.1.13 on a facial feature headform as defined in 3.3.43. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

6.6.6 No openings shall be permitted in the helmet shroud other than to meet the requirements of 6.6.5.

6.6.7 When the hood interface component is integrated with the protective garment, the shroud shall be permitted to consist of only the outer reflective layer and those other layers necessary to meet the requirements in 7.13.2 for thermal protective performance (TPP).

6.7 Protective Glove Elements Design Requirements for Both Ensembles.

6.7.1 Protective glove elements shall have at least the applicable design requirements specified in this section when inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.7.2 Gloves shall consist of a composite meeting the performance requirements of Section 7.7, 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 Supplemental gloves that are provided to meet the performance requirements of this standard but are not intended to be worn continuously with the wearing of the gloves shall not be permitted.

6.7.2.3 Where a glove is made up of multiple layers, all layers of the glove shall be individually graded per size.

6.7.2.4 Where the coat sleeve end terminates in a garment-glove interface and the interface demonstrates liquid integrity and continuous thermal protection in accordance with Section 7.16, Protective Wristlet Interface Component Performance Requirements for Both Ensembles, gloves shall not be required to meet the requirements in 6.7.3 through 6.7.3.4.

6.7.3 The glove shall consist of a glove body.

6.7.3.1 The glove shall extend from the tip of the fingers to at least 50 mm (2 in.) beyond the wrist crease.

6.7.3.2 The portion of the glove that extends from the tip of the fingers to 50 mm (2 in.) beyond the wrist crease shall be considered to be the glove body and shall meet the glove body requirements in Sections 7.7, Protective Glove Elements Performance Requirements for Both Ensembles; 7.8, Additional Performance Requirements for Structural Fire Fighting Protective Glove Elements Only; and 7.9, Additional Performance Requirements for Proximity Fire Fighting Protective Glove Elements Only, as applicable.

6.7.3.3 The portion of the glove that extends greater than 50 mm (2 in.) beyond the wrist crease but less than or equal to 125 mm (5 in.) beyond the wrist crease, where present, shall be considered to be the glove interface component and shall meet

the glove interface component requirements in Sections 7.7, 7.8, and 7.9, as applicable.

6.7.3.4 The portion of the glove that extends greater than 125 mm (5 in.) beyond the wrist crease up to the end of the entire glove, where present, shall be considered to be the glove extension and shall meet the glove extension requirements in Sections 7.7, 7.8, and 7.9, as applicable.

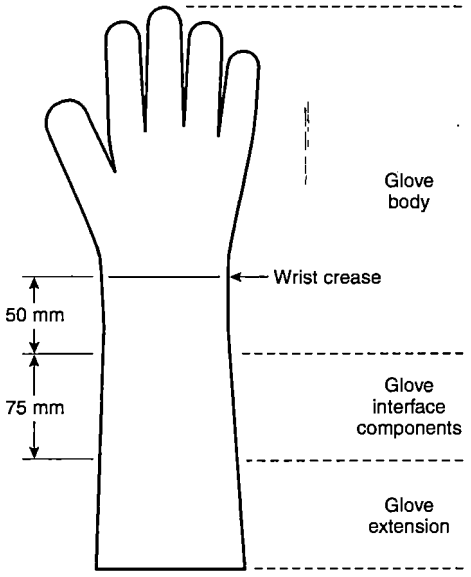
6.7.3.5* The location of the wrist crease shall be determined by the following procedures, as shown in Figure 6.7.3.5:

(1) The location of the wrist crease shall be determined by first placing the glove on a measurement board palm down and securing (locking) the fingertips down onto the board.
(2) A 1 lb weight shall be attached to the end of the glove body, glove interface component, or glove extension. The weight shall not be attached to a knitted wristlet glove interface component. The weight shall be applied evenly across the glove.
(3) The weight shall be allowed to hang freely for 60 seconds prior to taking any measurements.
(4)* The bottom of digit three shall be found by drawing a line on the back side of the glove from the finger crotches on either side of digit three. A point shall then be placed at the center of that line. Depending on the index finger length for the glove size, the distance to the wrist crease shall be determined by laying a ruler parallel with the length of the glove from the point representing the bottom of digit three to a second point using one of the following dimensions that corresponds to the index finger length. The second point shall be marked on the back of the glove.
    (a) 64 [N (normal), W (wide), and XW (extra-wide)]: 8.36 cm (3.29 in.)
    (b) 70 (N, W, and XW): 9.46 cm (3.72 in.)
    (c) 76 (N, W, and XW): 10.68 cm (4.20 in.)
    (d) 82 (N, W, and XW): 11.73 cm (4.62 in.)
(5) A straight line shall be drawn across the back of the glove perpendicular to the two points. This line shall be extended around the side edges of the glove.
(6) The glove shall be removed from the measurement board. A line shall be drawn on the palm side of the glove by connecting the lines from the side edges of the glove.
(7) The resulting straight line around the circumference of the glove shall be the location of the wrist crease.

6.7.4 All sewing thread utilized in the construction of gloves shall be made of an inherently flame-resistant fiber.

Δ **6.7.5*** For selection of the proper glove size, the dimensions for index finger length and hand breadth shall be measured as follows:

(1) Using a straight ruler, the index finger length shall be measured to the nearest 1 mm (1/16 in.) from the tip of the index finger to the base of the finger located by the crease as shown in Figure 6.7.5(a).
(2) Using a set of calipers or similar measuring device, the hand breadth shall be measured to the nearest 1 mm (1/16 in.) across the back of the hand knuckles from metacarpale II landmark (thumb side of index finger or digit 2) to the metacarpale V landmark (outside of little finger, or digit 5), as shown in Figure 6.7.5(b).



Δ **FIGURE 6.7.3.5 Location of Wrist Crease.**

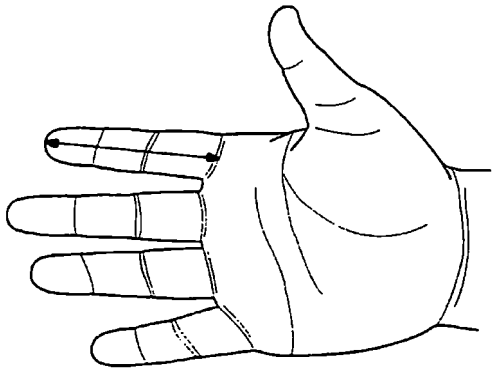


FIGURE 6.7.5(a) Measurement Location for Index Finger Length.

6.7.6* 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:

(1) 64N (normal)
(2) 70N (normal)
(3) 70W (wide)
(4) 76N (normal)
(5) 76W (wide)
(6) 82N (normal)
(7) 82W (wide)

Δ **6.7.6.1** The glove sizes from 64N through 82W indicated on the label shall be determined by the hand dimensions given in Figure 6.7.6.1.

Δ **6.7.7*** The glove size indicated on the label shall be determined by the hand dimensions given in Figure 6.7.6.1.

Δ **6.7.7.1** Where custom sized or specially fitted gloves are provided, the glove size indicated on the label shall be determined

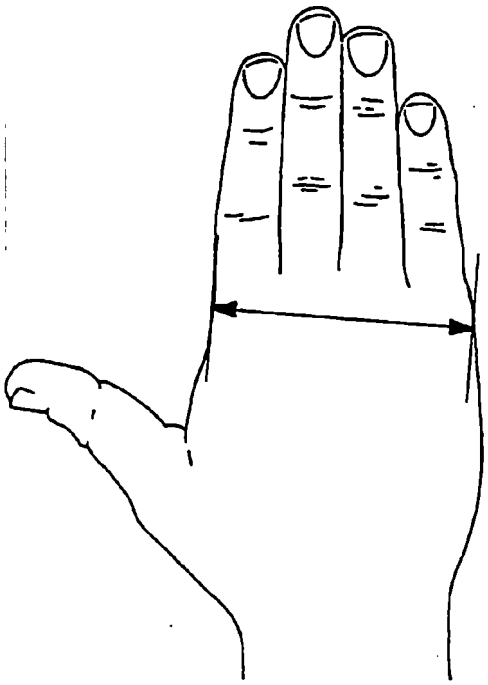
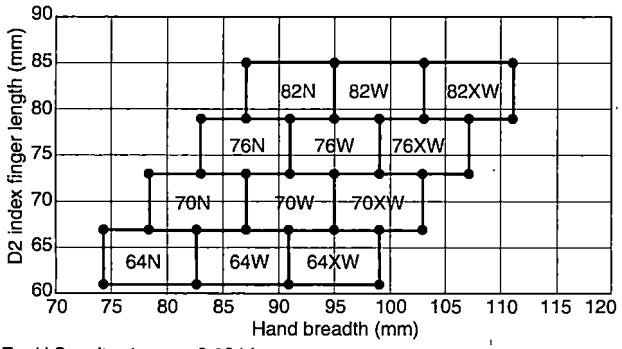


FIGURE 6.7.5(b) Measurement Location for Hand Breadth.



For U.S. units, 1 mm = 0.394 in.

N **FIGURE 6.7.6.1 NFPA 1971 Size Definitions.**

by the closest hand dimensions given in Figure 6.7.6.1, followed by the word "Custom."

6.8 Additional Design Requirements for Structural Fire Fighting Protective Glove Elements Only. (Reserved)

6.9 Additional Design Requirements for Proximity Fire Fighting Protective Glove Elements Only.

6.9.1 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 and evaluated by the certification organization as specified in Section 4.3.

6.9.2 Gloves shall not be permitted to have any hardware.

6.9.3 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.

6.9.3.1 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 6.9.3.1.

6.9.3.2 The radiant reflective material shall provide coverage for the finger/thumb tip of at least 195 degrees, +10°/−0°, as specified in Figure 6.9.3.1.

6.9.3.3 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.

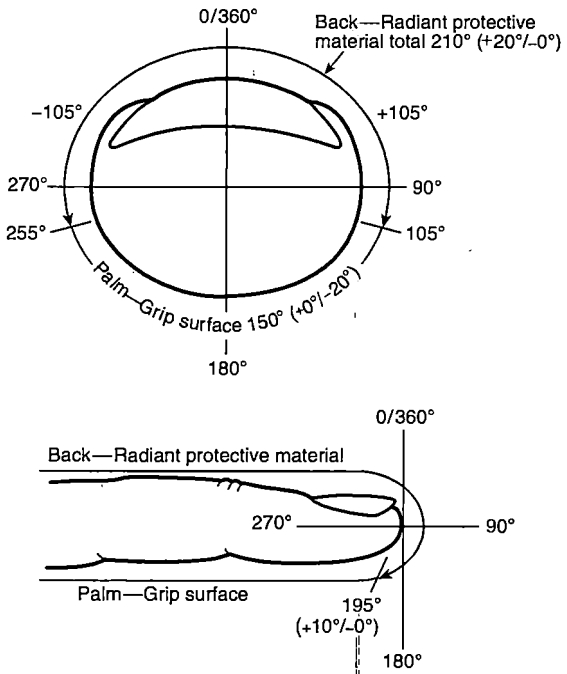
6.9.4 The outer shell of the glove interface component and glove extension, where provided, shall be a radiant reflective material, with the exception of a knitted wristlet as the interface component.

6.10 Protective Footwear Elements Design Requirements for Both Ensembles.

6.10.1 Protective footwear elements shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.10.2 Footwear shall consist of at least the following assembled components: a sole with a heel, an upper with lining, a puncture resistant device, an insole, a ladder shank or whole sole equivalent, and an impact- and compression-resistant toe cap.

6.10.2.1 Where booties are incorporated as a component of the pant and are specified by the manufacturer as removable



Δ FIGURE 6.9.3.1 Glove Radiant Reflective Protection Areas.

for laundering or replacement only, the booties component shall meet the performance requirements of 7.1.12, 7.1.13, 7.1.14, 7.1.15, 7.1.16, and 7.1.17.

6.10.2.2 Where booties are incorporated as a component of the footwear, the combination of the bootie component incorporated in the footwear shall meet the performance requirements of 7.10 with the exception of 7.10.4 and 7.10.5.

6.10.2.3 Where booties are used, the outer footwear shall not be required to have a liner in the upper.

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

6.10.3 Footwear height shall be a minimum of 250 mm (9.84 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 footwear at the lowest point of the top line, excluding the tongue and gusset.

6.10.3.2 Removable insoles shall not be removed prior to measurement.

6.10.3.3 Thermal, physical, and moisture protection shall be continuous circumferentially to within 50 mm (2 in.) of the footwear top line at all locations, with the exception of the area inside of and within 13 mm (½ in.) around pull-up holes that fully penetrate the footwear from outside to inside. The height of thermal, physical, and moisture protection at all locations of the boot shall be no less than 250 mm (9.84 in.) when measured as described in 6.10.3.1.

6.10.4 The footwear heel breast shall not be less than 13 mm (½ 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 extend more than 13 mm (½ 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 The puncture-resistant device shall cover the maximum area of the insole as specified in Section 3.3 of CSA Z195, *Protective Footwear.*

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

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

6.10.6.2 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.

6.10.7 All sewing thread utilized in the construction of footwear shall be made of an inherently flame-resistant fiber.

6.10.8 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 5–16, including half sizes and a minimum of three widths
(2) Women's 5–10, including half sizes and a minimum of three widths

6.10.8.1 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.

6.10.8.2 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. Dual sizing of the same pair of boots to cover men's and women's boot styles shall not be acceptable.

6.10.9 Footwear shall meet the performance requirements as specified in ASTM F2413, *Performance Requirements for Protective (Safety) Toe Cap Footwear,* for impact, compression, and puncture-resistance, with the exception that flex resistance to cracking shall be evaluated at 1,000,000 cycles.

6.11 Additional Design Requirements for Structural Fire Fighting Protective Footwear Only. (Reserved)

6.12 Additional Design Requirements for Proximity Fire Fighting Protective Footwear Only. (Reserved)

6.13 Protective Hood Interface Component Design Requirements for Both Ensembles.

6.13.1 Hood interface components shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.13.2 Hoods shall be permitted to be integrated with the protective coat.

6.13.3 The hood shall be designed to cover and provide the limited protection, as specified within this section, to the head, face, and neck areas but not including the face opening specified in 6.13.6.

6.13.3.1 Where the hood is integrated with the protective coat, the hood shall not be required to meet the design requirement specified in 6.13.5.

6.13.4 All sewing thread utilized in the construction of hoods shall be made of an inherently flame-resistant fiber.

6.13.5 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.

6.13.5.1 In this position, the hood shall provide a full coverage above the reference plane on each side measured downward from the reference plane at the coronal plane of 225 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, including the face opening, of 305 mm (12 in.).

6.13.6 Hoods shall be designed with a face opening.

6.13.6.1 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 be able to be stretched to a circumference of at least 800 mm (31 in.).

6.13.6.2 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 (½ in.). It shall be permitted to use the test equipment and approach specified in 8.47.4.2 and 8.47.4.5.

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

• **6.14 Optional Protective Barrier Hood Interface Component Design Requirements.**

N **6.14.1** Barrier hoods shall meet all design criteria specified in Section 6.13.

N **6.14.2** The portions of the particulate blocking hood interface component that include a particulate blocking material specifically for meeting the requirements of 7.14.1 shall include all areas of the hood to at least 37 mm (1.5 in.) above the reference plane when measured at the coronal plane and all areas of the hood to at least 200 mm (8 in.) at the sides when measured at the coronal plane and 225 mm (9 in.) at the front and rear when measured at the midsagittal plane below the reference plane as measured when the hood is placed on an ISO Size J headform.

N **6.14.3** Bindingincluding the elastic and stitching around the particulate blocking hood face opening shall be permitted to exclude particulate blocking material specifically for meeting the requirements of 7.14.1 for a distance of 50 mm (2 in.) from the leading edge of the hood face opening. The distance shall be measured in eight separate locations with the hood lying on a flat surface with the face opening facing upwards and measured from the innermost row of stitching to the face opening leading edge.

6.15 Additional Design Requirements for Proximity Fire Fighting Protective Hood Interface Components Only. (Reserved)

6.16 Protective Wristlets Interface Component Design Requirements for Both Ensembles.

6.16.1 Wristlet interface components shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.16.2* Wristlets shall be designed to cover and provide limited protection to the wrist areas.

6.16.3 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 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. (Reserved)

6.18 Additional Design Requirements for Proximity Fire Fighting Protective Wristlet Interface Components Only. (Reserved)

6.19 Optional Design Requirements for Protection from Liquid and Particulate Contaminants.

6.19.1 Liquid and Particulate Contaminants Protective Ensemble Design Requirements for Both Ensembles.

6.19.1.1 Liquid and particulate contaminant protective ensembles shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.19.1.2 Liquid and particulate contaminant protective ensembles, including SCBA, shall be designed to protect the wearer's upper and lower torso, head, arms, legs, hands, and feet.

6.19.1.3 Liquid and particulate contaminant protective ensemble elements shall include garments, helmet, gloves, footwear, interface components, and hood when the hood is not already part of the protective garment.

Δ **6.19.1.4** The manufacturer shall specify each SCBA that is part of the liquid and particulate contaminant protective ensemble. All SCBA specified by the ensemble manufacturer for inclusion in the ensemble shall be certified to NFPA 1981.

6.19.1.5 Liquid and particulate contaminant ensembles shall be designed to accommodate the SCBA specified by the manufacturer for the specific ensemble.

6.19.2 Additional Liquid and Particulate Contaminant Protection Design Requirements for Structural Fire Fighting Protective Ensembles Only. (Reserved)

6.19.3 Additional Liquid and Particulate Contaminant Protection Design Requirements for Proximity Fire Fighting Protective Ensembles Only. (Reserved)

6.19.4 Liquid and Particulate Contaminant Protective Garment Element Design Requirements for Both Ensembles.

6.19.4.1 Liquid and particulate contaminant protective garments shall have at least the applicable design requirements specified in this subsection where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.19.4.2 Liquid and particulate contaminant protective garments shall be designed and configured to protect at least the wearer's upper and lower torso, arms and legs, but excluding the hands, feet, and head.

6.19.4.2.1 Liquid and particulate contaminant protective garments shall be permitted to include integrated hoods to protect the wearer's head in conjunction with the SCBA specified by the ensemble manufacturer.

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

6.19.5 Additional Liquid and Particulate Contaminant Protection Design Requirements for Structural Fire Fighting Protective Garment Elements Only. (Reserved)

6.19.6 Additional Liquid and Particulate Contaminant Protection Design Requirements for Proximity Fire Fighting Protective Garment Elements Only. (Reserved)

6.19.7 Liquid and Particulate Contaminant Protective Helmet Elements Design Requirements for Both Ensembles.

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

Δ **6.19.7.2** Where the liquid and particulate protection is provided by the protective hood and provides an interface with the SCBA specified by the ensemble manufacturer, the manufacturer shall not be required to specify a specific helmet as part of the liquid and particulate contaminant protective ensemble.

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6.19.8 Additional Liquid and Particulate Contaminant Protection Design Requirements for Structural Fire Fighting Protective Helmet Elements Only. (Reserved)

6.19.9 Additional Liquid and Particulate Contaminant Protection Design Requirements for Proximity Fire Fighting Protective Helmet Elements Only. (Reserved)

6.19.10 Liquid and Particulate Contaminant Protective Glove Elements Design Requirements for Both Ensembles.

6.19.11 Additional Liquid and Particulate Contaminant Protection Design Requirements for Structural Fire Fighting Protective Glove Elements Only. (Reserved)

6.19.12 Additional Liquid and Particulate Contaminant Protection Design Requirements for Proximity Fire Fighting Protective Glove Elements Only. (Reserved)

6.19.13 Liquid and Particulate Contaminant Protective Footwear Elements Design Requirements for Both Ensembles.

6.19.14 Additional Liquid and Particulate Contaminant Protection Design Requirements for Structural Fire Fighting Protective Footwear Elements Only. (Reserved)

6.19.15 Additional Liquid and Particulate Contaminant Protection Design Requirements for Proximity Fire Fighting Protective Footwear Elements Only. (Reserved)

6.19.16 Liquid and Particulate Contaminant Protective Hood Interface Component Design Requirements for Both Ensembles.

6.19.16.1 Liquid and particulate contaminant protective hood interface components shall have at least the applicable design requirements specified in this subsection where inspected by the certification organization as specified in Section 4.3, Inspection and Testing.

6.19.16.2 Liquid and particulate contaminant protective hood interface components shall be designed and configured to protect the wearer's head, neck, and face areas, excluding the portion of the face covered by the facepiece of the SCBA specified by the ensemble manufacturer.

6.19.16.3 Liquid and particulate contaminant protective hood interface components shall be permitted to be integrated with the protective garment.

6.19.17 Liquid and Particulate Contaminant Protective Hood Interface Component Design Requirements for Structural Fire Fighting Ensembles. (Reserved)

6.19.18 Liquid and Particulate Contaminant Protective Shroud Interface Component Design Requirements for Proximity Fire Fighting Ensembles. (Reserved)

Chapter 7 Performance Requirements

7.1 Protective Garment Elements Performance Requirements for Both Ensembles.

7.1.1* Protective garment elements composite consisting of outer shell, moisture barrier, and thermal barrier shall be tested for thermal insulation as specified in Section 8.10, Thermal Protective Performance (TPP) Test, and shall have an average TPP of not less than 35.0.

7.1.2 Garments shall be tested for overall liquid penetration resistance as specified in Section 8.48, Whole Garment and Ensemble Liquid Penetration Test, and shall allow no liquid penetration except as permitted in 8.48.8.2.

Δ **7.1.3** 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, 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.

7.1.3.1 Labels shall meet the performance requirements specified in 7.1.3 only where placed on the exterior of the garment.

7.1.3.2 Zippers and seam-sealing materials shall meet the performance requirements specified in 7.1.3 only where located on the exterior of the garment or located where they will directly contact the wearer's body.

7.1.3.3 Elastic and hook and pile fasteners shall meet the performance requirements specified in 7.1.3 only where located where they will directly contact the wearer's body.

Δ **7.1.3.4** 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 shall be tested for resistance to flame as specified in Section 8.2, 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.

7.1.3.5 Life safety harnesses, escape belts, and ladder belts shall meet the performance requirements specified in 7.1.3 only when they penetrate the outer shell, are incorporated as part of a garment closure system, or are attached to the garment.

7.1.4 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, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10.0 percent in any direction.

7.1.5 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, Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

7.1.6 Garment moisture barrier seams shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not drip or ignite.

7.1.7 Garment outer shells and collar linings shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not char.

7.1.8 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, Heat and Thermal Shrinkage Resistance Test, and shall not ignite and shall remain functional.

7.1.9 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, Conductive and Compressive Heat Resistance (CCHR) Test, and shall demonstrate passing performance.

7.1.10 All sewing thread utilized in the construction of garments and DRDs shall be tested for resistance to melting as specified in Section 8.11, Thread Melting Test, and shall not melt at or below 260°C (500°F).

7.1.11 Garment outer shells and collar linings shall be individually tested for resistance to tearing as specified in Section 8.12, Tear Resistance Test, and shall have a tear strength of not less than 100 N (22 lbf).

7.1.12 Garment moisture barriers, thermal barriers, and winter liners, where provided, shall be tested for resistance to tearing as specified in Section 8.12, Tear Resistance Test, and shall have a tear strength of not less than 22 N (5 lbf).

7.1.13 All garment seam assemblies shall be tested for strength as specified in Section 8.14, Seam-Breaking Strength Test.

7.1.13.1 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 8.14.3.2.1.

7.1.13.2 Seam breaking strength shall be considered acceptable where the fabric strength is less than the required seam strength specified in 7.1.13.1, providing the fabric fails without failure of the seam below the applicable forces specified in 7.1.13.1.

7.1.13.3 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 8.14.3.2.2.

7.1.13.4 All combination woven and knit or stretch knit seam specimens shall meet the requirements specified in 7.1.13.1.

7.1.14 Garment moisture barriers shall be tested for resistance to water penetration as specified in Section 8.26, Water Penetration Resistance Test, and shall have a minimum water penetration resistance of 172 kPa (25 psi).

7.1.15* Garment moisture barrier materials and seams shall be tested for resistance to liquid penetration as specified in Section 8.27, Liquid Penetration Resistance Test, and shall show no penetration of the test liquids for at least 1 hour.

7.1.16 Garment moisture barriers and moisture barrier seams shall be tested for resistance to liquid or bloodborne pathogens as specified in Section 8.28, Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.1.17 Garment moisture barriers, thermal barriers, winter liners where provided, and collar linings shall be individually tested for resistance to shrinkage as specified in Section 8.24, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

7.1.18 Garment outer shells and collar linings shall be individually tested for resistance to water absorption as specified in Section 8.25, Water Absorption Resistance Test, and shall not have more than 15 percent water absorption.

7.1.19 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 8.29, 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.

7.1.20 Labels shall be tested for durability and legibility as specified in Section 8.41, Label Durability and Legibility Test 1, shall remain in place, and shall be legible.

7.1.21 DRD materials, seams, splices, and joints shall be tested for material strength as specified in Section 8.58, Drag Rescue Device (DRD) Materials Strength Test, and shall have a minimum tensile strength of 7 kN (1573 lbf).

7.1.22 Garments with the DRD installed shall be tested for functionality as specified in Section 8.59, Drag Rescue Device (DRD) Function Test, and shall allow for the mannequin to be dragged for a minimum of 2.5 m (98 in.), the DRD shall be deployed within 10 seconds, the SCBA shall not move higher on the torso from the donned position, and the SCBA shall not separate from the mannequin.

7.1.23 Garment moisture barrier materials shall be tested for resistance to light degradation as specified in Section 8.62, Light Degradation Resistance Test, and water shall not appear on the surface of the specimen.

7.1.24 Garment zippers shall be tested for crosswise breaking strength of chain; crosswise breaking strength of separating unit; holding strength of stops, retainers, and separating units; operating force; and slider lock strength requirements of A-A-55634A, *Commercial Item Description, Zippers (Fasteners, Slide, Interlocking).*

7.1.25 Fastener tape shall be tested for breaking strength as specified in Section 8.69, Fastener Tape Strength Test, and shall meet or exceed the minimum breaking strength require-

ments as established in Table 1 of A-A 55126B, *Commercial Item Description, Fastener Tapes, Hook and Loop, Synthetic.*

7.1.26 Fastener tape shall be tested for shear strength as specified in Section 8.69, Fastener Tape Strength Test, and shall meet or exceed the minimum shear strength requirements as established in Table 1 of A-A 55126B, *Commercial Item Description, Fastener Tapes, Hook and Loop, Synthetic.*

7.1.27 Fastener tape shall be tested for peel strength as specified in Section 8.69, Fastener Tape Strength Test, and shall meet or exceed the minimum peel strength requirements as established in Table 1 of A-A 55126B, *Commercial Item Description, Fastener Tapes, Hook and Loop, Synthetic.*

7.2 Additional Performance Requirements for Structural Fire Fighting Protective Garment Elements Only.

7.2.1 Structural 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 Elements Performance Requirements for Both Ensembles.

7.2.2* Garment composite consisting of the outer shell, moisture barrier, and thermal barrier shall be tested for evaporative heat transfer as specified in Section 8.33, Total Heat Loss (THL) Test, and shall have a THL of not less than 205 W/m^2.

7.2.3 Garment trim shall be tested for retroreflectivity and fluorescence as specified in Section 8.45, Retroreflectivity and Fluorescence Test, and shall have a coefficient of retroreflection (R_a) of not less than 100 cd/lux/m^2 (100 cd/fc/ft^2), and shall have the color be fluorescent yellow-green, fluorescent orange-red, or fluorescent red.

7.2.4 Garment outer shells shall be individually tested for resistance to shrinkage as specified in Section 8.24, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

7.2.5 Garment outer shells and collar linings shall be individually tested for strength after washing as specified in Section 8.50, Breaking Strength Test, and shall have a breaking strength of not less than 623 N (140 lbf).

Δ **7.2.6** Garment element sleeves that include enhancements exterior to the outer shell shall be considered enhanced composites. Enhancements shall include items such as visibility markings and other materials used in construction, including, but not limited to, padding, reinforcements, emblems, patches, and logos, but excluding reinforcement materials that do not extend more than 25 mm (1 in.) when measured from the edge of the cuff along the sleeve. The enhanced composite shall be tested for transmitted and stored thermal energy as specified in Section 8.67, Transmitted and Stored Thermal Energy Test, and shall have an average predicted time to second-degree burn of 130 seconds or greater.

7.3 Additional Performance Requirements for Proximity Fire Fighting Protective Garment Elements 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 Elements Design Requirements for Both Ensembles.

7.3.2 Garment outer shells shall be tested for radiant reflective capability as specified in Section 8.52, Radiant Protective Performance Test, and shall have an intersect time 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, Wet Flex Test, and shall show no signs of cracking on the face or delamination.

7.3.4 Garment outer shells shall be tested for adhesion durability as specified in Section 8.55, Adhesion After Wet Flex–Tape Method, and shall show no evidence of separation or removal of the surface coating.

7.3.5 Garment outer shells shall be tested for flex durability as specified in Section 8.56, Flex at Low Temperature Test, 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, Resistance to High-Temperature Blocking, and shall show no blocking.

7.4 Protective Helmet Elements Performance Requirements for Both Ensembles.

7.4.1 Protective helmet elements shall be tested for resistance to impact as specified in Section 8.15, Top Impact Resistance Test (Force), and shall have no sample transmit a force of more than 3780 N (850 lbf).

7.4.2 Helmets shall be tested for resistance to impact as specified in Section 8.16, Impact Resistance Test (Acceleration), and shall have no specimen exceed the maximum acceleration specified in Table 7.4.2. 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. Helmets shall maintain sufficient structural integrity to withstand impacts in all five locations.

7.4.3 Helmets shall be tested for resistance to penetration as specified in Section 8.19, Physical Penetration Resistance Test, and shall exhibit no electrical or physical contact between the penetration test striker and the headform.

7.4.4 Helmets shall be tested for resistance to heat as specified in Section 8.6, 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) Distortion of the back of the helmet shell extending more than 40 mm (1 5/8 in.) below the original position of the helmet shell

Table 7.4.2 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	300 × Gn	2943.0	9660

Note: Gn denotes gravitational acceleration, which is defined as 9.81 m · sec/sec (32.2 ft · sec/sec).

(3) Distortion of the front and sides of the helmet shell extending more than 30 mm (1 $^{3}/_{16}$ in.) below the original position of the helmet shell
(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)* Any component of the helmet assembly, including but not limited to supplemental faceshields, extending more than 30 mm (1 $^{3}/_{16}$ in.) below the initial lowest point of the helmet shell in the front area, both before and after oven exposure
(9) Dripping of the faceshield/goggle component

7.4.5 Helmets shall be tested for resistance to flame as specified in Section 8.3, 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 Helmet ear covers and helmet shrouds 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.

7.4.7 Helmets shall be tested for retention ability as specified in Section 8.34, 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 Helmet suspension systems shall be tested for retention ability as specified in Section 8.35, Suspension System Retention Test, and shall not separate from the helmet.

7.4.9 Helmets shall be tested for shell retention ability as specified in Section 8.43, Shell Retention Test, and shall not have the helmet shell separate from the helmet suspension and retention systems.

7.4.10 All materials utilized in the construction of helmet chin straps, excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body or hood, shall be individually tested for resistance to flame as specified in Section 8.2, 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 All materials utilized in the construction of helmet chin straps, excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body or hood, shall be individually tested for resistance to heat as specified in Section 8.6, 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 All sewing thread used in the construction of helmets shall be tested for melting resistance as specified in Section 8.11, Thread Melting Test, and shall not melt below 260°C (500°F).

7.4.13 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 8.29, 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.

7.4.14 Labels shall be tested for durability and legibility as specified in Section 8.42, Label Durability and Legibility Test 2, shall remain in place, and shall be legible.

7.4.15 Faceshield/goggle components shall be tested for resistance to impact as specified in Section 8.17, Faceshield/Goggle Component Lens Impact Resistance Test, Tests One and Two, and shall not have any faceshield/goggle component contact an "eye" of the headform, and shall not have any parts or fragments be ejected from the component that could contact the eye of the headform.

7.4.16 Faceshield/goggle components shall be tested for flame resistance as specified in Section 8.3, Flame Resistance Test 2, Procedure B, and shall not show any visible afterflame 5.0 seconds after removal of the test flame.

7.5 Additional Performance Requirements for Structural Fire Fighting Protective Helmet Elements Only.

7.5.1 Structural fire fighting protective helmet elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.4, Protective Helmet Elements Performance Requirements for Both Ensembles.

7.5.2 All fabrics utilized in construction of faceshield/goggle components shall be tested for flame resistance as specified in Section 8.2, Flame Resistance Test 1, and 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.

7.5.3 Faceshield/goggle component lenses shall be tested for resistance to scratching as specified in Section 8.22, Faceshield/Goggle Component Lens Scratch Resistance Test, and shall not exhibit a delta haze of greater than 25 percent.

7.5.4 Faceshield/goggle component lenses shall be tested for transmittance of light as specified in Section 8.44, Luminous (Visible) Transmittance Test, and shall have clear lenses transmit a minimum of 85 percent of the incident visible radiation, and shall have colored lenses transmit a minimum of 43 percent of the incident visible radiation.

7.5.5 Where provided, the faceshield/goggle component attachment hardware shall be tested for flame resistance as specified in Section 8.3, Flame Resistance Test 2, Procedure D, and shall not show any visible afterflame 5.0 seconds after removal of the test flame.

7.5.6 Helmets shall be tested for resistance to electricity as specified in both Procedure A and Procedure B of Section 8.30, Electrical Insulation Test 1, and shall not have leakage current exceeding 3.0 mA in each test.

7.5.7 All materials utilized in the construction of helmet ear covers, excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body or hood, shall be individually tested for resistance to flame as specified in Section 8.2, Flame Resistance Test 1, 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.

Δ **7.5.8** All materials utilized in the construction of helmet ear covers, excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body or hood, shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction, and shall not melt, separate, or ignite.

7.5.9 Helmet visibility markings shall be tested for retroreflectivity and fluorescence as specified in Section 8.45, Retroreflectivity and Fluorescence Test, and shall have a coefficient of retroreflection (*Ra*) of not less than 100 cd/lux/m^2 (100 cd/fc/ft^2), and shall have the color be fluorescent yellow-green, fluorescent orange-red, or fluorescent red.

N **7.5.10** Helmet ear covers shall be capable of being detached from and reinstalled on the helmet per the manufacturer's instructions within a period of 20 minutes.

7.6 Additional Performance Requirements for Proximity Fire Fighting Helmet Elements Only.

7.6.1 Proximity fire fighting protective helmet elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.4, Protective Helmet Elements Performance Requirements for Both Ensembles.

7.6.2 Helmets shall be tested for radiant heat resistance as specified in Section 8.53, Radiant Heat Resistance Test 3, and shall not have a temperature rise of more than 25°C (45°F).

7.6.3 Helmet shrouds shall be tested for radiant reflective capability as specified in Section 8.52, Radiant Protective Performance Test, and shall have an intersect time of not less than 20 seconds.

7.6.4 Helmet shrouds with a laminate base fabric shall be tested for resistance to delamination as specified in Section 8.54, Wet Flex Test, and shall show no signs of cracking on the face or delamination.

7.6.5 Helmet shrouds shall be tested for adhesion durability as specified in Section 8.55, Adhesion After Wet Flex–Tape Test, and shall show no evidence of separation or removal of the surface coating.

7.6.6 Helmet shrouds shall be tested for flex durability as specified in Section 8.56, Flex at Low Temperature Test, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.6.7 Helmet shrouds shall be tested for blocking durability as specified in Section 8.57, Resistance to High-Temperature Blocking Test, and shall show no blocking.

Δ **7.6.8** All materials utilized in the construction of proximity helmet covers and shrouds, excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body or hood, shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction, and shall not melt, separate, or ignite.

7.6.9 Helmet shroud outer shell material shall be individually tested for resistance to tearing as specified in Section 8.12, Tear Resistance Test, and shall have a tear strength of not less than 100 N (22 lbf).

7.6.10 Helmet faceshield component lenses shall be tested for transmittance of light as specified in Section 8.44, Luminous (Visible) Transmittance Test, and shall transmit not less than 30 percent of the incident visible radiation.

7.6.11 Helmet faceshields shall be tested for radiant reflective capability as specified in Section 8.52, Radiant Protective Performance Test, and shall have an intersect time of not less than 30 seconds.

7.6.12 Helmet outer covers, where provided, shall be tested for radiant reflective capability as specified in Section 8.52, Radiant Protective Performance Test, and shall have an intersect time of not less than 20 seconds.

7.6.13 Helmet outer covers, where provided, shall be tested for resistance to delamination as specified in Section 8.54, Wet Flex Test, and shall show no signs of cracking on the face or delamination.

7.6.14 Helmet outer covers, where provided, shall be tested for adhesion durability as specified in Section 8.55, Adhesion After Wet Flex–Tape Method Test, and shall show no evidence of separation or removal of the surface coating.

7.6.15 Helmet outer covers, where provided, shall be tested for flex durability as specified in Section 8.56, Flex at Low Temperature Test, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.6.16 Helmet outer covers, where provided, shall be tested for blocking durability as specified in Section 8.57, Resistance to High-Temperature Blocking Test, and shall show no blocking.

7.6.17 Helmet outer covers, where provided, shall be tested for resistance to tearing as specified in Section 8.12, Tear Resistance Test, and shall have a tear strength of not less than 22 N (5 lbf).

7.6.18 All materials utilized in the construction of proximity helmet covers and shrouds, excluding elastic and hook and pile fasteners where these items are placed so that they will not directly contact the wearer's body or hood, shall be individually tested for resistance to flame as specified in Section 8.2, 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.

N **7.6.19** Helmet faceshield component lenses shall be tested for resistance to scratching as specified in Section 8.22, Faceshield/Goggle Component Lens Scratch Resistance Test, and shall not exhibit a delta haze of greater than 5 percent.

N **7.6.20** Proximity faceshields shall be tested for adhesion of reflective coating as specified in Section 8.46, Adhesion of Reflective Coating on Proximity Faceshield — Tape Method, and shall show evidence of removal not to exceed 2B classification (i.e., 15 percent to 35 percent removal).

7.7 Protective Glove Elements Performance Requirements for Both Ensembles.

7.7.1 The glove body composite 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 35.0.

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N **7.7.2** The glove interface component composite 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.

7.7.3 Gloves shall be tested for resistance to heat as specified in Section 8.6, 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.

7.7.3.1 Hook and pile fasteners on gloves shall be excluded from these requirements where these items are placed such that they will not directly contact the wearer's body.

7.7.3.2 Where hook and pile fasteners are placed on the gloves such that they will directly contact the wearer's body, they shall not melt, separate, or ignite when tested as part of the whole glove.

7.7.4 The glove lining materials of the glove body shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

Δ **7.7.5** Portions of the glove body composite representative of the palm of the glove shall be tested for conductive heat resistance as specified in Section 8.7, 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 The glove body composite, including, but not limited to, trim, external labels, and external tags, but excluding hardware, and excluding hook and pile fasteners that do not directly contact the wearer's body, shall be tested for resistance to flame as specified in Section 8.4, 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.

Δ **7.7.7** The glove interface component composite, including but not limited to trim, external labels, and external tags, but excluding hardware and hook and pile fasteners that do not directly contact the wearer's body, shall be tested for resistance to flame as specified in Section 8.4, 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.

Δ **7.7.8** The glove extension composite, including but not limited to trim, external labels, and external tags, but excluding hardware and hook and pile fasteners that do not directly contact the wearer's body, shall be tested for resistance to flame as specified in Section 8.4, 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.

7.7.9* All sewing thread utilized in the construction of gloves shall be tested for melting resistance as specified in Section 8.11, Thread Melting Test, and shall not melt at or below 260°C (500°F).

7.7.10 The glove body seams shall be tested for resistance to liquid-borne or blood-borne pathogens as specified in Section 8.28, Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.7.11* Glove body seams shall be tested for resistance to liquid penetration as specified in Section 8.27, Liquid Penetration Resistance Test, and shall allow no penetration of test liquids for at least 1 hour.

7.7.12 The glove body composite shall be tested for resistance to cut as specified in Section 8.21, Cut Resistance Test, and shall have a distance of blade travel of more than 20 mm (0.8 in.).

7.7.13 The glove interface component shall be tested for resistance to cut as specified in Section 8.21, Cut Resistance Test, and shall have a distance of blade travel of more than 20 mm (0.8 in.).

7.7.14 The glove body composite shall be tested for resistance to puncture as specified in Section 8.20, Puncture Resistance Test, and shall not be punctured under an average applied force of 40 N (8.8 lbf).

7.7.15* Gloves shall be tested for hand function as specified in Section 8.37, Glove Hand Function Test, and shall have an average percent of bare-handed control not exceeding 220 percent.

7.7.16 Knit glove wristlet material(s) shall be tested for material strength as specified in Section 8.13, Burst Strength Test, and shall have a burst strength of not less than 225 N (51 lbf).

7.7.17 Glove body to glove interface component major seams shall be tested for seam strength as specified in Section 8.14, Seam-Breaking Strength Test, and shall have a burst strength of not less than 182 N (41 lbf).

7.7.18* Gloves shall be tested for resistance to leakage as specified in Section 8.32, Overall Liquid Integrity Test 1, and shall show no leakage.

7.7.19* Gloves shall be tested for ease of donning as specified in Section 8.36, Glove Donning Test, and shall have the dry hand donning time not exceed 10 seconds, shall have the wet hand donning time not exceed 30 seconds, shall have no detachment of the inner liner, shall have no detachment of the moisture barrier, and shall allow full insertion of all digits.

7.7.20 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.

7.7.21 Labels shall be tested for durability and legibility as specified in Section 8.41, Label Durability and Legibility Test 1, shall remain in place, and shall be legible.

7.7.22 Gloves shall be tested for grip as specified in Section 8.38, Grip Test, and shall not have a drop of force of more than 30 percent in any 0.2-second interval.

7.7.23 Gloves shall be tested using the torque test as specified in Section 8.68, Torque Test, and shall have an average percent of bare-handed control not less than 80 percent.

7.7.24 Gloves shall be tested for hand function as specified in Section 8.70, Glove Tool Test, and shall have an average percent of bare-handed control not exceeding 175 percent.

N **7.7.25** The glove body composite at the back of the glove shall be tested for radiant heat resistance as specified in Section 8.67, Transmitted and Stored Thermal Energy Test, and shall have a second-degree burn time of not less than 130 seconds.

7.8 Additional Performance Requirements for Structural Fire Fighting Protective Glove Elements Only.

7.8.1 Structural fire fighting protective glove elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.7, Protective Glove Elements Performance Requirements for Both Ensembles.

7.8.2 All glove metal hardware and all glove hardware that include metal parts shall be individually tested for resistance to corrosion as specified in Section 8.29, 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.

7.9 Additional Performance Requirements for Proximity Fire Fighting Protective Glove Elements Only.

7.9.1 Proximity fire fighting protective glove elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.7, Protective Glove Elements Performance Requirements for Both Ensembles.

7.9.2 The radiant reflective protective areas as required in Section 6.9, Additional Design Requirements for Proximity Fire Fighting Protective Glove Elements Only, of the glove body, glove interface component, and glove extension shall be tested for radiant reflective capability as specified in Section 8.53, Radiant Protective Performance Test, and shall have an intersect time of not less than 20 seconds.

7.9.3 The radiant reflective protective areas as required in Section 6.9, Additional Design Requirements for Proximity Fire Fighting Protective Glove Elements Only, of the glove body, glove interface component, and glove extension shall be tested for resistance to delamination as specified in Section 8.55, Wet Flex Test, and shall show no signs of cracking on the face or delamination.

7.9.4 The radiant reflective protective areas as required in Section 6.9, Additional Design Requirements for Proximity Fire Fighting Protective Glove Elements Only, of the glove body, glove interface component, and glove extension shall be tested for adhesion durability as specified in Section 8.55, Adhesion After Wet Flex–Tape Method Test, and shall show no evidence of separation or removal of the surface coating.

7.9.5 The radiant reflective protective areas as required in Section 6.9, Additional Design Requirements for Proximity Fire Fighting Protective Glove Elements Only, of the glove body, glove interface component, and glove extension shall be tested for flex durability as specified in Section 8.56, Flex at Low Temperature, and shall show no evidence of breaking, shattering, or cracking of the coating, laminate, or fabric.

7.9.6 The radiant reflective protective areas as required in Section 6.9, Additional Design Requirements for Proximity Fire Fighting Protective Glove Elements Only, of the glove body, glove interface component, and glove extension shall be tested for blocking durability as specified in Section 8.57, Resistance to High-Temperature Blocking Test, and shall show no blocking.

7.10 Protective Footwear Elements Performance Requirements for Both Ensembles.

7.10.1 Protective footwear elements shall be tested for thermal insulation as specified in Section 8.8, Conductive Heat Resistance Test 2, and the temperature of the insole surface in contact with the foot shall not exceed 44°C (111°F).

7.10.2 Footwear, with components in place, shall be tested for resistance to flame as specified in Section 8.5, Flame Resistance Test 4, shall not have an afterflame of more than 5.0 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.10.3 All sewing thread utilized in the construction of footwear shall be tested for melt resistance as specified in Section 8.11, Thread Melting Test, and shall not melt below 260°C (500°F).

7.10.4 The footwear upper material composite and footwear seams shall be tested for resistance to liquid penetration as specified in Section 8.27, Liquid Penetration Resistance Test, and shall allow no penetration of the test liquids for at least 1 hour.

7.10.5 The footwear upper material composite and footwear seams shall be tested for resistance to liquid- or blood-borne pathogens as specified in Section 8.28, Viral Penetration Resistance Test, and shall allow no penetration of the Phi-X-174 bacteriophage for at least 1 hour.

7.10.6 Footwear shall be tested for resistance to puncture as specified in Section 8.20, Puncture Resistance Test, and shall not puncture the footwear upper under an average applied force of 60 N (13 lbf).

7.10.7 Footwear uppers shall be tested for resistance to cut as specified in Section 8.21, Cut Resistance Test, and shall have a cut distance resistance of more than 20 mm (0.8 in.).

7.10.8 Footwear shall be tested for slip resistance as specified in Section 8.40, Slip Resistance Test, and shall have a coefficient of friction of 0.40 or greater.

7.10.9 Footwear soles and heels shall be tested for resistance to abrasion as specified in Section 8.23, Abrasion Resistance Test, and the relative volume loss shall not be greater than 250 mm^3 (0.015 $in.^3$).

7.10.10* Footwear shall be tested for resistance to electricity as specified in Section 8.31, Electrical Insulation Test 2, and shall have no current leakage in excess of 3.0 mA.

7.10.11 Footwear ladder shanks or whole sole equivalents shall be tested for resistance to bending as specified in Section 8.39, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm (¼ in.).

7.10.12 Footwear stud posts and eyelets shall be tested for attachment strength as specified in Section 8.49, Eyelet and Stud Post Attachment Test, and shall have a minimum detachment strength of 294 N (66 lbf).

Δ **7.10.13** All footwear metal hardware and specimens of all footwear hardware that include metal parts, including but not limited to toe cap, ladder shank, and components, shall be

individually tested for resistance to corrosion as specified in Section 8.29, 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.

Δ **7.10.14** Labels shall be tested for durability and legibility as specified in Section 8.41, Label Durability and Legibility Test 1, shall remain in place, and shall be legible.

7.10.15 Footwear shall be tested for resistance to heat as specified in Section 8.6, 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.

7.11 Additional Performance Requirements for Structural Fire Fighting Protective Footwear Elements Only.

7.11.1 Structural fire fighting protective footwear elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.10, Protective Footwear Elements Performance Requirements for Both Ensembles.

7.11.2 Footwear shall be tested for thermal insulation as specified in Section 8.9, Radiant Heat Resistance Test 1, and the temperature of the upper surface in contact with the skin shall not exceed 44°C (111°F).

7.11.3 Footwear shall be tested for thermal insulation as specified in Section 8.7, 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.

7.12 Additional Performance Requirements for Proximity Fire Fighting Protective Footwear Elements Only.

7.12.1 Proximity fire fighting protective footwear elements shall also meet the performance requirements specified in this section in addition to the performance requirements specified in Section 7.10, Protective Footwear Elements Performance Requirements for Both Ensembles.

7.12.2 Footwear shall be tested for thermal insulation as specified in Section 8.60, Conductive Heat Resistance Test 3, and the temperature of the upper lining surface in contact with skin shall not reach 44°C (111°F) in 10 minutes or less.

7.12.3 Footwear shall be tested for thermal insulation as specified in Section 8.61, Radiant Heat Resistance Test 2, and the temperature of the upper lining surface in contact with the skin shall not exceed 44°C (111°F).

7.13 Protective Hood Interface Component Performance Requirements for Both Ensembles.

7.13.1 Fire fighting protective hood face openings that are not designed for interface with a specific SCBA facepiece shall be tested for shape retention as specified in Section 8.47, Hood Opening Size Retention Test, and shall slide freely over the top half of the hood measuring device while in the relaxed state and shall not show any gaps when placed on the lower half of the hood measuring device.

7.13.1.1 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, 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 (½ in.).

7.13.2 Hoods 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 not less than 20.0.

7.13.3 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, 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.

7.13.4 Hoods, excluding labels, hook and pile fasteners, and elastic, shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall slide freely over the top half of the hood measuring device while in the relaxed state, shall not show any gaps when placed on the lower half of the hood measuring device, and shall not shrink more than 10 percent.

7.13.5 Hoods, 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, Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

Δ **7.13.6** Hoods with elastic or manually adjustable face openings shall be individually tested for resistance to shrinkage as specified in Section 8.24, Cleaning Shrinkage Resistance Test, and shall slide freely over the top half of the hood measuring device while in the relaxed state, shall not show any gaps when placed on the lower half of the hood measuring device, and shall not have the measurements made from the top of the hood to the marks at the back and both sides of the hood exhibit shrinkage of more than 5 percent.

N **7.13.6.1** Hoods designed to interface with a specific SCBA facepiece shall be individually tested for resistance to shrinkage as specified in Section 8.24, Cleaning Shrinkage Resistance Test, and the overlap of the outer edge of the hood and the specific SCBA facepiece shall not shrink more than 5 percent. The measurements from the top of the hood to the marks at the back and both sides of the hood shall not exhibit shrinkage of more than 5 percent.

7.13.7 All sewing thread utilized in the construction of hoods shall be tested for melting resistance as specified in Section 8.11, Thread Melting Test, and shall not melt below 260°C (500°F).

7.13.8 The outermost hood material shall be tested for material strength as specified in Section 8.13, Burst Strength Test, and shall have a burst strength of not less than 225 N (51 lbf). All additional hood material layers shall be tested for material strength as specified in Section 8.13, Burst Strength Test, and shall have a burst strength of not less than 225 N (51 lbf).

7.13.9 Hood seams shall be tested for seam strength as specified in Section 8.14, Seam-Breaking Strength Test, and shall have a burst strength of not less than 181 N (41 lbf).

Δ **7.13.10** Labels shall be tested for durability and legibility as specified in Section 8.41, Label Durability and Legibility Test 1, shall remain attached to the hood, and shall be legible.

7.14* Additional Performance Requirements for Optional Structural Fire Fighting Protective Hood Interface Components Providing Particulate Protection.

N **7.14.1** Hood composite materials shall meet all performance criteria specified in Section 7.13, Protective Hood Interface Component Performance Requirements for Both Ensembles.

N **7.14.2** Hood composite materials that incorporate a particulate blocking layer shall be tested for particulate blocking as specified in Section 8.71, Particulate Blocking Test, and shall have a particulate filtration efficiency of 90 percent or greater for each particle size from 0.1 μm to 1.0 μm.

N **7.14.3*** Hood compositesincluding a particulate blocking layer shall be tested for evaporative heat transfer as specified in Section 8.33, Total Heat Loss (THL) Test, and shall have a THL of not less than 325 W/m^2.

7.15 Additional Performance Requirements for Proximity Fire Fighting Protective Hood Interface Components Only. (Reserved)

7.16 Protective Wristlet and Garment-Glove Interface Component Performance Requirements for Both Ensembles.

7.16.1 Protective wristlet interface components 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 not less than 20.0.

7.16.1.1 Where the coat sleeve end terminates in a garment-glove interface, the interface composite 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 not less than 35.0.

7.16.2 Wristlet material(s) shall be individually tested for resistance to flame as specified in Section 8.2, 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 Wristlet material(s) shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not shrink more than 10 percent in any direction.

7.16.4 Wristlet material(s) shall be individually tested for resistance to heat as specified in Section 8.6, Heat and Thermal Shrinkage Resistance Test, and shall not melt, separate, or ignite.

7.16.5 Wristlet material(s) shall be individually tested for resistance to shrinkage as specified in Section 8.24, Cleaning Shrinkage Resistance Test, and shall not shrink more than 5 percent in any direction.

7.16.6 All sewing thread utilized in the construction of wristlets shall be tested for melting resistance as specified in Section 8.11, Thread Melting Test, and shall not melt at or below 260°C (500°F).

7.16.7 Knit wristlet material(s) shall be tested for material strength as specified in Section 8.13, Burst Strength Test, and shall have a burst strength of not less than 225 N (51 lbf).

7.16.8 Knit wristlet seams 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 181 N (41 lbf).

7.16.9 Where the coat sleeve end terminates in a garment-glove interface, the interface area shall be tested in accordance with Section 8.48, Whole Garment and Ensemble Liquid Penetration Test, and shall allow no liquid penetration.

7.17 Additional Performance Requirements for Structural Fire Fighting Protective Wristlet Interface Components Only. (Reserved)

7.18 Additional Performance Requirements for Proximity Fire Fighting Protective Wristlet Interface Components Only. (Reserved)

7.19 Reserved.

7.20 Optional Performance Requirements for Protection from Liquid and Particulate Contaminants.

7.20.1 Liquid and Particulate Contaminant Protective Ensemble Performance Requirements for Both Ensembles.

Δ **7.20.1.1** The entire protective ensemble shall be tested for overall particulate inward leakage as specified in Section 8.66, Particle Inward Leakage Test, and shall allow no visual particulate inward leakage.

7.20.1.2 The entire CBRN ensemble shall be tested as specified in Section 8.48, Whole Garment and Ensemble Liquid Penetration Test, and shall show no liquid penetration.

• **7.20.2 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Structural Fire Fighting Protective Ensembles Only. (Reserved)**

7.20.3 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Proximity Fire Fighting Protective Ensembles Only. (Reserved)

7.20.4 Liquid and Particulate Contaminant Protective Garment Element Performance Requirements for Both Ensembles. (Reserved)

• **7.20.5 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Structural Fire Fighting Protective Garment Elements Only. (Reserved)**

7.20.6 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Proximity Fire Fighting Protective Garment Elements Only. (Reserved)

7.20.7 Protective Helmet Element Liquid and Particulate Contaminant Protection Performance Requirements for Both Ensembles. (Reserved)

7.20.8 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Structural Fire Fighting Protective Helmet Elements Only. (Reserved)

7.20.9 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Proximity Fire Fighting Protective Helmet Elements Only. (Reserved)

7.20.10 Protective Glove Elements Liquid and Particulate Contaminant Protection Performance Requirements for Both Ensembles. (Reserved)

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7.20.11 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Structural Fire Fighting Protective Glove Elements Only. (Reserved)

7.20.12 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Proximity Fire Fighting Protective Glove Elements Only. (Reserved)

7.20.13 Protective Footwear Elements Liquid and Particulate Contaminant Protection Performance Requirements for Both Ensembles. (Reserved)

7.20.14 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Structural Fire Fighting Protective Footwear Elements Only. (Reserved)

7.20.15 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Proximity Fire Fighting Protective Footwear Elements Only. (Reserved)

7.20.16 Protective Hood Interface Component Liquid and Particulate Contaminant Protection Performance Requirements for Both Ensembles. (Reserved)

7.20.17 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Structural Fire Fighting Protective Hood Interface Components Only. (Reserved)

7.20.18 Additional Liquid and Particulate Contaminant Protection Performance Requirements for Proximity Fire Fighting Protective Hood Interface Components Only. (Reserved)

Chapter 8 Test Methods

8.1 Sample Preparation Procedures.

8.1.1 Application.

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

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

Δ **8.1.2 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 of Fabrics after Home Laundering*. A 1.82 kg ± 0.1 kg (4.0 lb ± 0.2 lb) load shall be used. A laundry bag shall not be used. Gloves shall be tumble dried for 60 minutes and shall be removed immediately at the end of the drying cycle. At the conclusion of the final drying cycle, the gloves shall be direct dried on a forced-air non-tumble-drying mechanism operated at 10°C ± 5°C (18°F ± 9°F) above current room temperature until dry but for not less than 8 hours.

8.1.3 Room Temperature Conditioning Procedure for Garments, Trim, Helmets, Gloves, Footwear, and Faceshield/Goggle Components.

Δ **8.1.3.1** Garment, glove, trim, and footwear samples shall be conditioned at a temperature of 21°C ± 3°C (70°F ± 5°F) and a relative humidity of 65 percent ± 5 percent until equilibrium is reached, as determined in accordance with ASTM D1776/D1776M, *Standard Practice for Conditioning and Testing Textiles*, or for at least 24 hours. Specimens shall be tested within 5 minutes after removal from conditioning.

Δ **8.1.3.2** Helmet and faceshield/goggle component samples 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 for at least 4 hours. Specimens shall be tested within 5 minutes after removal from conditioning.

Δ **8.1.4 Low Temperature Environmental Conditioning Procedure for Helmets and Faceshield/Goggle Components.** Samples 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.

Δ **8.1.5 Convective Heat Conditioning Procedure for Helmets, Faceshield/Goggle Components, Gloves, Footwear, Moisture Barriers, Moisture Barrier Seams, Labels, Particulate Blocking Layer(s), and Trim.** Samples shall be conditioned by exposing them to the procedures specified in 8.6.4 and in 8.6.5.2 through 8.6.5.3, with the following modifications:

(1) The oven temperature shall be stabilized at 140°C, +6/−0°C (285°F, +10°/−0°F), for helmets, footwear, moisture barriers, moisture barrier seams, labels, particulate blocking layer(s), and trim, and the test exposure time shall be 10 minutes, +15/−0 seconds.

(2) The oven temperature 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 8.6.13.4 shall be followed.

(3) The exposure time shall begin when the test thermocouple reading has stabilized at the required exposure temperature.

(4) The requirements of 8.6.5.4 and 8.6.5.5 shall be disregarded.

(5) Helmet specimens shall be placed on a room temperature nonconductive headform conforming to the dimensions in Figure 8.6.12.3 before being placed in the oven. After oven exposure, 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 subsection. Only one helmet shall be conditioned at a time.

(6) For gloves, footwear, trim, labels, moisture barriers, and moisture barrier seam specimens, the required conditioning shall be performed no sooner than 24 hours after removal from conditioning. Samples shall be suspended in the oven such that there is a distance of at least 150 mm (6 in.) between items.

(7) 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 and by exposing them to a temperature of 108°C, +2/−0°C (225°F, +3/−0°F), for 20 minutes, +15/−0 seconds. Goggles shall be permitted to be placed directly on the headform without being attached to the helmet. 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 retested.

(8) The oven temperature shall be stabilized at 177°C, +6/−0°C (350°F, +10/−0°F), for glove moisture barriers, and the exposure time shall be 10 minutes, +15/−0 seconds. The glove moisture barrier sample pouch shall be filled to capacity with nominal 4 mm (5/32 in.) sized perforated soda-lime or borosilicate 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 samples shall be placed in the test oven at one time. The samples shall be suspended such that each sample is the same distance from the airflow source, so that no sample is blocking the airflow to other samples.

8.1.6 Radiant and Convective Heat Environmental Conditioning Procedure for Helmets.

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

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

8.1.6.3 The radiometer shall be a Schmidt-Boelter or Gardon type radiant heat flux transducer with a diameter of 25 mm, a minimum viewing angle of 150 degrees, a minimum spectral response flat within 3 percent over a range of at least 1.0 to 10.0 µm, and an overall accuracy of at least ±5 percent of the reading.

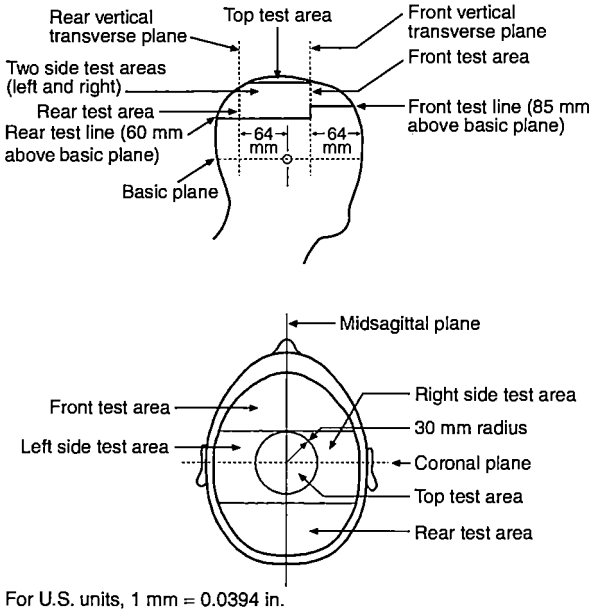
8.1.6.4 The radiant panel shall have an effective radiating surface of 150 mm ± 6 mm (6 in. ± 0.25 in.) square. The spectral radiant emittance curve of the radiant panel shall be that of a black body at a temperature of 1000°K ± 200°K (1340°F ± 360°F).

8.1.6.5 The radiant heat transducer shown in Figure 8.1.6.5 shall be constructed from sheet copper, ASTM B152/B152M, *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 (0.6 in. ± 0.39 in.) from the edges of the copper sheet on the same side, as shown in Figure 8.1.6.5. The side of the copper sheet opposite that with the wires attached shall be painted flat black. The resulting transducer is a Type J thermocouple that shall be used in conjunction with appropriate instrumentation to monitor the heat exposure to which the helmet is to be subjected.

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

8.1.6.7 The radiant panel shall be introduced in front of the radiometer with its effective radiating surface parallel to the plane tangent to the helmet surface at the center of the impact/penetration site on the helmet. The radiant panel shall be adjusted to obtain a stable uniform irradiance of 1.0 W/cm^2 ± 0.1 W/cm^2 over 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* 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



Δ FIGURE 8.1.6.1 Helmet Test Areas and Landmarks.

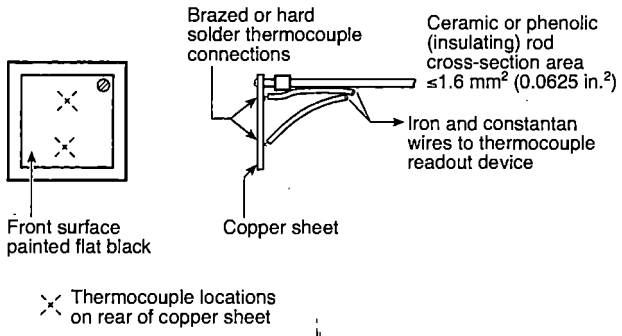


FIGURE 8.1.6.5 Radiant Heat Transducer.

± 15.0 seconds. A closed, insulated chamber shall be required to achieve this exposure time.

8.1.6.9 The chamber and helmet shall be stabilized at 25°C ± 5°C (77°F ± 9°F). The helmet shall be positioned in the chamber in the same position specified in 8.1.6.6. The helmet shall be subjected to the exposure conditions specified in 8.1.6.2 for the time recorded in 8.1.6.8. The exposure time shall be not less than the time recorded in 8.1.6.8, nor more than 5 seconds longer than that time.

8.1.7 Wet Conditioning Procedure for Helmets and Faceshield/Goggle Components. Samples 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 allowed to drain and be tested within 10 minutes after removal from water.

8.1.8 Wet Conditioning Procedure for Glove Composites.

8.1.8.1 Samples shall be conditioned by complete immersion in water at a temperature of 21°C ± 3°C (70°F ± 5°F) for 2 minutes.

Δ **8.1.8.2** Samples shall be removed from water, hung in a vertical position with glove pouch opening facing down for 5 minutes, and laid horizontal with AATCC textile blotting paper both under and over the specimen under a pressure of 0.035 kg/cm^2 ± 0.003 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.*

N **8.1.9* Wet Conditioning Procedure 2 for Glove Composites.**

N **8.1.9.1** Samples shall be conditioned by being subjected to a water spray that evenly deposits a mist of water on the thermal barrier layer of the composite using the apparatus and procedures described in 8.1.9.2 through 8.1.9.7.

N **8.1.9.2** A means of spraying water at a rate of 4.4 g ± 1.0 g (0.16 oz ± 0.04 oz) over a 20 second period or at an average rate of 0.22 g/s ± 0.5 g/s (0.008 oz/s ± 0.02 oz/s) uniformly over a 150 mm × 150 mm (6 in. × 6 in.) sample while measuring the weight of the sample shall be employed.

N **8.1.9.2.1** The nozzle shall be positioned directly over the sample.

N **8.1.9.2.2** The nozzle for applying the water spray shall be designed not to drip on the sample before the onset or after the completion of the designated water spray period.

N **8.1.9.2.3** The spraying shall be conducted in a closed chamber or area that limits disturbance of the mist deposition of the sample from air currents.

N **8.1.9.2.4** The sample shall be positioned on a balance that is capable of measuring the sample weight to the nearest 0.1 g (0.004 oz). The balance pan shall have a minimum pan dimension of 150 mm × 150 mm (6 in. × 6 in.).

N **8.1.9.2.5** The uniformity of the water spray shall be determined (calibration) by measuring the mass of water deposited into nine cups that measure 50 mm × 50 mm (2 in. × 2 in.) square that are positioned where water collects on the sample, as shown in Figure 8.1.9.2.5. Uniformity of the spray pattern shall be determined by measuring the weight of each dry cup prior to the calibration and then measuring the weight of the cup following the application of the spray for a period of 20 seconds where the coefficient of variance of the weight gained by the nine cups is no more than 20 percent.

N **8.1.9.3** Samples for conditioning shall be the innermost layer of the glove composite that are cut to 150 mm × 150 mm (6 in. × 6 in.).

N **8.1.9.4** The dry weight of the glove composite innermost layer sample to be wetted shall be measured on a spray chamber balance to the nearest 0.1 g (0.004 oz).

N **8.1.9.5** Separate sets of samples shall have a mass of 2.0 g / ± 0.1 g (0.070 oz /± 0.004 oz), 2.5 g ± 0.1 g (0.09 oz ± 0.004 oz), and 3.0 g /± 0.1 g (0.11 oz /± 0.004 oz) of water sprayed on the innermost layer of the glove composite as confirmed by the measurement of its weight on the balance.

N **8.1.9.6** Following the application of the water spray, the innermost layer of the glove shall be handled by the edges and assembled in a composite sample representative of the glove's construction for the area of the glove to be evaluated.

N **8.1.9.7** Samples subjected to this conditioning shall be evaluated within 5 minutes following the wetting.

8.1.10 Wet Conditioning Procedure for Whole Gloves.

Δ **8.1.10.1** 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 Figure 6.7.6.1 for size 70W (wide) and size 76W (wide) gloves.

8.1.10.2 The test subject shall don the test specimen gloves.

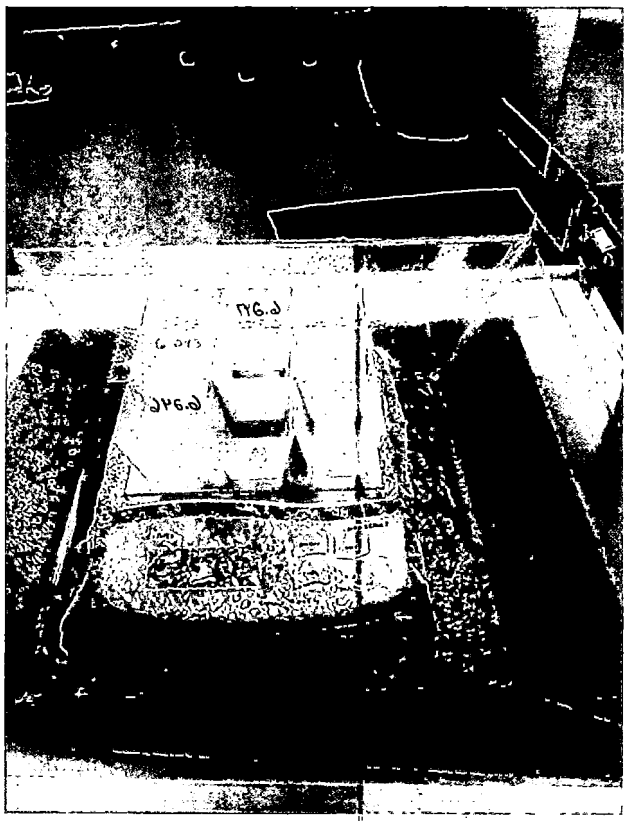


FIGURE 8.1.9.2.5 Glove Composite Wetting Method.

8.1.10.3 The test subject shall immerse the donned specimens straight down into two containers of water at a temperature of 21°C ± 3°C (70°F ± 5°F), to a height of 25 mm +12.5/−0 mm (1 in. +0.5/−0 in.) above (away from the fingers) the end of the glove, including glove interface components or extensions, for 2 minutes, +12/−0 seconds.

8.1.10.4 The gloves shall then be removed and hung vertically by digit 5 with the glove opening facing down for 2 minutes ± 12 seconds.

8.1.10.5 The glove specimens shall then be tested within 1 minute.

8.1.11 Flexing Procedure for Gloves.

8.1.11.1 Glove samples shall be selected to fit the individual test subject.

8.1.11.2 The test subject shall don the glove sample.

8.1.11.3 Glove specimens shall be flexed by making a tight fist 10 times during a 30-second period.

8.1.12 Washing and Drying Procedure for Garments, Gloves, and Glove Pouches.

8.1.12.1 The complete garment shall be washed with all closures fastened and the garment in its "as-worn" orientation. Garments with separable liners shall not have the liners separated.

8.1.12.2 A front-loading washer/extractor shall be used. The capacity shall be between 16 kg (35 lb) and 24.9 kg (55 lb).

8.1.12.3 The wash load shall be two-thirds the rated capacity of the washer. If ballast is needed to reach two-thirds capacity, similar material or outer shell material shall be used for garment samples, and 212.6 g/m² (7.5 oz/yd²) woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber ballast shall be used for glove or glove pouch samples.

Δ **8.1.12.4** The wash cycle procedure and water levels specified in Table 8.1.12.4(a) and Table 8.1.12.4(b) shall be followed. In addition, the *g* force shall not exceed 100 *g* throughout the wash cycle.

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

8.1.12.6 Samples 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 samples shall be allowed to air dry for at least 48 hours prior to conducting the test and the use of a forced-air dryer operated at ambient temperature, −0°± 5°C (−0°± 10°F) shall be permitted. At the conclusion of the final drying cycle, glove or glove pouch samples shall be dried on a forced-air, non-tumble-drying mechanism operated at 10°C ± 5°C (50°F ± 9°F) above current room temperature until dry but not for less than 8 hours.

8.1.12.7 Garments, gloves, and glove pouches shall be washed and dried for a total of five cycles.

• **8.1.13 Helmet Positioning.**

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

Table 8.1.12.4(a) Wash Cycle Procedure for Whole Garments and CBRN Materials

Operation	Time (min)	Temperature ±3°C	Temperature ±5°F	Water Level
Suds using AATCC detergent #1993, 1.0 g/gal water	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	—	—	—

*See Table 8.1.12.4(b) for high and low water levels.

Δ **Table 8.1.12.4(b) Water Level for Whole Garments, Gloves, and Glove Pouches Operation Wash Cycle Procedure**

Low Water Level ±1 cm (⅜ in.)		High Water Level ±1 cm (⅜ in.)	
cm	in.	cm	in.
12.7	5.0	25.4	10.0

8.1.13.2 The HPI shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the front lateral midpoint of the helmet shell aligned with the midsagittal plane to the basic plane of an ISO size J headform conforming to the nominal dimensions in Figure 8.16.4.1, with the helmet firmly positioned on the headform.

8.1.13.3 When positioning the helmet for testing on headforms other than the ISO size J, the basic plane used for the HPI positioning shall be located 130 mm below and parallel to the crown of the headform and shall be marked on the headform.

8.1.14 Pouch Construction for Glove Composite Samples One.

8.1.14.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test. However, for the tests specified in Sections 8.7, Conductive Heat Resistance Test 1, and 8.10, Thermal Protective Performance (TPP), the pouch size shall not be reduced.

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

8.1.14.3 The two glove composites shall be of the same materials and construction.

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

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

8.1.14.6 The two glove composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

8.1.14.7 The two glove composite swatches and resulting pouch shall be permitted to not be stitched or to have reduced stitching if a laundering or wetting conditioning is not required to be performed on the composite samples.

8.1.15 Pouch Construction for Glove Composite Samples Two.

8.1.15.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test.

8.1.15.2 The pouch shall be made of two composite swatches.

8.1.15.3 The two composite swatches shall each consist of a composite constructed to simulate a glove body composite using the following layers and construction in order:

(1) Layer 1: 3.0 to 3.5 oz/yd^2 cowsplit leather
(2) Layer 2: Glove moisture barrier
(3) Layer 3: 7 to 10 oz/yd^2 modacrylic knit

8.1.15.4 Where the thermal liner and barrier are combined, the modacrylic knits shall be permitted to be omitted from the composite.

8.1.15.5 Where the moisture barrier material seam is being tested, the moisture barrier layer shall contain a seam. The seam shall run within 25 mm (1 in.) of the center and shall extend across the entire width of the specimen.

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

8.1.15.7 The two glove composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

8.1.15.8 Where a glove is made of materials other than leather and modacrylic, the composite swatches shall be permitted to be constructed of materials that are used in the actual glove.

8.1.16 Faceshield/Goggle Component Stowed Position.

8.1.16.1 The stowed position of the faceshield/goggle component shall be determined by the manufacturer.

8.1.16.1.1 The stowed position shall not be beyond the point of any resistance when the faceshield/goggle component is pushed up and back from the deployed position, such as coming into contact with the helmet or any helmet attachments.

8.1.16.1.2 In cases in which the faceshield/goggle component can be stowed on the front or rear of the helmet, the following positions shall be used:

(1) In the situations described in 6.4.6 and 8.6.12.3, the front position shall be used.
(2) In situations described in 6.5.3.1 and 6.5.3.2, the front and rear positions shall be used.

8.1.17* Glove Test Areas. The glove test areas shall be as described in this paragraph and as shown in Figure 8.1.17, with the glove test area abbreviations designated as follows:

(1) P = palm; B = back; S = side
(2) A-P: Palm side of hand from finger crotch line to ⅓ of the way down (grasp area)
(3) B-P: Palm side of hand from ⅓ of the way down (grasp area) to the wrist crease
(4) C-P: Palm side of hand from the wrist crease to 50 mm (2 in.) past the wrist crease
(5) D-P: Palm side of thumb
(6) E-P: Palm side of tip of thumb
(7) F-P: Palm side of index finger
(8) G-P: Palm side of fingertip of index finger
(9) H-P: Palm side of nonindex fingers
(10) I-P: Palm side of fingertip of nonindex fingers
(11) A-PS: Sides of hand adjacent to area A-P
(12) B-PS: Outside of hand adjacent to section B-P
(13) C-PS: Sides of hand adjacent to area C-P
(14) D-PS: Outside of thumb adjacent to area D-P
(15) E-PS: Inside of thumb adjacent to area D-P
(16) F-PS: Outside of index finger adjacent to area F-P
(17) H-PS: Between fingers adjacent to areas F-P and H-P
(18) I-PS: Outside of and adjacent to the smallest finger
(19) A-B: Back side of hand from finger crotch line to ⅓ of the way down (knuckle area)
(20) B-B: Back side of hand from ⅓ of the way down (knuckle area) to the wrist crease
(21) C-B: Back side of hand from the wrist crease to 50 mm (2 in.) past the wrist crease
(22) D-B: Back side of thumb
(23) E-B: Back side of tip of thumb
(24) F-B: Back side of index finger
(25) G-B: Back side of fingertip of index finger
(26) H-B: Back side of nonindex fingers
(27) I-B: Back side of fingertip of nonindex fingers
(28) A-BS: Sides of hand adjacent to area A-B
(29) B-BS: Outside of hand adjacent to area B-B
(30) C-BS: Sides of hand adjacent to area C-B
(31) D-BS: Outside of thumb adjacent to area D-B
(32) E-BS: Inside of thumb adjacent to area D-B
(33) F-BS: Outside of index finger adjacent to area F-B
(34) H-BS: Between fingers adjacent to areas F-B and H-B

N **8.1.18 Room Temperature Conditioning Procedure for Particulate Blocking Layer.** Samples shall be conditioned at a temperature of 20°C ± 3°C and a relative humidity of 50 percent ± 5 percent for at least 12 hours. Specimens shall be tested within 5 minutes after removal from conditioning. Specimens shall be tested within 5 minutes after removal from conditioning.

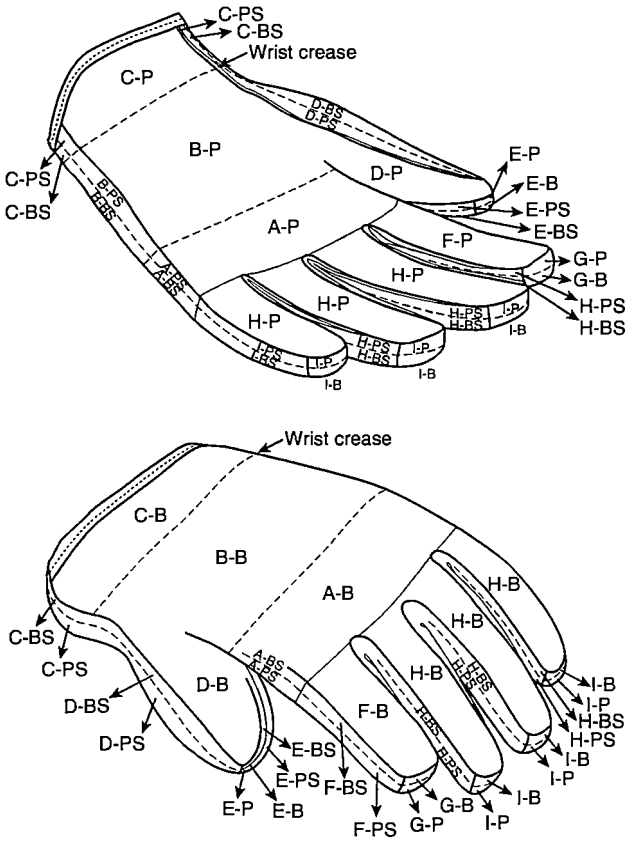
8.2 Flame Resistance Test 1.

8.2.1 Application.

8.2.1.1 This test method shall apply to protective garment textiles, drag rescue devices (DRDs), hoods, wristlets, gauntlets, helmet cover materials, helmet shroud materials, helmet ear cover materials, helmet chin strap materials, helmet goggle strap materials, and trim materials.

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

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



Δ **FIGURE 8.1.17 Glove Test Areas.**

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

8.2.1.5 Modifications to this test method for testing trim materials shall be as specified in 8.2.11.

8.2.1.6 Modifications to this test method for testing hood label materials shall be as specified in 8.2.12.

8.2.1.7 Modifications to this test method for testing lettering including transfer film shall be as specified in 8.2.13.

8.2.1.8 Modifications to this test method for testing small specimens not meeting the specimen size requirements in 8.2.2.1 shall be tested as specified in 8.2.14.

8.2.1.9 Modifications to the test method for testing helmet chin strap materials and helmet goggle strap materials shall be as specified in 8.2.15.

8.2.1.10 Modifications to the test method for testing DRD materials shall be as specified in 8.2.16.

8.2.2 Samples.

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

8.2.2.2 Each separable layer of multilayer material systems or composites shall be individually tested.

8.2.3 Specimens.

8.2.3.1 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2.

8.2.3.2 All specimens to be tested shall be conditioned as specified in 8.1.3.

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

8.2.5 Procedure.

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

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

8.2.6 Report.

8.2.6.1 Afterflame time and char length shall be recorded and reported for each specimen. The average afterflame time and char length for each material in each direction tested shall be calculated, reported, and recorded. The afterflame time shall be recorded and reported to the nearest 0.1 second and the char length to the nearest 1 mm ($\frac{1}{25}$ in.).

8.2.6.2 Observations of melting or dripping for each specimen shall be recorded and reported.

8.2.7 Interpretation.

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

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

8.2.8 Specific Requirements for Testing Woven Textile Materials.

8.2.8.1 Five specimens from each of the warp and filling directions shall be tested. 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 Samples for conditioning shall be at least a 1 m (39 in.) square of each material.

8.2.8.3 Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.2.9 Specific Requirements for Testing Knit Textile Materials.

8.2.9.1 Five specimens from each of the wale and course directions shall be tested.

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

8.2.9.3 Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.2.10 Specific Requirements for Testing Nonwoven Textile Materials.

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

8.2.10.2 Samples for conditioning shall include material that is a minimum of 75 mm × 305 mm (3 in. × 12 in.).

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

8.2.11 Specific Requirements for Testing Trim Materials.

8.2.11.1 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 Samples for conditioning shall include material sewn onto a 1 m (39 in.) 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 Testing shall be performed in only one direction.

8.2.11.4 Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.2.12 Specific Requirements for Testing Hood Label Materials.

8.2.12.1 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 Samples for conditioning shall be whole hoods, including the label as normally attached.

8.2.12.3 Testing shall be performed as specified in 8.2.2 through 8.2.7 with the flame applied to the edge of the label.

8.2.13 Specific Requirements for Testing Lettering Including Transfer Film.

8.2.13.1 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. 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 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 Samples for conditioning shall include material sewn onto a 1 m (39 in.) 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.

8.2.13.4 Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.2.14 Specific Requirements for Testing Small Specimens.

8.2.14.1 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 Samples for conditioning shall be at least 1 m (39 in.) square of the textile layer on which the small specimens are attached.

8.2.14.3 Testing shall be performed as specified in 8.2.2 through 8.2.7. Char length shall not be measured.

8.2.15 Specific Requirements for Testing Helmet Chin Strap Materials and Helmet Goggle Strap Materials.

8.2.15.1 Five specimens of helmet chin strap materials and helmet goggle strap materials, excluding elastic or hook and pile fasteners, shall be tested. Specimens shall be at least 305 mm (12 in.) in length by the widest width of the chin strap or goggle strap used on the helmet.

8.2.15.2 Testing shall be performed in only one direction.

8.2.15.3 Samples for conditioning shall be chin strap materials or goggle strap materials.

8.2.15.4 The specimen holder shall be modified to permit the testing of narrow specimens.

8.2.15.5 Testing shall be performed as specified in 8.2.2 through 8.2.7.

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 Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.3 Flame Resistance Test 2.

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

8.3.2 Samples. Helmets shall be conditioned as specified in 8.1.3.

8.3.3 Specimens. Three helmets shall be tested.

8.3.4 Apparatus.

8.3.4.1 A standard Bunsen burner shall be used.

8.3.4.2 The Bunsen burner shall be fueled by a bottled methane gas, 99 percent pure.

8.3.4.3 A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 0.035 kg/cm^2 ± 0.003 kg/cm^2 (½ psi, +0.1/−0 psi) at the burner shall be utilized.

8.3.4.4 The barrel of the Bunsen burner shall be 13 mm ± 3 mm (½ in. ± ⅛ in.) in diameter. A flame spreader shall not be used.

8.3.5 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 HPI as described in 8.1.14.

8.3.5.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ± 1.5 mm (2 in. ± 1/16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1/16 in.). The temperature of the flame at the tip of the inner cone shall be measured with a K-type thermocouple and shall be 1200°C ± 100°C (2192°F ± 180°F). 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 90 degrees to the basic plan, as shown in Figure 8.3.5.2, as follows:

(1) At the intersection of the front edge of the brim and the midsagittal plane
(2) At the intersection of the each side of the brim and the coronal plane
(3) At one random location on the edge of 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, reported, 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 50 mm ± 1.5 mm (2 in. ± 1/16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1/16 in.). The temperature of the flame at the tip of the inner cone shall be measured with a K-type thermocouple and shall be 1200°C ± 100°C (2192°F ± 180°F). 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, reported, and recorded.

8.3.7 Procedure C.

8.3.7.1 The helmet shall be positioned according to the HPI as described in 8.1.13 on the ISO size J headform specified in Figure 8.16.4.1. The helmet shall then be placed under the radiant heat source specified in 8.1.6, while the basic plane of the headform is 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 50 mm ± 1.5 mm (2 in. ± 1/16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1/16 in.). The temperature of the flame at the tip of the inner cone shall be measured with a K-type thermocouple and shall be 1200°C ± 100°C (2192°F ± 180°F).

8.3.7.3 Specimen 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, reported, and recorded.

8.3.8 Procedure D.

8.3.8.1 Specimen helmets with faceshield/goggle component attachment hardware in place shall be positioned according to the HPI as described in 8.1.13 on the ISO size J headform specified in Figure 8.16.4.1.

8.3.8.2 The flame of the Bunsen burner shall be adjusted to produce a 50 mm ± 1.5 mm (2 in. ± 1/16 in.) blue flame with an inner cone of 25 mm ± 1.5 mm (1 in. ± 1/16 in.). The tempera-

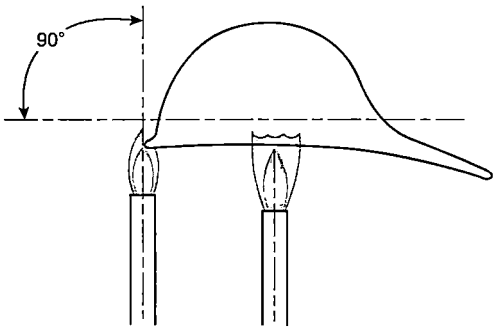


FIGURE 8.3.5.2 Test Procedure A.

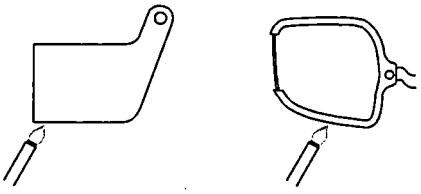


FIGURE 8.3.6.1 Test Procedure B.

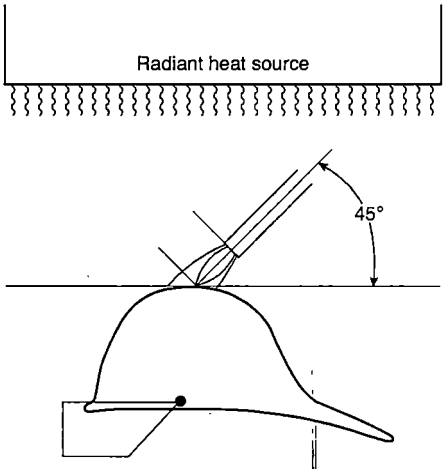


FIGURE 8.3.7.1 Test Procedure C.

ture of the flame at the tip of the inner cone shall be measured with a K-type thermocouple and shall be 1200°C ± 100°C (2192°F ± 180°F). The tip of the inner cone of the flame shall then be applied to each faceshield/goggle comment attachment hardware location along the helmet brim line from below the brim of the helmet at an angle of 90 degrees 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, reported, and recorded.

8.3.9 Report.

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

8.3.9.2 The afterflame times shall be recorded and 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.

8.4 Flame Resistance Test 3.

8.4.1 Application.

8.4.1.1 This test method shall apply to the protective glove body, glove interface components, and glove extension composites.

8.4.1.2 Modifications to this test method for evaluation of glove body composites shall be as specified in 8.4.8.

8.4.1.3 Modifications to this test method for evaluation of glove interface components other than wristlet composites shall be as specified in 8.4.9.

8.4.1.4 Modifications to this test method for evaluation of wristlet glove interface components shall be as specified in 8.4.10.

8.4.1.5 Modifications to this test method for evaluation of glove extension composites shall be as specified in 8.4.11.

8.4.2 Specimens. Three specimens shall be tested for each material. Three specimens shall be tested after the conditioning specified in 8.1.3. Three additional specimens shall be tested after the conditioning specified in 8.1.12 followed by the conditioning specified in 8.1.3.

8.4.3 Samples.

8.4.3.1 Samples shall be prepared for each glove body, glove interface component, and glove extension composite.

8.4.3.2 Samples shall be conditioned as specified in 8.1.12 and 8.1.3.

8.4.4 Apparatus.

8.4.4.1 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 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 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.

8.4.4.4 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.

8.4.5 Procedure.

8.4.5.1 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 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 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 (1½ in.) as shown in Figure 8.4.4.3.

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

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

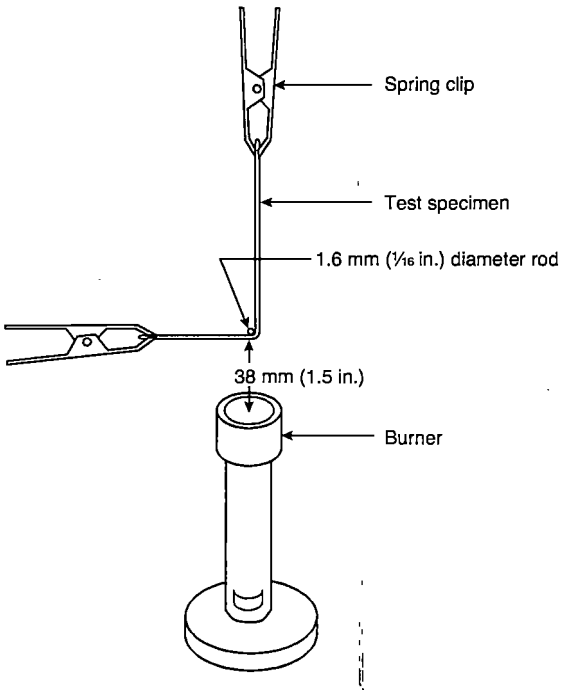


FIGURE 8.4.4.3 Relationship of Test Material to Burner.

8.4.5.7 Each tested sample shall be reconditioned as specified in 8.1.3 and then weighed to the nearest 0.1 g (0.04 oz).

8.4.5.8 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 through 8.4.5.8.4.

8.4.5.8.1 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 The hook shall be inserted into a hole punched in the specimen that is 6 mm (¼ in.) in diameter or less. The hole shall be punched out for the hook at one side of the charred area that is 6 mm (¼ in.) from the adjacent outside edge, at the point where the specimen contacted the steel rod, and 6 mm (¼ in.) in from the lower end.

8.4.5.8.3 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 shall be attached to the hook. The total tearing weight for determining charred length shall be based on the weight of the composite specimen and shall be determined from Table 8.4.5.8.3.

8.4.5.8.4 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 Report.

8.4.6.1 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, recorded, 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 The percent consumed shall be calculated using the following formula:

N

[8.4.6.2]

$$\text{Percent consumed} = \frac{W - R}{W} \times 100$$

where:
W = original conditioned weight
R = conditioned weight 24 hours after testing

Δ Table 8.4.5.8.3 Determination of 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	¼
>203–508	>6.0–15.0	0.2	½
>508–780	>15.0–23.0	0.3	¾
>780	>23.0	0.45	1

8.4.6.2.1 The percent consumed shall be recorded and reported for each specimen to the nearest 0.1 percent. The average percent consumed shall be calculated, recorded, and reported to the nearest 0.1 percent.

8.4.6.3 Observations of melting or dripping for each specimen shall be recorded and reported.

8.4.7 Interpretation. Pass or fail performance shall be based on melting or dripping, the average afterflame time, and the average char length.

8.4.8 Specific Requirements for Testing Glove Body Composites.

8.4.8.1 Samples for conditioning shall be glove body composite pouches as specified in 8.4.8.3.

8.4.8.2 Specimens shall be representative of each glove body composite construction.

8.4.8.3 For glove body composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.4.8.4 After conditioning, the pouch and necessary stitching shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing.

8.4.9 Specific Requirements for Testing Protective Glove Interface Components Other than Wristlet Composites.

8.4.9.1 Samples for conditioning shall be glove interface component composite swatches as specified in 8.4.9.3.

8.4.9.2 Specimens shall be representative of the glove interface component composite construction.

Δ 8.4.9.3 For glove interface component composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.4.9.4 After conditioning, the necessary stitching shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing.

8.4.10 Specific Requirements for Testing Protective Wristlet Glove Interface Components.

8.4.10.1 Samples for conditioning shall be wristlet glove interface component composite swatches as specified in 8.4.10.3.

8.4.10.2 Specimens shall be representative of the wristlet glove interface component composite construction.

8.4.10.3 For wristlet glove interface component composites, samples for conditioning shall include wristlet material. Three specimens shall be tested after the conditioning specified in 8.1.3. Three additional specimens shall be tested after the conditioning specified in 8.1.2 followed by the conditioning specified in 8.1.3.

Δ 8.4.10.4 After conditioning, the material shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing. Specimens shall not include seams where multiple layers are involved.

8.4.11 Specific Requirements for Testing Protective Glove Extension Composites.

8.4.11.1 Samples for conditioning shall be glove extension composite swatches as specified in 8.4.11.3.

8.4.11.2 Specimens shall be representative of the glove extension composite construction.

Δ **8.4.11.3** For glove extension composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.4.11.4 After conditioning, the necessary stitching shall be cut to form 50 mm × 150 mm (2 in. × 6 in.) specimens for testing.

8.5 Flame Resistance Test 4.

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

8.5.2 Samples.

8.5.2.1 Samples shall be complete footwear.

8.5.2.2 Samples shall be conditioned as specified in 8.1.3.

8.5.3 Specimens. Three complete footwear items shall be tested.

8.5.4 Apparatus.

8.5.4.1 The test apparatus shall consist of a fuel pan, movable shutter(s), specimen holder, n-heptane, ignition source, and timing device.

8.5.4.1.1 The fuel pan shall be 305 mm × 457 mm × 63.5 mm (12 in. × 18 in. × 2.5 in.).

Δ **8.5.4.1.2** The movable shutter(s) shall be located at a height of 255 mm ± 13 mm (10 in. ± ½ in.) above the surface of the water and n-heptane fluid as measured before ignition. The shutter(s) shall be of a size sufficient to cover the surface area of the fuel pan and shall be capable of being fully retracted or fully extended within 1 second.

8.5.4.1.3 The specimen holder shall be capable of suspending the specimen over the flame in a manner such that the holder does not impede the flames.

8.5.4.1.4 The stopwatch or other device shall measure the burning time to the nearest 0.1 second.

8.5.5 Procedure.

8.5.5.1 The test shall be conducted in a draft-free area.

8.5.5.2 The fuel pan shall be level.

8.5.5.3 Water shall be placed in the fuel pan to a height of 13 mm (½ in.).

8.5.5.4 400 to 500 mL of n-heptane shall be added to the fuel pan such that it will burn freely for 1.5 to 2.0 minutes.

Δ **8.5.5.5** The specimen shall be mounted in the specimen holder as follows:

(1) The toe shall be at an angle of 7.5 degrees ± 2.5 degrees, above the heel.
(2) The height of the lowest edge of the specimen shall be 305 mm ± 25 mm (12 in. ± 1 in.) from the surface of the water and n-heptane fluid as measured before ignition.
(3) The heel-toe axis of the specimen shall be parallel with the 457 mm (18 in.) side of the fuel pan.

8.5.5.6 With the shutter retracted, the n-heptane shall be ignited using a suitable ignition source.

8.5.5.6.1 Where paper or other material is used to ignite the n-heptane, it shall not be left in the fuel pan, where it can disturb the flame pattern.

8.5.5.7 The n-heptane shall burn freely for 1 minute, ±5 seconds.

8.5.5.8 The shutter(s) shall be positioned above the flame.

8.5.5.9 The specimen shall be positioned above the shutter(s) over the approximate center of the flame area.

8.5.5.10 The shutter(s) shall be retracted and specimen flame exposure shall commence not longer than 1 minute, 15 seconds from ignition.

8.5.5.11 The specimen shall be exposed to the flame for 12 seconds ± 0.2 second.

8.5.5.12 Following flame exposure, the shutter(s) shall be repositioned above the flame.

8.5.5.13 The afterflame time shall be measured as the time, in seconds, to the nearest 0.1 second that the specimen continues to flame after the shutter is repositioned over the flame.

8.5.5.14 Following the flame exposure, the specimen shall be visually examined for melting, dripping, and burn-through.

8.5.6 Report.

8.5.6.1 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 Observations of melting, dripping, or burn-through for each specimen shall be recorded and reported.

8.5.7 Interpretation. Pass or fail performance shall be based on the average afterflame time and any observed melting, dripping, or burn-through.

8.6 Heat and Thermal Shrinkage Resistance Test.

8.6.1 Application.

8.6.1.1 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) Hoods, wristlets, helmet ear cover materials, helmet shroud materials, helmet cover materials, helmet chin strap materials, innermost glove lining materials, trim, and label materials
(4) Protective helmets, protective gloves, and protective footwear

8.6.1.2 Modifications to this test method for testing garment outer shell, moisture barrier, thermal barrier, winter liner, helmet ear cover, helmet shroud, helmet cover, and innermost glove lining materials shall be as specified in 8.6.8.

8.6.1.3 Modifications to this test method for testing garment moisture barrier seams shall be as specified in 8.6.9.

8.6.1.4 Modifications to this test method for testing other garment, trim, and label materials shall be as specified in 8.6.10.

8.6.1.5 Modifications to this test method for testing hardware shall be as specified in 8.6.11.

8.6.1.6 Modifications to this test method for testing helmets shall be as specified in 8.6.12.

8.6.1.7 Modifications to this test method for testing gloves shall be as specified in 8.6.13.

8.6.1.8 Modifications to this test method for testing footwear shall be as specified in 8.6.14.

8.6.1.9 Modifications to this test method for testing lettering, including transfer film, shall be as specified in 8.6.15.

8.6.1.10 Modifications to this test method for testing hoods shall be as specified in 8.6.16.

8.6.1.11 Modifications to this test method for testing helmet chin strap materials shall be as specified in 8.6.17.

N **8.6.1.12** Modifications to this test method for testing wristlet materials shall be as specified in 8.6.18.

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

8.6.3 Specimens.

8.6.3.1 Only heat resistance testing shall be conducted on a minimum of three specimens for each moisture barrier seam, hardware item, glove lining material, trim material, label material, other protective garment materials, helmets, and footwear not specified in 8.6.3.2.

8.6.3.2 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, helmet ear cover, helmet shroud, helmet cover, and helmet chin strap materials. Each separable layer of multilayer material systems or composites shall be tested as an individual layer.

8.6.4 Apparatus. The test oven shall be as specified in ASTM F2894/F2894M, *Standard Test Method for Evaluation of Materials, Protective Clothing and Equipment for Heat Resistance Using a Hot Air Circulating Oven.*

•

8.6.5 Procedure.

N **8.6.5.1** Specimens shall be tested in accordance with ASTM F2894/F2894M, *Standard Test Method for Evaluation of Materials, Protective Clothing and Equipment for Heat Resistance Using a Hot Air Circulating Oven,* at a temperature of 260°C, +8°/–0°C (500°F, +14°/–0°F) for 5 minutes +15/–0 seconds.

8.6.5.2 While placing specimens in the oven for testing, the oven door shall not remain open more than 15 seconds.

Δ **8.6.5.3** The specimen mounted as specified in 8.6.5.2 shall be exposed in the test oven for 5 minutes, +0.15/–0 minute.

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

8.6.5.5 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 Report.

8.6.6.1 Where applicable, observations of ignition, melting, dripping, or separation shall be recorded and reported for each specimen.

8.6.6.2 Where applicable, 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 Interpretation.

8.6.7.1 Where applicable, any evidence of ignition, melting, dripping, or separation on any specimen shall constitute failing performance.

8.6.7.2 Where applicable, the average percent change in both dimensions shall be used to determine pass or fail performance. Failure in any one dimension shall constitute failure for the entire sample.

8.6.8 Specific Requirements for Testing Garment Outer Shell, Moisture Barrier, Thermal Liner, Winter Liner Materials, Helmet Ear Cover, Helmet Shrouds, Helmet Covers, and Glove Lining Materials.

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

8.6.8.2 Each specimen shall be 380 mm × 380 mm, ±13 mm (15 in. × 15 in., ±½ in.), and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.6.8.3 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2.

8.6.8.4 Testing shall be performed as specified in 8.6.2 through 8.6.7.

8.6.8.5 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.

8.6.8.6* For glove lining materials, all layers between the moisture barrier layer and the hand shall be individually tested. Where layers are permanently attached, the layers shall be permitted to be tested separately or attached. Where the moisture barrier layer is permanently attached to other layer(s) nearer to the hand and where the layer(s) nearer to the hand can be supplied individually for testing, only the layer(s) nearer the hand shall be tested and the moisture barrier shall not be tested. For glove lining materials, separation shall be reported if there is separation within a layer. However, separation between laminated layers shall not be reported as separation.

8.6.9 Specific Requirements for Testing Moisture Barrier Seams.

8.6.9.1 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 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 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.

8.6.9.4 For moisture barrier seam seal materials, observations shall be limited to seam material ignition and dripping.

8.6.9.5 Testing shall be performed as specified in 8.6.2 through 8.6.7. Thermal shrinkage shall not be measured.

8.6.10 Specific Requirements for Testing Other Garment, Clothing, Trim, and Label Materials.

8.6.10.1 Samples for conditioning shall include specimens attached to the textile layer as used in the protective garments positioned no closer than 50 mm (2 in.) apart in parallel strips. The textile material shall be at least 1 m (1 yd) square of the textile layer on which the specimens are attached. Specimens shall be removed from the textile material prior to testing, with the exception of label materials, which shall remain attached to the textile layer.

8.6.10.2 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 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2.

8.6.10.4 Testing shall be performed as specified in 8.6.2 through 8.6.7. Thermal shrinkage shall not be measured.

8.6.11 Specific Requirements for Testing Hardware.

8.6.11.1 A minimum of three complete hardware items shall be tested.

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

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

8.6.11.4 Testing shall be performed as specified in 8.6.2 through 8.6.7. Thermal shrinkage shall not be measured.

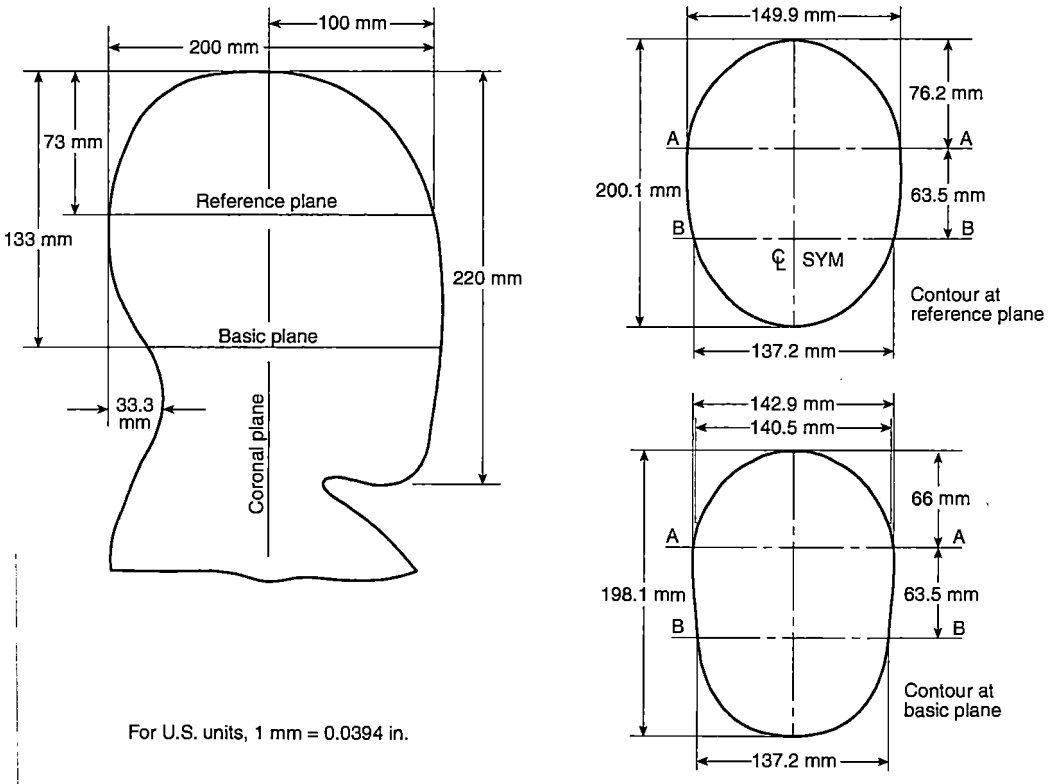
8.6.12 Specific Requirements for Testing Helmets.

8.6.12.1 Samples for conditioning shall include complete helmets.

8.6.12.2 Three complete helmet specimens shall be tested. Helmet specimens shall include all components required in 6.5.2 or 6.6.2 as appropriate for the evaluation of structural fire fighting protective helmet elements or proximity fire fighting protective helmet elements, respectively.

8.6.12.3 Helmets with ear covers deployed and with the faceshield/goggle component in the stowed position as described in 8.1.17 shall be positioned according to the HPI as described in 8.1.13 on the nonconductive test headform specified in Figure 8.6.12.3. The chinstrap shall be secured under the chin of the headform.

8.6.12.4 The shell shall be measured at the eight points radially separated by 45 degrees, as shown in Figure 8.6.12.4. The measurements shall be taken from the bottom of the helmet



Δ **FIGURE 8.6.12.3 Nonconductive Test Headform.**

shell to a flat base beneath the headform. The front area shall include measurement points 1, 2, and 3, the side areas shall include measurement points 4 and 8, and the back area shall include measurement points 5, 6, and 7. If there is a lower point of the helmet shell in the front area than the measurements taken at points 1, 2, and 3, then that point shall be measured also and shall be considered the initial lowest point of the helmet shell in the front area.

8.6.12.5 If any helmet components in the front area are lower than the lowest point of the helmet shell in the front area, then the lowest point of those components shall be measured.

8.6.12.6 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. Only one helmet specimen shall be tested at a time.

8.6.12.7 The minimum interior dimensions of the test oven shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

8.6.12.8 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.

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

8.6.12.10 The helmet shell shall then be measured as described in 8.6.12.4 to determine the shell distortion.

8.6.12.11 If there are any helmet components below the initial lowest point of the helmet shell in the front area, then the lowest point of those components shall be measured to determine component distortion.

8.6.12.12 The helmet shall be examined to ascertain any effects of the heat exposure.

8.6.12.13 Testing shall be performed as specified in 8.6.2 through 8.6.7. Thermal shrinkage shall not be measured.

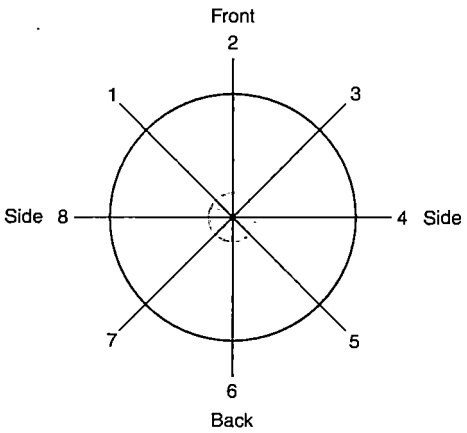


FIGURE 8.6.12.4 Helmet Shell Measurement Points.

8.6.13 Specific Requirements for Testing Gloves.

8.6.13.1 Samples for conditioning shall be whole gloves in size 76W.

•*N* **8.6.13.2** The glove specimen dimensions shall be measured. 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.

N **8.6.13.3** The gloves shall then be conditioned as specified in 8.1.12.

Δ **8.6.13.4** The glove body shall then be filled with nominal 4 mm (⅛ in.) sized perforated soda-lime or borosilicate glass beadsin the following manner:

(1) A total of 50 mL of beads shall be evenly distributed into each of the fingers resulting in approximately 10 mL of beads in each of the five digits.

(2)* A lightweight bag constructed of 170 g/m^2 (5.0 oz/yd^2) or less heat-resistant material and measuring 120.5 mm (4.75 in.) high by 183.0 mm (7.20 in.) wide, shall be filled with 375 mL of beads. The bag shall be sewn on all four sides with heat-resistant thread to keep the beads from spilling out. The bag filled with beads shall be placed inside the body of the glove.

(3) The glass beads shall be at a temperature of 21°C ± 3°C (71°F ± 5°F).

(4) 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 and not less than 150 mm (6 in.) from any other specimen, and airflow is parallel to the plane of the material.

(5) One to three glove specimens shall be placed in the test oven at one time.

(6) The glove specimens shall be suspended such that each specimen is the same distance from the airflow source so that no glove sample is blocking the airflow to other glove samples.

Δ **8.6.13.5** After the oven exposure, the glove specimen dimensions also shall be measured as described in 8.6.13.2to determine pass or fail.

8.6.13.6 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.

8.6.13.7 Specimens shall be donned and flexed as specified in 8.1.11 before and after the heat exposure.

8.6.13.8 Testing shall be performed as specified in 8.6.2 through 8.6.7.

8.6.14 Specific Requirements for Testing Footwear.

8.6.14.1 Samples for conditioning shall be whole boots.

8.6.14.2 Specimensshall be the whole footwear in men's size 9D.

8.6.14.3 Footwear specimens shall include sole, heel, and upper. Footwear specimens shall be filled to capacity with nominal 4 mm (⅛ in.) sized perforated soda-lime or borosilicate glass beads. Any closures shall be fastened.

8.6.14.4 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 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 Footwear specimens shall be placed in the center of the test oven with the centerline of the front of the specimen facing the airflow. Only one footwear specimen shall be tested at a time.

8.6.14.7 Testing shall be performed as specified in 8.6.2 through 8.6.7. Thermal shrinkage shall not be measured.

8.6.14.8 A minimum of three footwear items shall be tested.

8.6.14.9 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 5 minutes, +15/−0 seconds. Within 10 minutes, +15/−0 seconds, after removal from the oven, the test specimen shall be examined inside and outside for evidence of melting, separation, or ignition. Footwear separation of 1.4 mm × 18 mm (0.055 in. × 0.71 in.) or more in any orientation shall be recorded and reported.

8.6.14.10 Each test specimen shall then be reconditioned as specified in 8.1.3 and then reexamined inside and outside for evidence of melting, separation, or ignition.

8.6.14.11 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*, with the following modifications:

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

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

Δ **8.6.14.13** After flexing, the footwear specimen shall be marked with a water height line on the exterior at a height of 75 mm (3 in.) below the height of the boot as defined in 6.10.3.1 but no lower than 230 mm (9 in.) where measured up from the center of the insole at the heel. The measurement shall be made on the interior and transferred to the exterior. Plain white paper toweling shall be placed inside the footwear specimen such that the paper toweling intimately contacts all areas inside the footwear specimen to at least the water height line. The footwear specimen shall then be placed in a container that allows its immersion in tap water, treated with a dye and a surfactant that achieves a surface tension of 35 dynes/cm ± 5 dynes/cm, to the water height line.

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

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

8.6.15 Specific Requirements for Testing Lettering, Including Transfer Film.

8.6.15.1 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.

8.6.15.2 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 Samples for conditioning shall be outer shell material of 1 m (1 yd) square with letters applied.

8.6.15.4 Testing shall be performed as described in 8.6.2 through 8.6.7. Thermal shrinkage shall not be measured.

8.6.16 Specific Requirements for Testing Hoods.

Δ **8.6.16.1** Samples for conditioning shall include complete hoods with labels.

8.6.16.2 Hoods shall be tested both before and after the conditioning specified in 8.1.2.

8.6.16.3 Testing shall be performed as specified in 8.6.4 through 8.6.6 unless modified herein.

N **8.6.16.4** Specimen face openings with elastic or manually adjustable face openings shall be placed over a hood measuring device as shown in Figure 8.6.16.4. Specimen face openings in the relaxed state shall slide freely over the top half of the device where the circumference measures 45.6 cm ± 0.6 cm (18.0 in. ± 0.25 in.). Specimen face openings shall then be placed around the lower half of the device where the circumference measures 54.5 cm ± 0.6 cm (21.5 in. ± 0.25 in.). Specimens shall then be visually inspected for gaps between the hood and the measuring device surface.

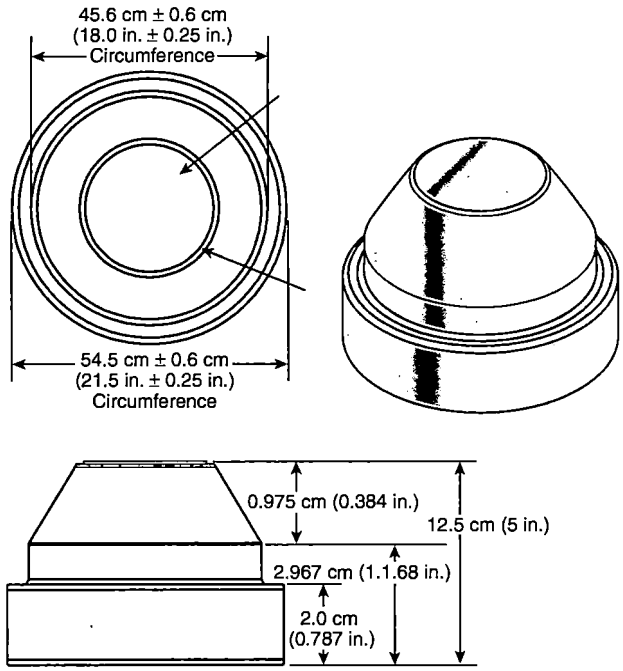
N **8.6.16.4.1** Specimen hoods with SCBA facepiece openings shall be measured as specified in 8.47.5.1 through 8.47.5.3.

Δ **8.6.16.5** Hoods shall then be donned on a nonconductive test headform as specified in Figure 8.6.12.3. 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 plane on the hood shall be marked at each location.

8.6.16.6 The headform with hood donned shall be placed in the center of the test oven with the centerline of the front of the hood facing the airflow.

8.6.16.7 The minimum interior dimensions of the test oven shall be 610 mm × 610 mm × 610 mm (24 in. × 24 in. × 24 in.).

8.6.16.8 The test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted 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.



Δ **FIGURE 8.6.16.4 Hood Measuring Device.**

Δ **8.6.16.9** Following removal from the oven, the hood shall be examined for evidence of ignition, melting, or separation. The hood shall be evaluated as described in 8.6.16.4. The distance from the top of the hood to the three marks along the basic plane shall also be measured.

• **8.6.16.10** Each of the three dimensions from the top of the hood to the marks along the basic plane before and after oven exposure shall be recorded and reported. •

N **8.6.16.11** Observations of the following for specimens with elastic or manually adjustable face openings shall be recorded and reported:

(1) The ability of the face opening to slide freely over the top half of the hood measuring device
(2) Gaps between the hood face opening and the bottom half of the hood measuring device before and after heat exposure

N **8.6.16.11.1** Specimen hoods with SCBA facepiece openings shall be measured as specified in 8.47.5.1 through 8.47.5.3.

8.6.16.12 The percent shrinkage of each of the three dimensions from the top of the hood to the marks along the basic plane shall be individually calculated, recorded, and reported. The percent shrinkage of the face opening overlap on specimens with specific SCBA facepiece openings shall be individually calculated, recorded, and reported.

• **8.6.16.13*** The average percent shrinkage of the three dimensions from the top of the hood to the marks along the basic plane for all specimens shall be calculated, recorded, and reported. The average percent shrinkage of the face opening overlap for each specimen with specific SCBA facepiece openings shall be individually calculated, recorded, and reported.

8.6.16.14* Pass or fail performance for specimens with elastic or manually adjustable face openings shall be based on the face opening being able to slide freely in the relaxed state over the top half of the hood measuring device and any observations of gaps between the hood face opening and the hood measuring device. Pass or fail performance for specimens designed to interface with a specific SCBA facepiece shall be based on the average percent shrinkage of the face opening overlap for each specimen.

N **8.6.16.15** Pass or fail performance shall also be based on the average percent shrinkage of the three dimensions from the top of the hood to the marks along the basic plane for each specimen. One or more hood specimens failing this test shall constitute failing performance.

8.6.17 Specific Requirements for Testing Helmet Chin Strap Materials.

8.6.17.1 Samples for conditioning shall be chin strap materials.

Δ **8.6.17.2** Specimens shall be 380 mm (15 in.) in length by the widest width of the chin strap used on the helmet.

8.6.17.3 Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2.

8.6.17.4 Thermal shrinkage shall be measured in the length direction only.

8.6.17.5 Testing shall be performed as specified in 8.6.2 through 8.6.7.

N **8.6.18 Specific Requirements for Testing Wristlet Materials.**

N **8.6.18.1** Specimen length shall be 150 mm (6 in.). Specimen width shall be the same as utilized in the clothing item. Where wristlets are supplied in a tubular configuration, the specimen shall be slit in the lengthwise direction to provide a single layer.

N **8.6.18.2** Specimens shall be tested both before and after being subjected to the procedure specified in 8.1.2.

N **8.6.18.3** Testing shall be performed as specified in 8.6.2 through 8.6.7. The optional stretching frame shall not be utilized.

8.7 Conductive Heat Resistance Test 1.

8.7.1 Application.

8.7.1.1 This test method shall apply to glove body composites representative of the palm of the gloves and footwear upper material.

8.7.1.2 Modifications for this test method for testing glove composites shall be as specified in 8.7.7.

8.7.1.3 Modifications for this test method for testing footwear composites shall be as specified in 8.7.8.

8.7.2 Samples.

8.7.2.1 Samples for conditioning shall be whole boots and glove composite pouches as specified in 8.7.7.2.

8.7.2.2 Samples shall be conditioned as specified in 8.1.3.

8.7.3 Specimens. A total of three specimens of gloves and three specimens of footwear shall be tested for each condition.

8.7.4 Procedure. Specimens shall be tested in accordance with ASTM F1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, with the following modifications:

(1) Specimens shall be tested using an exposure temperature of 280°C (536°F). The pressure applied during the test shall be as specified in 8.7.7 and 8.7.8.
(2) 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.
(3) The section of the apparatus lowering the specimen, sensor, and weighed system shall travel at a constant rate of speed. The specimen shall be lowered parallel to the hot plate. The recorder/computer shall be activated automatically by a mechanical or electrical contact when the specimen contacts the hot plate.
(4) Calibration shall be performed at 280°C, +3/−0°C. (536°F, +5/−0°F). A calibration media shall be used that generates a 6- to 7-second time to pain value and a 10- to 12-second time to second-degree burn value.

8.7.5 Report.

8.7.5.1 The time to pain and time to second-degree burn for each specimen shall be recorded and reported.

8.7.5.2 The average time to pain and time to second-degree burn shall be calculated, recorded, and reported.

8.7.5.3 Where 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 Interpretation. Pass or fail determinations shall be based on the average time to pain and time to second-degree burn of all specimens tested.

8.7.7 Specific Requirements for Testing Gloves.

8.7.7.1 Specimens shall be representative of the glove body composite construction at the palm of the glove at the following glove areas as described in 8.1.17: A-P, B-P, C-P, D-P, E-P, F-P, G-P, H-P, I-P, A-PS, B-PS, C-PS, D-PS, E-PS, F-PS, H-PS, and I-PS. Specimens shall be representative of each glove body composite construction at the palm of the hand. All variations in composite construction, including number of layers and the order of layering of composite materials, shall constitute a new composite and shall be tested separately.

8.7.7.2 For glove body composites, specimens for conditioning shall be in the form of a pouch as described in 8.1.15.

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 8.1.12 for a total of two conditions.

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 8.1.12 for a total of two conditions.

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

8.7.7.6 After the specimens are conditioned as specified in 8.7.7.2 and 8.7.7.4, the pouch and necessary stitching shall be cut to form 100 mm × 150 mm (4 in. × 6 in.) or 150 mm × 150 mm (6 in. × 6 in.) specimens for testing. Specimens shall not include seams where multiple layers are involved, except in the following cases:

(1) Where a ridged area or similar stitching is used to create specific performance characteristics rather than for glove assembly
(2) Where size constraints of a material make it necessary to allow stitching to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

8.7.7.7 The pressure applied during the test shall be 3.45 kPa ± 0.35 kPa (0.5 psi ± 0.05 psi) for specimens representative of the glove body composite construction at the palm of the glove as described in 8.7.7.1.

8.7.8 Specific Requirements for Testing Footwear Upper Materials.

8.7.8.1 Specimens shall consist of each composite of the footwear upper used in the actual footwear construction, including the tongue but excluding the gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

8.7.8.2 Testing shall be performed as specified in 8.7.2 through 8.7.6.

8.7.8.3 A pressure of 3.45 kPa ± 0.35 kPa (0.5 psi ± 0.05 psi) shall be applied during the test.

8.8 Conductive Heat Resistance Test 2.

8.8.1 Application. This test method shall apply to the protective footwear sole.

8.8.2 Samples.

8.8.2.1 Samples for conditioning shall be whole footwear with removable insoles in place.

8.8.2.2 Samples shall be conditioned as specified in 8.1.3.

8.8.3 Specimens. A minimum of three complete footwear items, including booties where provided, shall be tested.

8.8.4 Apparatus. The apparatus shall consist of an electric hotplate measuring 305 mm × 305 mm (12 in. × 12 in.) capable of maintaining a temperature of 260°C (500°F), Type J or Type K thermocouples, and a meter to read the thermocouple temperatures.

8.8.5 Procedure.

8.8.5.1 The thermocouples shall be taped to the insole surface of the specimen next to the foot in the following locations, as shown in Figure 8.8.5.1:

(1) Directly above the center of the ball of the footwear
(2) Directly above the center of the heel of the footwear
(3) Directly above the toe to heel center of the arch of the footwear, at the inside junction between the upper and the sole

8.8.5.2 The hot plate shall be heated to a temperature of 260°C ± 5°C (500°F ± 10°F) and shall maintain this temperature throughout the test period.

8.8.5.3 The specimen shall be filled with 4.55 kg ± 0.25 kg (10 lb ± 0.5 lb) of 10 mm ± 1 mm (0.39 in. ± 0.039 in.) steel balls. The weight of the steel balls shall be evenly distributed

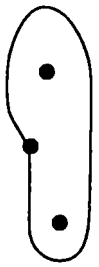


FIGURE 8.8.5.1 Thermocouple Locations.

inside the boot. The specimen shall be placed on the plate in the upright position for 20 minutes, +15/−0 seconds.

8.8.5.4 The thermocouple temperatures shall be recorded at 20 minutes, +15/−0 seconds, after the specimen is placed on the heated hot plate.

8.8.6 Report.

8.8.6.1 The temperature at 20 minutes of exposure shall be recorded and reported for each test location for each specimen.

8.8.6.2 The average temperature at 20 minutes of exposure for each test location for all specimens shall also be calculated, recorded, and reported.

8.8.7 Interpretation. The average temperature at 20 minutes of exposure for each test location for all specimens shall be used to determine pass or fail performance.

8.9 Radiant Heat Resistance Test 1.

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

8.9.2 Samples.

8.9.2.1 Samples for conditioning shall be complete footwear.

8.9.2.2 Samples shall be tested after being subjected to the conditioning procedure specified in 8.1.3.

8.9.3 Specimens. A minimum of three complete footwear items, including booties where provided, shall be tested.

8.9.4 Apparatus. The apparatus shall consist of the following:

(1) Radiometer of the Schmidt-Boelter or Gardon type with radiant heat flux transducer, with a diameter of 25 mm (1 in.), a minimum viewing angle of 150 degrees, a minimum spectral response flat within 3 percent over a range of at least 1.0 μm to 10.0 μm, and an overall accuracy of at least ±5 percent of the reading
(2) 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 1000K ± 200K (1340°F ± 360°F)
(3) Thermocouple with meter
(4) Test chamber that prevents interference from air movement

8.9.5 Procedure.

8.9.5.1 Tests shall be done on each area of the footwear upper, including the tongue but excluding the gusset, that consists of a different composite. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s).

8.9.5.2 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 The thermocouple shall be affixed with thermally conductive adhesive 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 30 seconds, +5/−0 seconds.

8.9.5.4 The thermocouple temperature shall be recorded at 30 seconds, +5/−0 seconds, of exposure.

8.9.6 Report.

8.9.6.1 The temperature at 30 seconds of exposure shall be recorded and reported for each area of the footwear upper for each specimen.

8.9.6.2 The average temperature at 30 seconds of exposure for each area of the footwear upper for all specimens shall also be calculated, recorded, and reported.

8.9.7 Interpretation. The average temperature at 30 seconds of exposure for each area of the footwear upper for all specimens tested shall be used to determine pass or fail performance.

8.10* Thermal Protective Performance (TPP) Test.

8.10.1 Application.

8.10.1.1* This test method shall apply to multilayer protective garment composites, glove body composites, glove interface component composites, wristlets, helmet ear covers, shrouds, and hoods, including single layer knit hoods that are worn in contact with the skin.

8.10.1.2 Modifications to this test method for testing garment composites shall be as specified in 8.10.8.

8.10.1.3 Modifications to this test method for testing hoods shall be as specified in 8.10.9.

8.10.1.4 Modifications to this test method for testing wristlets shall be as specified in 8.10.10.

8.10.1.5 Modifications to this test method for testing glove body composites shall be as specified in 8.10.11.

8.10.1.6 Modifications to this test method for testing glove interface components other than wristlets 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 Samples. Samples 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.

8.10.3 Specimens.

8.10.3.1 Thermal protective performance testing shall be conducted on three specimens.

8.10.3.2 Specimens shall be tested both before and after conditioning as specified in 8.1.2 and then conditioning as specified in 8.1.3.

Δ **8.10.4 Apparatus.** The test apparatus specified in ISO 17492, *Clothing for protection against heat and flame — Determination of heat transmission on exposure to both flame and radiant heat*, shall be used.

8.10.5* Procedure. Thermal protective performance testing shall be performed in accordance with ISO 17492, *Clothing for protection against heat and flame — Determination of heat transmission on exposure to both flame and radiant heat*, with the following modifications:

(1) An exposure heat flux of 84 kW/m^2 ± 2 kW/m^2 (2.0 cal/cm^{2}s ± 0.05 cal/cm^{2}s) shall be used.
(2) The contact configuration shall be used for testing of all material specimens.
(3) The thermal threshold index analysis method shall be used with calculations using the heat flux in calories per square centimeter per second and reported as the TPP rating.
(4) The radiant thermal flux source shall consist of nine 500W T3 translucent (frosted) quartz infrared lamps.
(5) The specimen mounting plate and specimen holding plate shall be stainless steel having a density of 7850 ± 200 kg/m^3.

8.10.6 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.

8.10.6.3 Where a TPP rating is greater than 60, then the TPP rating shall be recorded and reported as ">60."

8.10.7 Interpretation.

8.10.7.1 Pass or fail determinations shall be based on the average reported TPP rating of all specimens tested.

8.10.7.2 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 Specific Requirements for Testing Garments.

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

8.10.8.3 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.9 Specific Requirements for Testing Protective Hoods.

8.10.9.1 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 Samples for conditioning shall include hood material that is a minimum of 175 mm (7 in.) square.

8.10.9.3 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.10 Specific Requirements for Testing Protective Wristlets.

8.10.10.1 Specimens shall consist of materials from the portion of the protective wristlet that covers the wrist area or from the wristlet glove interface component. Specimens shall not include seams. Specimens shall not be stitched to hold individual layers together during testing.

8.10.10.2 Samples for conditioning shall include wristlet material that is a minimum of 180 mm (7 in.) square.

8.10.10.3 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.11 Specific Requirements for Testing Protective Glove Body Composites.

8.10.11.1 Samples for conditioning shall be glove body composite pouches as specified in 8.10.11.3.

Δ **8.10.11.2** Specimens shall be representative of each glove body composite construction. All variations in composite construction, including number of layers and the order of layering of composite materials, shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s).

8.10.11.3 For glove body composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.10.11.4 Specimens shall be tested both before and after conditioning as specified in 8.1.12 and then conditioned as specified in 8.1.3.

8.10.11.5 After conditioning, the pouch and stitching shall be cut to form 175 mm × 175 mm (7 in. × 7 in.) specimens for testing. Specimens shall not include seams where multiple layers are involved, except in the following cases:

(1) Where a ridged area or similar stitching is used to create specific performance characteristics rather than for glove assembly
(2) Where size constraints of a material make it necessary to allow stitching in order to create the sample size required

8.10.11.6 Stitching shall be of the same type as is used in the actual glove construction.

8.10.11.7 Specimens shall not be stitched to hold individual layers together during testing.

8.10.11.8 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.11.9 The requirement of 8.10.7.2 shall not apply.

8.10.12 Specific Requirements for Testing Protective Glove Interface Components Other Than Wristlet Composites.

8.10.12.1 Samples for conditioning shall be glove interface component composite swatches as specified in 8.10.12.3.

Δ **8.10.12.2** Specimens shall be representative of the glove interface component composite construction. All variations in composite construction, including number of layers and the order of layering of composite materials, shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s).

Δ **8.10.12.3** For glove interface component composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.10.12.4 Specimens shall be tested both before and after conditioning as specified in 8.1.12 and then conditioned as specified in 8.1.3.

8.10.12.5 After conditioning, the stitching shall be cut to form 175 mm × 175 mm (7 in. × 7 in.) specimens for testing. Specimens shall not include seams where multiple layers are involved, except in the following cases:

(1) Where a ridged area or similar stitching is used to create specific performance characteristics rather than for glove assembly
(2) Where size constraints of a material make it necessary to allow stitching in order to create the sample size required.

8.10.12.6 Stitching shall be of the same type as is used in the actual glove construction.

8.10.12.7 Specimens shall not be stitched to hold individual layers together during testing.

8.10.12.8 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.10.12.9 The requirements of 8.10.7.2 shall not apply.

8.10.13 Specific Requirements for Testing Helmet Ear Covers and Shrouds.

8.10.13.1 Specimens shall consist of materials from the portion of the ear covers that cover the ear and neck area or from the portion of the shroud that covers the head, face, 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 175 mm (7 in.) square.

8.10.13.3 Testing shall be performed as described in 8.10.2 through 8.10.7.

8.11 Thread Melting Test.

8.11.1 Application. This test method shall apply to each type of sewing thread used in the construction of protective garments, hoods, wristlets, gloves, helmets, helmet covers, shrouds, and footwear.

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

8.11.3 Specimens.

8.11.3.1 A total of three different specimens of each thread type shall be tested.

8.11.3.2 All specimens shall be conditioned as specified in 8.1.3 prior to testing.

• **8.11.4* Procedure.**

Δ **8.11.4.1** The melting temperature of specimens shall be determined in accordance with ASTM D7138, *Standard Test Method to Determine Melting Temperature of Synthetic Fibers*, using Procedure 1.

• **8.11.5 Report.**

Δ **8.11.5.1** The melting point of the sample unit shall be the average of the results obtained from the specimens tested and shall be recorded and reported to the nearest degree C.

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

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

8.12 Tear Resistance Test.

8.12.1 Application.

8.12.1.1 This test shall apply to woven materials used in protective garments, hoods, helmet covers, shrouds, and wristlets.

8.12.1.2 This test shall also apply to bootie materials where a bootie is used as part of the garment construction.

8.12.2 Samples.

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

8.12.2.2 Samples shall be tested both before and after being conditioned as specified in 8.1.2.

8.12.3 Specimens.

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

8.12.3.2 Where the material is isotropic, then 10 specimens shall be tested.

8.12.4 Procedure.

8.12.4.1 Specimens shall be tested in accordance with ASTM D5587, *Standard Test Method for the Tearing Strength of Fabrics by Trapezoid Procedure.*

8.12.4.2 Slippage of the specimen shall not be permitted.

8.12.5 Report.

8.12.5.1 The tear resistance of an individual specimen shall be the average of the five highest peak loads of resistance registered.

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

8.12.5.3 An average tear strength shall be calculated, recorded, and reported for warp and filling directions.

8.12.6 Interpretation.

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

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

8.12.7 Specific Requirements for Testing Protective Garments.

8.12.7.1 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 Where one or more of these barriers are configured 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 Burst Strength Test.

8.13.1 Application. This test shall apply to knit materials used in protective garments, hoods, and wristlets.

8.13.2 Samples.

8.13.2.1 Samples shall be conditioned as specified in 8.1.3.

Δ **8.13.2.2** Samples for conditioning shall be 1 m (1 yd) square of knit material for materials provided in roll form, and 1 m (1 yd) in length for knit materials provided in tubular form.

8.13.3 Specimens. A total of 10 specimens shall be tested.

8.13.4 Procedure. Specimens shall be tested as specified in ASTM D6797, *Standard Test Method for Bursting Strength of Fabrics Constant-Rate-of-Extension (CRE) Ball Burst Test.*

8.13.5 Report. The burst strength of each specimen shall be recorded and reported. The average burst strength of all specimens shall be calculated, recorded, and reported.

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

8.14 Seam-Breaking Strength Test.

8.14.1 Application.

8.14.1.1 This test method shall apply to seams used in protective clothing items, including booties where present, clothing item wristlets, glove interface components, and hoods.

Δ **8.14.1.2** Modifications to this test method for testing clothing item wristlets and glove interface components shall be as specified in 8.14.7.

8.14.2 Samples.

8.14.2.1 Samples for conditioning shall be 1 m (1 yd) length of seam.

8.14.2.2 Samples shall be submitted for testing after being subjected to the procedure specified in 8.1.2.

8.14.3 Specimens.

8.14.3.1 A minimum of five seam specimens representative of the clothing item shall be tested for each seam type.

8.14.3.2 The five seam specimens shall be straight seams. Seam specimens shall be permitted to be cut from the finished clothing item or shall be permitted to be prepared by joining two pieces of the clothing item fabric. Where specimens are cut from finished clothing items, such specimens shall be conditioned after being cut from the finished clothing item.

8.14.3.2.1 Where two pieces of woven clothing item fabric are joined, 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, seam type, and stitch type as used in the finished clothing item.

8.14.3.2.2 Where two pieces of knit or stretch woven clothing item fabric are joined, the knit fabric seam specimen shall be prepared as specified in 7.2.2 of ASTM D3940, *Standard Test Method for Bursting Strength (Load) and Elongation of Sewn Seams of Knit or Woven Stretch Textile Fabrics*, using the same thread, seam type, and stitch type as used in the finished clothing item.

8.14.3.2.3 Specimens of clothing item seam assemblies constructed from other than woven or knit textiles shall be tested as specified in 8.14.3.2.1.

8.14.3.2.4 Where a piece of woven clothing item 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 D1683, *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 clothing item.

8.14.4 Procedure.

8.14.4.1 All woven seam assemblies shall be tested in accordance with ASTM D1683, *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 All knit seam assemblies and all stretch woven seam assemblies shall be tested in accordance with ASTM D6797, *Standard Test Method for Bursting Strength of Fabrics Constant-Rate-of-Extension (CRE) Ball Burst Test.*

8.14.4.3 Combination woven and knit or stretch woven seam assemblies shall be tested in accordance with ASTM D1683, *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 Report.

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

8.14.5.2 The average seam-breaking strength for each seam type shall also be recorded and reported.

8.14.5.3 The type of seams tested shall be recorded and reported as to whether the specimens were cut from the finished clothing item or prepared from fabric samples.

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

8.14.7 Specific Requirements for Testing Protective Clothing Item Wristlets and Glove Interface Components.

8.14.7.1 Specimens for conditioning and testing shall consist of seams taken from the wristlet/clothing item sleeve or the glove interface/glove body junction.

8.14.7.2 Whole gloves shall be permitted to be used for conditioning.

8.14.7.3 Glove specimens shall be conditioned as specified in 8.1.12 prior to testing.

8.14.7.4 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.

8.14.7.5 Evaluation for sewn seam strength in accordance with Section 11.1 of ASTM D1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, shall be used to determine pass or fail performance.

8.15 Top Impact Resistance Test (Force).

8.15.1 Application. This test shall apply to complete helmets.

8.15.2 Samples. Samples for conditioning shall be complete helmets. Externally mounted faceshield/goggle components shall be removed. Internally mounted faceshield components shall be removed except where the internal faceshield is an integral part of the structural integrity of the helmet. Front holders, which could interfere with the impacting of the helmet shell, shall be removed. Mounting holes shall remain.

8.15.3 Specimens.

8.15.3.1 Three helmet specimens shall be tested for each condition specified.

8.15.3.2 Specimens shall be conditioned for each environmental condition specified in 8.1.3, 8.1.4, 8.1.5, 8.1.6, and 8.1.7 prior to each impact.

8.15.3.3 If during testing for the conditions specified in 8.1.3, 8.1.4, and 8.1.7 the helmet is returned to the conditioning environment before the time out of that environment exceeds 4 minutes, the helmet shall be kept in the environment for a minimum of 3 minutes before resumption of testing with that helmet. If the time out of the environment exceeds 4 minutes, the helmet shall be returned to the environment for a minimum of 3 minutes for each minute or portion of a minute that the helmet remained out of the environment in excess of 4 minutes or for a maximum of 24 hours, whichever is less, before resumption of testing with that helmet.

8.15.4 Apparatus.

8.15.4.1 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 and Figure 8.15.4.1(a) through Figure 8.15.4.1(c).

Table 8.15.4.1 Data for Contour Drawing of ISEA Headform (all dimensions in mm)

	Horizontal Plane	Distance from Datum Plane	Vertical Section												
			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

For SI units, 1 in. = 25.4 mm.
Note: All dimensions ±5 mm.

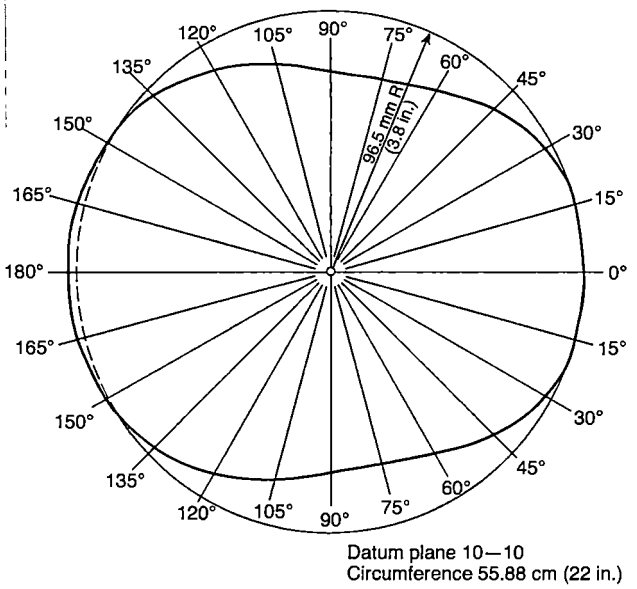


FIGURE 8.15.4.1(a) ISEA Size 7 Headform, Top.

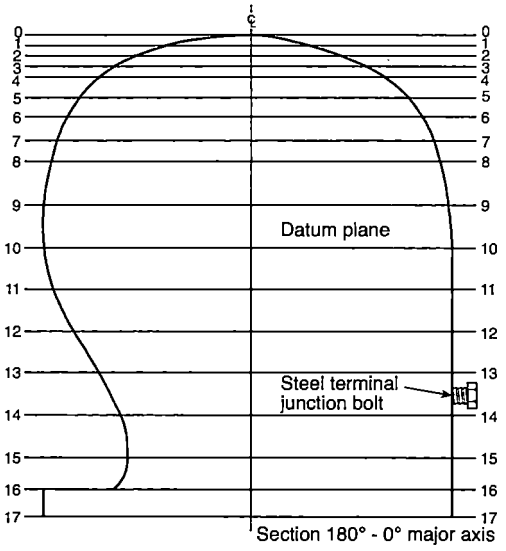


FIGURE 8.15.4.1(b) ISEA Size 7 Headform, Side with Modification for Steel Terminal Junction Bolt.

8.15.4.2 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 (1⅞ in. ± 5/16 in.) and a chord length of at least 75 mm (3 in.).

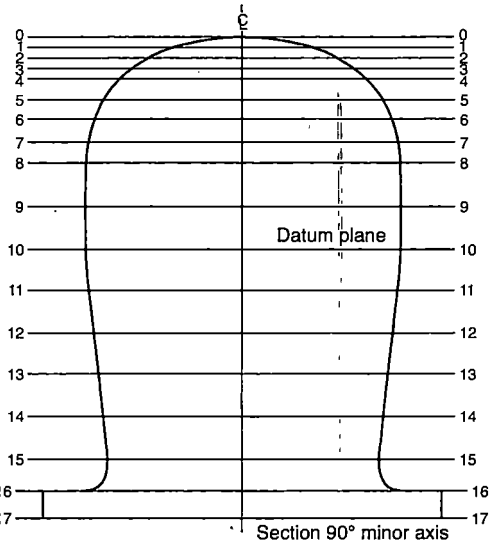


FIGURE 8.15.4.1(c) ISEA Size 7 Headform, Front.

8.15.4.3 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 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:

N

[8.15.4.4]

$$f = \frac{\left(\sqrt{kg/m}\right)}{2\pi}$$

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 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 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 0.185 m^2 (2 ft^2).

8.15.4.7 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 The vertical centerline of the drop mass, the headform, and the load cell shall all be colinear within 3 mm (⅛ in.). The sensitive axis of the load cell shall be aligned within 1 degree of vertical. The guide or guides shall be vertical, and in the case of a double guide system, parallel to within 6.4 mm per 3 m (¼ in. per 10 ft) of length.

8.15.4.9* The instrumentation shall be calibrated. The equipment shall be checked for repeatability before and after each test series by impacting a standardized elastomeric shock pad. A minimum of three such impacts shall be recorded before and after testing. If the post-test average readings of the three impacts differ from the pre-test average by more than 5 percent, the entire test series shall be discarded.

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

8.15.4.12 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 Procedure.

8.15.5.1 Specimen helmets shall be positioned according to the HP1 as described in 8.1.13 on a headform. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. Where the internal faceshield is an integral part of the structural integrity of the helmet, the faceshield shall be deployed as far as possible without interfering with the test equipment. Specimens shall be subjected to the environmental conditions specified in 8.1.3, 8.1.4, 8.1.5, 8.1.6, and 8.1.7 prior to each impact and within the specified time after being removed from conditioning.

8.15.5.2 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.

8.15.6 Report.

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

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

8.15.7 Interpretation.

8.15.7.1 Pass or fail performance shall be determined for each specimen.

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

8.16 Impact Resistance Test (Acceleration).

8.16.1 Application. This test shall be applied to complete helmets.

8.16.2 Samples. Samples for conditioning shall be complete helmets. Externally mounted faceshield/goggle components shall be removed. Internally mounted faceshield/goggle components shall be removed except where the internal faceshield is an integral part of the structural integrity of the helmet. Front holders, which could interfere with the impacting of the helmet shell, shall be removed. Mounting holes shall remain.

8.16.3 Specimens.

8.16.3.1 Three helmet specimens shall be tested for each condition specified.

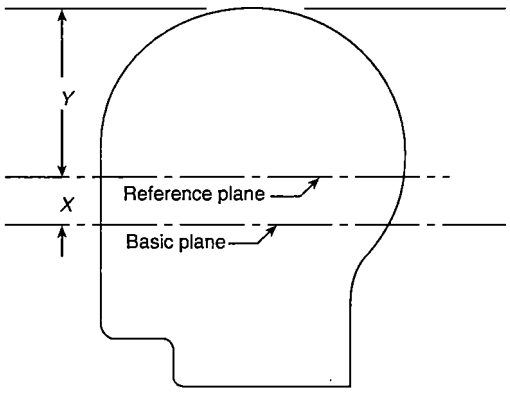
8.16.3.2 Specimens shall be conditioned for each environmental condition specified in 8.1.3, 8.1.4, 8.1.6, and 8.1.7 prior to each impact.

8.16.3.3 When testing helmets following the conditioning environments specified in 8.1.3, 8.1.4, and 8.1.7, and the helmet is returned to the conditioning environment before the time the helmet is out of that conditioning environment exceeds 4 minutes, the helmet shall be kept in the conditioning environment for a minimum of 3 minutes before resumption of testing with that helmet. When the time the helmet is out of the conditioning environment exceeds 4 minutes, before resumption of testing with that helmet, the helmet shall be returned to the conditioning environment for a minimum of 3 minutes for each minute, or portion of a minute, that the helmet remained out of the conditioning environment in excess of 4 minutes, or for a maximum of 24 hours, whichever is less.

8.16.4 Apparatus.

8.16.4.1 An ISO size J headform conforming to the nominal dimensions in Figure 8.16.4.1 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.

8.16.4.2 A drop assembly shall be used. The drop assembly shall consist of the test headform, the accelerometer, and the



Headform	Size (mm)	X (mm)	Y (mm)
A	500	24	90
B	540	26	96
J	570	27.5	102.5
M	600	29	107
O	620	30	110

For U.S. units, 1 mm = 0.0394 in.

Δ FIGURE 8.16.4.1 Location of Reference Plane.

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 The guidance assembly shall comprise not more than 20 percent of the total mass of the drop assembly.

8.16.4.4 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 the targeted impact over the center of the test anvil.

8.16.4.5 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 0.185 m^2 (2 ft^2).

8.16.4.6 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 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* The instrumentation shall be calibrated. The equipment shall be checked for repeatability before and after each test series by impacting a standardized elastomeric shock pad. A minimum of three such impacts shall be recorded before and after testing. If the post-test average readings of the three impacts differ from the pre-test average by more than 5 percent, the entire test series shall be discarded.

8.16.4.9 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 The test system shall be analyzed dynamically to ensure that any mechanical resonance does not distort the output data.

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

8.16.4.12 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.

8.16.5 Procedure.

8.16.5.1 A conditioned specimen shall be positioned according to the HPI as described in 8.1.13 on a headform and shall be secured to the drop assembly by its retention system so as to maintain this position during the test. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. No part of the helmet shell shall be cut away to accommodate the test system, and no part of the test system other than the anvil shall contact the helmet shell either as mounted or during an impact test. Where the internal faceshield is an integral part of the structural integrity of the helmet, the faceshield shall be deployed as far as possible without interfering with the test equipment.

8.16.5.2 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. Test series number 1 shall require helmet specimens 5, 6, 8, and 10 to be impacted at the top, front, rear, and side impact areas. Helmet front, rear, and side targeted impact areas shall be at a distance of 63 mm, +13/−0 mm (2½ in., +0.5/−0 in.), above the test line as shown in Figure 8.1.6.1. The headform with mounted helmet shall be rotated such that the targeted helmet impact area is over the center of the anvil.

8.16.5.3 The impact areas shall be as specified in Figure 8.1.6.1. The top, front, left, right, and rear of the helmet shall be tested in this order. Each helmet test specimen shall be impacted in all five test areas. All five impacts shall occur on the same helmet.

8.16.5.3.1 Reattachment of components is allowed between impacts, but no broken components shall be replaced. The helmet test specimen shall continue to be tested as long as the specimen can be held on the test headform using existing components as originally received.

8.16.5.4 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 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 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 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 Each conditioned specimen in a series shall be impacted one on the top, front, left, right, and rear test areas of the helmets as defined in Figure 8.1.6.1. Helmets shall be tested in this order. At least one impact shall occur in each test area.

8.16.5.9* The initial point of contact of the helmet with the anvil shall not occur on the brim of the helmet.

8.16.6 Report.

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

8.16.6.2 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 Interpretation.

8.16.7.1 Pass or fail performance shall be determined for each specimen. If the helmet test specimen cannot be held on the test headform and impacted in all five locations, then this shall be considered failing performance.

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

8.17 Faceshield/Goggle Component Lens Impact Resistance Test.

8.17.1 Application. This test shall apply to complete helmets.

8.17.2 Samples. Samples for conditioning shall be complete helmets with faceshield component or goggle component. Goggle samples shall be permitted to be complete goggle components not attached to the helmet.

8.17.3 Specimens.

8.17.3.1 Where the manufacturer produces helmets with faceshield components, a minimum of three complete faceshield components shall be tested for each of the conditions specified in 8.17.3.3.

8.17.3.2 Where the manufacturer produces helmets with goggle components, a minimum of three complete goggle components shall be tested for each of the conditions specified in 8.17.3.3.

8.17.3.3 Samples shall be conditioned for each of the environmental conditions specified in 8.1.3, 8.1.4, 8.1.5, and 8.1.7.

8.17.3.4 When testing for the conditions specified in 8.1.3, 8.1.4, and 8.1.7 and when the faceshield/goggle component is returned to the conditioning environment before the time out of that conditioning environment exceeds 4 minutes, the faceshield/goggle shall be kept in the conditioning environment for a minimum of 3 minutes before resumption of testing with that helmet. When the time out of the conditioning environment exceeds 4 minutes, the faceshield/goggle shall be returned to the conditioning environment for a minimum of 3 minutes for each minute or portion of a minute that the faceshield/goggle remained out of the conditioning environment in excess of 4 minutes or for a maximum of 24 hours, whichever is less.

8.17.4 Test One, High Mass Impact.

8.17.4.1 Apparatus.

8.17.4.1.1 A facial feature headform as defined in 3.3.43 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 ($\frac{1}{16}$ in.).

8.17.4.1.2 The missile shall have a 30 degree conical tip with a 1 mm ($\frac{1}{25}$ 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* The missile shall be dropped through a loose-fitting guide tube having a smooth internal diameter.

8.17.4.2 Procedure.

8.17.4.2.1 Only one faceshield/goggle component shall be tested at a time.

8.17.4.2.2 The helmet with faceshield/goggle component deployed shall be positioned according to the HPI as described in 8.1.13 on a headform. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance. Goggles shall be permitted to be placed directly on the headform without being attached to the helmet. 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 missile shall be dropped from a height of 1300 mm ($51\frac{3}{16}$ in.). At least four specimens shall be tested.

8.17.4.3 Report. The pass or fail result for each device shall be recorded and reported.

8.17.5 Test Two, High Velocity Impact.

8.17.5.1 Apparatus.

8.17.5.1.1* The test apparatus shall consist of a device capable of propelling a steel ball reproducible at the velocity designated at 76 m/sec (250 ft/sec). The device shall show a sample standard deviation of not greater than 2 percent of 76 m/sec (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 ($\frac{1}{4}$ 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 A facial feature headform as defined in 3.3.43 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 degree angular position.

8.17.5.2 Procedure.

8.17.5.2.1 Only one faceshield/goggle component shall be tested at a time.

8.17.5.2.2 The helmet with faceshield/goggle component deployed shall be mounted to a facial feature headform as defined in 3.3.43 in accordance with the HPI as described in 8.1.13. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance. Goggles shall be permitted to be placed directly on the headform without being attached to the helmet.

8.17.5.2.3 The headform shall be adjusted so that the path of the projectile passes through the center of the left eye. It shall be then rotated to the first test position, which shall be 15 degrees to the nasal side. The faceshield/goggle component shall then be impacted at the test velocity at 0 degrees, 45 degrees, and 90 degrees. The impacts at the 45 degree and 90 degree positions shall be at either 10 mm ($\frac{1}{3}$ in.) above or

10 mm (⅓ in.) below the plane of the eyes. A single specimen or multiple specimens shall be permitted to be used for the impact testing. At least one impact shall be conducted on each specimen utilized.

8.17.5.2.4 The headform shall be adjusted so that the path of the projectile passes through the center of the right eye. It shall be then rotated to the first test position, which shall be 15 degrees to the nasal side. The faceshield/goggle component shall then be impacted at the test velocity at 0 degrees, at 45 degrees, and at 90 degrees. The impacts at the 45 degree and 90 degree positions shall be at either 10 mm (⅓ in.) above or 10 mm (⅓ in.) below the plane of the eyes. A single specimen or multiple specimens shall be permitted to be used for the impact testing. At least one impact shall be conducted on each specimen utilized.

8.17.6 Report. The pass or fail performance for each helmet shall be recorded and reported.

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

8.18 Impact and Compression Tests. (Reserved)

8.19 Physical Penetration Resistance Test.

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

8.19.2 Samples. Samples for conditioning shall be complete helmets. Externally mounted faceshield/goggle components shall be removed. Internally mounted faceshield/goggle components shall be removed except where the internal faceshield is an integral part of the structural integrity of the helmet. Front holders, which could interfere with the impacting of the helmet shell, shall be removed. Mounting holes shall remain.

8.19.3 Specimens.

8.19.3.1 Three helmet specimens shall be tested for each condition as specified.

8.19.3.2 Specimens shall be conditioned for each environmental condition specified in 8.1.3, 8.1.4, 8.1.5, 8.1.6, and 8.1.7 prior to each physical penetration.

8.19.3.3 When testing helmets following the conditioning environments specified in 8.1.3, 8.1.4, and 8.1.7, and the helmet is returned to the conditioning environment before the time the helmet is out of that conditioning environment exceeds 4 minutes, the helmet shall be kept in the conditioning environment for a minimum of 3 minutes before resumption of testing with that helmet. When the time the helmet is out of the conditioning environment exceeds 4 minutes, before resumption of testing with that helmet, the helmet shall be returned to the conditioning environment for a minimum of 3 minutes for each minute, or portion of a minute, that the helmet remained out of the environment in excess of 4 minutes, or for a maximum of 24 hours, whichever is less.

8.19.4 Apparatus.

8.19.4.1 The ISO size J headform shall conform to the nominal dimensions in Figure 8.16.4.1. Above the test line, it shall have an electrically conductive surface that is electrically connected to the contact indicator.

8.19.4.2 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 (1½ in.), and a tip radius of 0.5 mm ± 0.1 mm (0.020 in. ± 0.004 in.). The hardness of the striking tip shall be Rockwell Scale C-60, minimum. The penetration striker shall be electrically connected to the contact indicator.

8.19.4.3 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 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 Procedure.

8.19.5.1 The environmentally conditioned helmet shall be positioned according to the HPI, as described in 8.1.13, on the test headform and secured by the helmet retention system or by other means that will not interfere with the test. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. The helmet shall be positioned so that the penetration striker shall impact perpendicular to the helmet anywhere above the test line. Where the internal faceshield is an integral part of the structural integrity of the helmet, the faceshield shall be deployed as far as possible without interfering with the test equipment. 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 The drop height of the penetration striker shall be adjusted so that the velocity at impact is at 7 m/sec ± 0.1 m/sec (23 ft/sec ± 0.5 ft/sec). A total of two penetration tests for each of the five environmental conditions specified in 8.1.3, 8.1.4, 8.1.5, 8.1.6, and 8.1.7 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. 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 Report. The pass or fail result for each helmet shall be recorded and reported.

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

8.20 Puncture Resistance Test.

8.20.1 Application. This test method shall apply to protective gloves and footwear uppers.

8.20.2 Samples. Samples for conditioning shall be complete gloves, glove composite pouches, or footwear upper sections.

8.20.3 Specimens.

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

8.20.3.2 Specimens shall be tested after conditioning as specified in 8.1.3.

8.20.4 Procedure. Specimens shall be tested in accordance with ASTM F1342/F1342M, *Standard Test Method for Protective Clothing Material Resistance to Puncture,* Test Method A.

8.20.5 Report.

8.20.5.1 The puncture force in N (lbf) shall be recorded and reported for each puncture on each specimen.

8.20.5.2 The average puncture force in N (lbf) shall be recorded and reported for all specimens tested.

8.20.6 Interpretation. The average puncture force shall be used to determine pass or fail performance.

8.20.7 Specific Requirements for Testing Gloves.

8.20.7.1 Specimens shall be representative of each glove body composite construction. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases:

(1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly
(2) When there are size constraints of a material, making it necessary to allow stitching in order to create the sample size required

8.20.7.1.1 Stitching shall be of the same type as is used in the actual glove construction.

8.20.7.2 For glove body composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.20.7.3 Glove specimens shall also be tested after wet conditioning as specified in 8.1.8, representing a second separate test.

8.20.7.4 Testing shall be performed as specified in 8.20.2 through 8.20.6.

8.20.8 Specific Requirements for Testing Footwear Uppers.

8.20.8.1 Specimens shall consist of each composite of the footwear upper used in the actual footwear construction, including the tongue but excluding the gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

8.20.8.2 Testing shall be performed as specified in 8.20.2 through 8.20.6.

8.21 Cut Resistance Test.

8.21.1 Application.

8.21.1.1 This test method shall apply to glove body, glove interface component, and footwear upper materials.

• **8.21.1.2** Modifications to this test method for evaluation of glove body composites shall be as specified in 8.21.7.

8.21.1.3 Modifications to this test method for evaluation of glove interface components other than wristlets shall be as specified in 8.21.9.

8.21.1.4 Modifications to this test method for evaluation of wristlet glove interface components shall be as specified in 8.21.10.

8.21.1.5 Modifications to this test method for evaluation of footwear upper materials shall be as specified in 8.21.8.

• **8.21.2 Samples.**

8.21.2.1 Glove body and glove interface component other than wristlet material samples shall be conditioned as specified in 8.1.12.

8.21.2.2 Glove wristlet interface components shall be conditioned as specified in 8.1.2.

8.21.2.3 Footwear upper material samples shall be conditioned as specified in 8.1.3.

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

Δ **8.21.4 Procedure.** Specimens shall be evaluated in accordance with ASTM F1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, with the modification that specimens shall be tested to a specific load with the measurement of cut distance.

8.21.5 Report.

8.21.5.1 The distance of blade travel shall be recorded and reported to the nearest 1 mm ($\frac{3}{64}$ in.) for each sample specimen.

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

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

8.21.7 Specific Requirements for Testing Glove Body Composites.

8.21.7.1 Samples for conditioning shall be glove body composite pouches as specified in 8.21.7.3.

8.21.7.2 Specimens shall be representative of each glove body composite construction. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Stitching shall be of the same type as is used in the actual glove construction.

8.21.7.3 For glove body composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.21.7.4 After conditioning, the pouch and necessary stitching shall be cut to form 50 mm × 100 mm (2 in. × 4 in.) specimens for testing.

8.21.7.5 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 except in the following cases:

(1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly
(2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required

8.21.7.5.1 Stitching shall be of the same type as is used in the actual glove construction.

8.21.7.6 Cut resistance testing shall be performed under a load of 300 g.

8.21.8 Specific Requirements for Testing Footwear Upper Materials.

8.21.8.1 Samples for conditioning shall be footwear uppers.

8.21.8.2 Specimens shall consist of each composite of footwear upper used in the actual footwear construction, including the tongue but excluding the gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

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

8.21.9 Specific Requirements for Testing Glove Interface Components Other Than Wristlet Composites.

8.21.9.1 Samples for conditioning shall be glove interface component composite swatches as specified in 8.21.9.3.

8.21.9.2 Specimens shall be representative of each glove interface composite construction. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Stitching shall be of the same type as is used in the actual glove construction.

8.21.9.3 For glove interface component composites, samples for conditioning shall be in the form of a pouch as described in 8.1.14.

8.21.9.4 After conditioning, the stitching shall be cut to form 50 mm × 100 mm (2 in. × 4 in.) specimens for testing.

8.21.9.5 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.

8.21.9.6 No stitching or binding mechanism shall be used in the test area except in the following cases:

(1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly
(2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required.

8.21.9.6.1 Stitching shall be of the same type as is used in the actual glove construction.

8.21.9.7 Cut resistance testing shall be performed under a load of 300 g.

8.21.10 Specific Requirements for Testing Wristlet Glove Interface Components.

8.21.10.1 Samples for conditioning shall be wristlet glove interface component composite swatches as specified in 8.21.10.3.

8.21.10.2 Specimens shall be representative of the wristlet glove interface component composite construction.

8.21.10.3 For wristlet glove interface component composites, samples for conditioning shall include wristlet material.

8.21.10.4 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.

8.21.10.5 The swatch shall be permitted to stitched, or otherwise held together at the ends of the swatch for placement on the test apparatus.

8.21.10.6 No stitching or binding mechanism shall be used in the test area.

8.21.10.7 Cut resistance testing shall be performed under a load of 300 g.

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8.22 Faceshield/Goggle Component Lens Scratch Resistance Test.

8.22.1 Application.

N **8.22.1.1** This test method shall apply to faceshield/goggle component lenses.

N **8.22.1.2** Modifications to this test method for testing proximity fire fighting helmet faceshield component lenses shall be as specified in 8.22.8.

8.22.2 Samples.

8.22.2.1 Samples for conditioning shall be faceshield/goggle component lenses.

8.22.2.2 Samples shall be conditioned as specified in 8.1.3.

8.22.3 Specimens.

8.22.3.1 A minimum of four faceshield/goggle component lenses shall be selected.

8.22.3.2 Seven specimens shall be chosen from a minimum of four lenses. Four specimens shall be taken from the left viewing area and three specimens shall be taken from the right viewing area. One of the four specimens taken from the left viewing area shall be the setup sample.

8.22.3.3 The left viewing area test specimens shall include all of the following criteria:

(1) The specimen shall be a square measuring 50 mm × 50 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 specimen.
(3) The specimen 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 the helmet with a faceshield/goggle component deployed according to the HPI as described in 8.1.13 on a facial feature headform as defined in 3.3.43. Goggle samples shall be permitted to be complete goggle components not attached to the helmet.

8.22.3.4 The right viewing area test specimens shall include all of the following criteria:

(1) The specimen shall be a square measuring 50 mm × 50 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 specimen.
(3) The specimen 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 the helmet with a faceshield/goggle component deployed according to the HPI as described in 8.1.13 on a facial feature headform as defined in 3.3.43. Goggle samples shall be permitted to be complete goggle components not attached to the helmet.

8.22.3.5 Each of the specimens shall be cleaned in the following manner:

(1) The specimen shall be rinsed with clean tap water.
(2) The specimen shall be washed with a solution of nonionic, low-phosphate detergent and water using a clean, soft gauze pad.
(3) The specimen shall be rinsed with clean tap water.
(4) The specimen shall be blown dry with filtered compressed air or nitrogen.

8.22.4 Apparatus.

Δ **8.22.4.1** The faceshield/goggle component lens scratch test apparatus shall be constructed in accordance with Figure 8.22.4.1.

8.22.4.2 The specimen holder shall be configured with a flat surface under the lens or with an inner radius support.

8.22.4.3 The pad holder shall consist of a cylinder 10 mm (3/8 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.

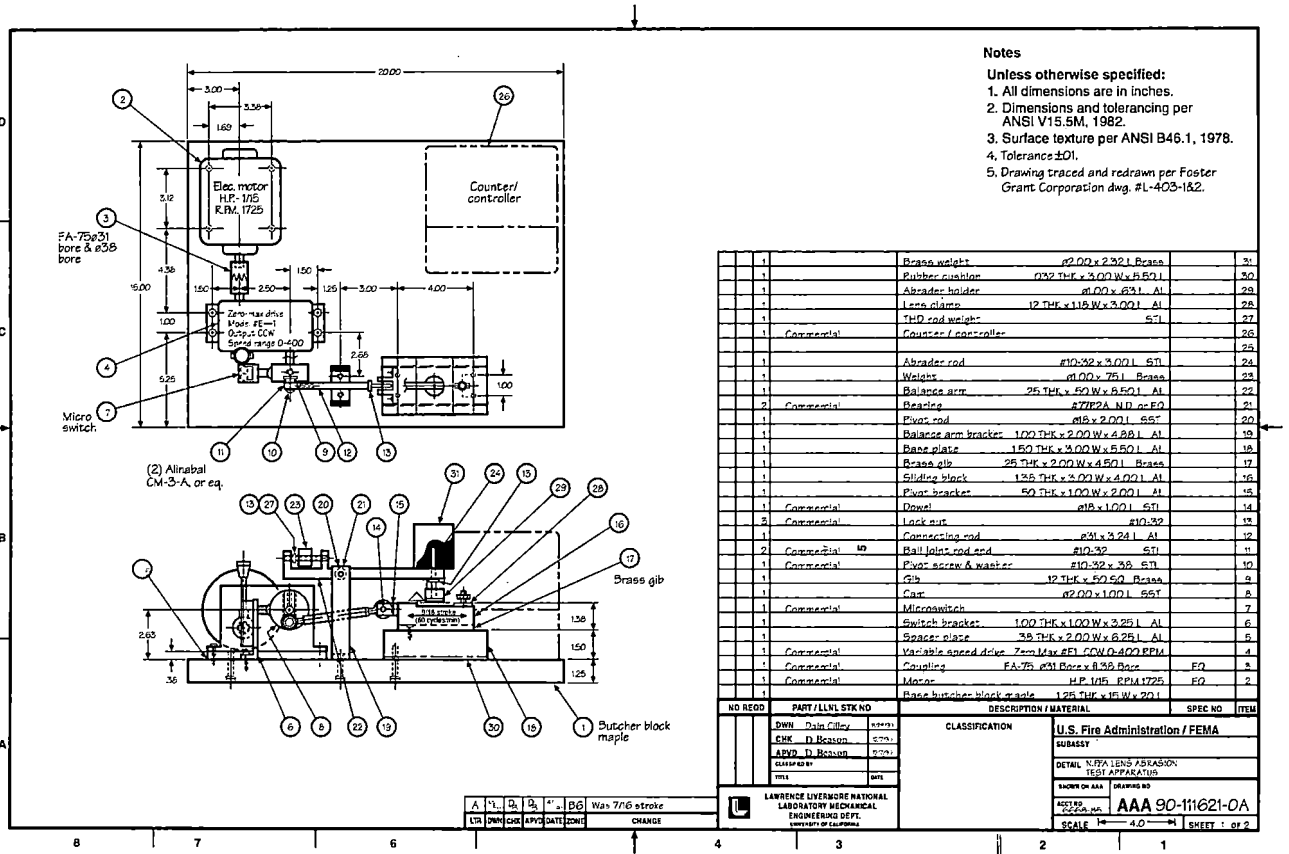
8.22.4.4 The pad shall be a Blue Streak M306M or equivalent wool felt polishing pad 30 mm (1 3/16 in.) in diameter.

8.22.4.5 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.

8.22.5 Procedure.

Δ **8.22.5.1** The haze of the specimen shall be measured using a haze meter in accordance with ASTM D1003, *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 (±1/16 in.).



Δ **FIGURE 8.22.4.1 Faceshield/Goggle Component Lens Test Apparatus.**

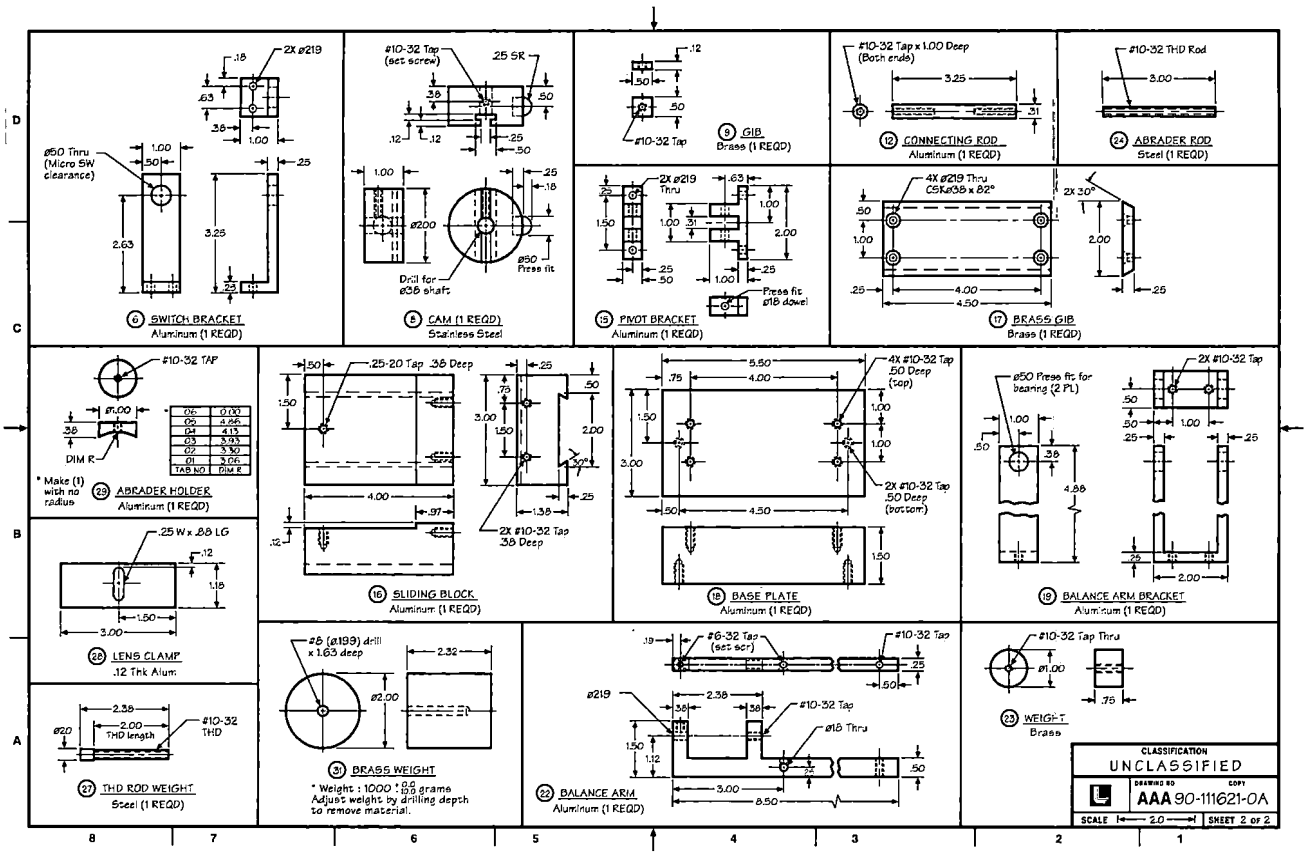


FIGURE 8.22.4.1 *Continued*

(2) The specimen shall be repositioned to achieve the maximum haze value within the area specified in 8.22.5.1(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 D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.*

8.22.5.2 The setup sample shall be placed cover side up in the test apparatus specimen holder.

8.22.5.3 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.

8.22.5.4 The stroking arm shall be counterbalanced with the pad holder, pad, and abrasive disc in place.

8.22.5.5 The setup sample shall be replaced with one of the six specimens to be tested.

8.22.5.6 A test weight of 1 kg ± 8 g (2.2 lb ± 0.2 oz), shall be installed on the pin above the test specimen.

Δ **8.22.5.7** The test shall be run for 200 cycles ± 1 cycle. One cycle shall consist of a complete revolution of the eccentric wheel.

8.22.5.8 The length of stroke shall be 14 mm ($^{17}/_{32}$ in.); producing a pattern 38 mm (1½ 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 ($^{1}/_{16}$ in.) of the center of the sample.

8.22.5.9 The specimen shall be removed and cleaned following the procedure specified in 8.22.3.5. The abrasive disc shall be discarded.

8.22.5.10 The testing steps specified in 8.22.5 shall be repeated five additional times with a new specimen and abrasive disc.

8.22.6 Report.

8.22.6.1 After each of the six specimens have been tested and cleaned, the haze of the specimen shall be measured following the procedure specified in 8.22.5.1, recorded, and reported.

8.22.6.2 The delta haze shall be calculated by subtracting the initial haze measurement from the final haze measurement.

8.22.7 Interpretation.

8.22.7.1 The six delta haze values shall be averaged.

8.22.7.2 The resultant value shall be compared to the value specified in 7.5.3 to determine pass or fail performance.

N **8.22.8 Specific Requirements for Testing Proximity Fire Fighting Helmet Faceshield Component Lenses.** The abrasive disc pad shall be made from 3M Part #7445 Hand Pad or equivalent.

8.23 Abrasion Resistance Test.

8.23.1 Application. This test method shall apply to protective footwear soles with heels.

8.23.2 Samples.

8.23.2.1 Samples for conditioning shall be uniform cylinders of footwear sole and heel materials as specified in ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device.*

8.23.2.2 Samples shall be conditioned as specified in 8.1.3.

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

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

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

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

8.24 Cleaning Shrinkage Resistance Test.

8.24.1 Application.

8.24.1.1 This test method shall apply to the protective garment outer shell, moisture barrier, thermal barrier, winter liner, wristlet, bootie material where present, and protective hoods.

8.24.1.2 Modifications to this test method for testing woven textile materials shall be as specified in 8.24.7.

8.24.1.3 Modifications to this test method for testing knit and stretch woven materials shall be as specified in 8.24.8.

8.24.1.4 Modifications to this test method for testing hoods shall be as specified in 8.24.9.

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

8.24.3 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.

8.24.4 Procedure.

8.24.4.1 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.*

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

N **8.24.4.3** Laundry water hardness shall not exceed 25 ppm.

8.24.4.4 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.*

8.24.4.5 Knit specimens shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement.

8.24.5 Report.

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

8.24.5.2 Results shall be recorded and reported as the average of all three specimens in each dimension.

8.24.6 Interpretation.

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

8.24.6.2 Failure of either dimension shall constitute failure for the entire sample.

8.24.7 Specific Requirements for Testing Woven Textile Materials.

8.24.7.1 Each specimen shall be 380 mm × 380 mm ± 13 mm (15 in. × 15 in. ± ½ in.), and shall be cut from the fabric to be utilized in the construction of the clothing item.

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

8.24.7.3 Testing shall be performed as specified in 8.24.2 through 8.24.6.

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

8.24.8.1 Other than for wristlets, the dimensions of each specimen shall be 380 mm × 380 mm ± 13 mm (15 in. × 15 in. ± ½ in.), and shall be cut from the fabric to be utilized in the construction of the clothing item.

8.24.8.2 The dimensions of wristlet specimens shall be 113 mm × 113 mm ± 13 mm (4½ in. × 4½ in. ± ½ in.), and shall be cut from the wristlet fabric.

8.24.8.3 Samples for conditioning shall include material that is at least 50 mm (2 in.) larger in each of the two required specimen dimensions.

8.24.8.4 Testing shall be performed as specified in 8.24.2 through 8.24.6.

8.24.9 Specific Requirements for Testing Hoods.

8.24.9.1 Samples for conditioning shall include complete hoods with labels.

8.24.9.2 Specimens for testing shall be complete hoods with labels. A total of three specimens shall be tested.

Δ **8.24.9.3** Specimens shall be donned on a nonconductive test headform specified in Figure 8.6.12.3. Measurements shall 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 plane on the hood shall be marked at each location.

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N **8.24.9.4** Specimen face openings with elastic or manually adjustable face openings shall be placed over a hood measur-

ing device as shown in Figure 8.6.16.4. Specimen face openings in the relaxed state shall slide freely over the top half of the device where the circumference measures 45.6 cm ± 0.6 cm (18.0 in. ± 0.25 in.). Specimen face openings shall then be placed around the lower half of the device where the circumference measures 54.5 cm ± 0.6 cm (21.5 in. ± 0.25 in.). Specimens shall then be visually inspected for gaps between the hood and the measuring device surface.

N **8.24.9.4.1** Specimen hoods with SCBA facepiece interface openings shall be measured as specified in 8.47.5.3.

Δ **8.24.9.5** After washing, each elastic or manually adjustable face opening shall be placed over a hood measuring device as shown in Figure 8.6.16.4. Specimen face openings in the relaxed state shall slide freely over the top half of the device where the circumference measures 45.6 cm ± 0.6 cm (18.0 in. ± 0.25 in.). Specimen face openings shall then be placed around the lower half of the device where the circumference measures 54.5 cm ± 0.6 cm (21.5 in. ± 0.25 in.). Specimens shall then be visually inspected for gaps between the hood and the measuring device surface.

N **8.24.9.5.1** After washing, each hood with SCBA facepiece interface openings shall be measured as specified in 8.47.5.3.

N **8.24.9.5.2** After washing, all specimens shall then be donned on a nonconductive test headform specified in Figure 8.6.12.3. Knit specimens shall be pulled to original dimensions and shall be allowed to relax for 1 minute prior to measurement. Measurements shall be made from the top of the hood to the marks at the back and both sides of the hood.

N **8.24.9.6** Observations shall be recorded and reported of the ability of the elastic and manually adjustable face openings to slide freely over the top half of the hood measuring device as well as gaps between the hood face opening and the bottom half of the hood measuring device before and after laundering. The average percent shrinkage of the SCBA facepiece openings for each hood shall be recorded and reported.

N **8.24.9.7** Each of the three dimensions from the top of the hood to the marks along the basic plane before and after laundering shall be recorded and reported.

N **8.24.9.8** The percentage of shrinkage of each of the three dimensions from the top of the hood to the marks along the basic plane shall be individually calculated, recorded, and reported.

N **8.24.9.9*** The average percentage of shrinkage of the three dimensions from the top of the hood to the marks along the basic plane for all specimens shall be calculated, recorded, and reported.

N **8.24.9.10*** Pass or fail performance shall be based on the average percent shrinkage of the three dimensions from the top of the hood to the marks along the basic plane for each specimen.

N **8.24.9.11** Pass or fail performance shall also be based on the elastic or manually adjustable face opening being able to slide freely in the relaxed state over the top half of the hood measuring device and any observations of gaps between the hood face opening and the hood measuring device. One or more hood specimens failing this test shall constitute failing performance.

N **8.24.9.12** Pass or fail performance shall also be based on the average percent shrinkage of the SCBA facepiece openings.

8.25 Water Absorption Resistance Test.

8.25.1 Application. This test method shall apply to the protective garment outer shell and collar lining materials.

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

8.25.3 Specimens.

8.25.3.1 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.

8.25.3.2 Specimens shall be tested after being subjected to the procedure specified in 8.1.2.

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

(1) A metal roller approximately 115 mm (4½ in.) long and weighing 1 kg (2½ lb) shall be used.
(2) Metal embroidery hoops, measuring 150 mm to 180 mm (6 in. to 7 in.) in diameter shall be used for mounting the specimen.

8.25.5 Procedure.

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

8.25.5.2 The direction of the flow of water down the specimen shall coincide with the warp wise direction of the specimen as placed on the stand.

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

8.25.5.4 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. 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.

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

(1) The specimen shall be removed from the hoops and placed between sheets of blotting paper on a flat horizontal surface. The metal roller shall be rolled quickly forward and back one time over the paper without application of any pressure other than the weight of the roller.
(2) A square 100 mm × 100 mm (4 in. × 4 in.) shall be cut out of the center of the wet portion of the specimen and weighed to the nearest 0.05 g. This weight shall be designated as 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.
(3) The same 100 mm (4 in.) square shall be conditioned as specified in 6.1.3 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 as the "dry weight."

8.25.5.6 The percent water absorption (PWA) shall be calculated using the following equation:

N

[8.25.5.6]

$$PWA = [(\text{Wet Weight} - \text{Dry Weight})/(\text{Dry Weight})] \times 100$$

8.25.6 Report.

8.25.6.1 The percent water absorbed for each specimen shall be recorded and reported.

8.25.6.2 The average percent water absorption shall be calculated, reported, and recorded.

8.25.7 Interpretation. The average percent water absorption shall be used for determining pass or fail performance.

8.26 Water Penetration Resistance Test.

Δ **8.26.1 Application.** This test method shall apply to moisture barrier materials and booties where present.

8.26.2 Samples.

8.26.2.1 Samples for conditioning shall be at least 1 m (1 yd) square.

8.26.2.2 Samples for the conditioning specified in 8.1.5 shall be 150 mm (6 in.) squares cut from a sample subjected to the procedures specified in 8.1.2 and 8.1.3.

8.26.3 Specimens.

8.26.3.1 A minimum of five specimens of moisture barrier material shall be tested for each sequence of conditioning.

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

8.26.3.3 Specimens shall also be tested after conditioning as specified in 8.1.2, followed by 8.1.3, followed by 8.1.5.

8.26.4 Procedure.

8.26.4.1 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.*

8.26.4.2 The surface of the material toward the exterior of the garment as worn shall be exposed to the water challenge.

8.26.4.3 There shall be no placement of a restraining cloth over the test specimen during the hydrostatic exposure.

8.26.5 Report. The pass or fail performance for each specimen shall be recorded and reported.

8.26.6 Interpretation.

8.26.6.1 The appearance of any water shall constitute failure.

8.26.6.2 One or more test failures of any specimen against any liquid shall constitute failure of the material.

8.27 Liquid Penetration Resistance Test.

8.27.1 Application.

Δ **8.27.1.1** This test method shall apply to garment moisture barrier materials and moisture barrier seams, shroud moisture barrier materials and moisture barrier seams, footwear moisture barrier materials and moisture barrier seams, bootie moisture barrier materials and moisture barrier seams where present, and glove moisture barrier materials and moisture barrier seams.

Δ **8.27.1.2** Modifications to this test method for testing garment moisture barrier materials and moisture barrier seamsand bootie moisture barrier materials and moisture barrier seams where present shall be as specified in 8.27.7.

8.27.1.3 Modifications to this test method for testing glove moisture barrier materials and moisture barrier seams shall be as specified in 8.27.8.

8.27.1.4 Modifications to this test method for testing footwear shall be as specified in 8.27.9.

8.27.2 Samples. Samples for conditioning shall be as specified in 8.27.7.1 for moisture barriers and moisture barrier seams, 8.27.8.2 for glove materials, and 8.27.9.1 for footwear materials.

8.27.3 Specimens.

8.27.3.1 A minimum of three specimens shall be tested for each material type.

Δ **8.27.3.2** Glove specimens shall be tested after being subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.11.
(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 as specified in 8.1.3.

8.27.3.3 Footwear specimens to be tested shall be conditioned as specified in 8.1.5 followed by 8.1.3.

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Δ **8.27.3.4** 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.
(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.

8.27.4 Procedure.

Δ **8.27.4.1** Liquid penetration resistance testing shall be conducted in accordance with ASTM F903, *Standard Test Method for Resistance of Protective Clothing to Penetration by Liquids,* using exposure Procedure C at a test temperature of 21°C, ± 3°C (70°F, ± 5°F) and relative humidity of 65 percent, ± 5 percent.

8.27.4.2* 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 by weight sulfuric acid to water)
(3) Fire-resistant hydraulic fluid, phosphate ester base, containing 50 to 80 percent tributyl phosphate [CAS No. 126-73-8]
(4) Surrogate gasoline Fuel H as defined in ASTM D471, *Standard Test Method for Rubber Property–Effect of Liquids,* consisting of 42.5% toluene, 42.5% iso-octane, and 15% ethanol, by volume, respectively.

(5) Swimming pool chlorinating chemical containing at least 65 percent-free chlorine (saturated solution)
(6) Automobile antifreeze fluid (ethylene glycol, 90 percent by weight or higher concentration)

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

8.27.5 Report. The pass or fail performance for each specimen shall be recorded and reported.

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

8.27.7 Specific Requirements for Testing Moisture Barrier Materials and Moisture Barrier Seams.

8.27.7.1 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/yd^2 woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber, the moisture barrier, a layer of 3.8 oz/yd^2 ± 0.3 oz/yd^2 aramid needle punched nonwoven, quilted to 3.4 oz/yd^2 ± 0.2 oz/yd^2 aramic woven plain weave thermal barrier material, and another layer of 7.5 oz/yd^2 woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber. 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.

8.27.7.1.1 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 conditioned shall be constructed using those materials.

8.27.7.2 The moisture barrier layer shall be removed from the four-layer composite samples after all conditioning has been completed and shall become the moisture barrier specimen.

8.27.7.2.1 Where the moisture barrier is configured as indicated in 8.27.7.1.1, 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 8.27.7.1.1.

8.27.7.3 Testing shall be performed as specified in 8.27.3 through 8.27.6.

8.27.8 Specific Requirements for Testing Glove Moisture Barrier Materials and Moisture Barrier Seams.

8.27.8.1 Specimens shall be representative of the glove moisture barrier and moisture barrier seams. Three specimens shall be tested.

8.27.8.2 Samples for conditioning shall be in the form of a pouch as described in 8.1.15.

8.27.8.3 The glove moisture barrier layers shall be removed from the multilayer composite samples after all conditioning has been completed and shall become the glove barrier test specimen.

8.27.8.4 Specimens for testing shall be the barrier layer only.

8.27.8.5 Testing shall be performed as specified in 8.27.2 through 8.27.6.

8.27.8.6 Where the moisture barrier material is continuous through the glove body, only the barrier seams shall be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

8.27.9 Specific Requirements for Testing Footwear Materials.

8.27.9.1 Samples for conditioning shall be whole footwear or footwear composite swatches. Footwear composite swatches shall be representative of the footwear construction.

8.27.9.2 Three specimens shall be representative of the moisture barrier, and three specimens shall be representative of each type of moisture barrier seam.

8.27.9.3 Testing shall be performed as described in 8.27.2 through 8.27.6.

8.27.9.4 Specimens for testing shall be the barrier layer only.

8.28 Viral Penetration Resistance Test.

8.28.1 Application.

Δ **8.28.1.1** This test method shall apply to garment moisture barrier materials and moisture barrier seams, shroud moisture barrier materials and moisture barrier seams, footwear moisture barrier materials and moisture barrier seams, bootie moisture barrier materials and moisture barrier seams where present, and glove moisture barrier materials and moisture barrier seams.

Δ **8.28.1.2** Modifications to this test method for testing moisture barrier materials and moisture barrier seams, and bootie moisture barrier materials and moisture barrier seams where present shall be as specified in 8.28.7.

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

8.28.1.4 Modifications to this test method for testing footwear shall be as specified in 8.28.9.

8.28.2 Samples. Samples for conditioning shall be as specified in 8.28.7.1 for moisture barriers and moisture barrier seams, 8.28.8.2 for glove materials, and 8.28.9.2 for footwear materials.

8.28.3 Specimens.

8.28.3.1 A minimum of three specimens shall be tested for each material type.

Δ **8.28.3.2** Glove specimens shall be tested after being subjected to the following conditioning:

(1) Specimens shall first be subjected to the procedure specified in 8.1.11.
(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 as specified in 8.1.3.

8.28.3.3 Footwear specimens to be tested shall be conditioned as specified in 8.1.5 followed by 8.1.3.

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Δ **8.28.3.4** 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.
(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.

8.28.4 Procedure. Viral penetration resistance testing shall be conducted in accordance with ASTM F1671/F1671M, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X-174 Bacteriophage as a Test System.*

8.28.4.1 The normal outer surface of the material shall be exposed to the viral challenge as oriented in the clothing item.

8.28.5 Report. The pass or fail performance for each specimen shall be recorded and reported.

8.28.6 Interpretation. A failure of any specimen against any virus constitutes failure of the material.

8.28.7 Specific Requirements for Testing Moisture Barrier Materials and Moisture Barrier Seams.

8.28.7.1 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/yd^2 woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber, the moisture barrier, a layer of 3.8 oz/yd^2 ± 0.3 oz/yd^2, aramid needle punched nonwoven, quilted to 3.4 oz/yd^2 ± 0.2 oz/yd^2, aramid woven plain weave thermal barrier material, and another layer of 7.5 oz/yd^2 woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber.

8.28.7.2 The moisture barrier layer shall be removed from the four-layer composite samples after all conditioning has been completed and shall become the moisture barrier test specimen.

8.28.7.3 Testing shall be as specified in 8.28.3 through 8.28.6.

8.28.8 Specific Requirements for Testing Glove Materials Moisture Barrier Materials and Moisture Barrier Seams.

8.28.8.1 Specimens shall be representative of the glove moisture barrier and moisture barrier seams. Three specimens shall be tested.

8.28.8.2 Samples for conditioning shall be in the form of a pouch as described in 8.1.15.

8.28.8.3 The glove moisture barrier layers shall be removed from the multilayer composite samples after all conditioning has been completed and shall become the glove barrier test specimen.

8.28.8.4 Specimens for testing shall be the barrier layer only.

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

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

8.28.9 Specific Requirements for Testing Footwear Materials.

8.28.9.1 Three specimens shall be representative of the moisture barrier, and three specimens shall be representative of each type of moisture barrier seam.

8.28.9.2 Samples for conditioning shall be whole footwear, or footwear composite swatches. Footwear composite swatches shall be representative of the footwear construction.

8.28.9.3 Testing shall be as described in 8.28.2 through 8.28.6.

8.28.9.4 Specimens for testing shall be the barrier layer only.

8.29 Corrosion Resistance Test.

8.29.1 Application.

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

8.29.1.2 Modifications to this test method for testing garment and glove hardware shall be as specified in 8.29.7.

8.29.1.3 Modifications to this test method for testing helmet and partial eye/face protective devices shall be as specified in 8.29.8.

8.29.1.4 Modifications to this test method for testing footwear shall be as specified in 8.29.9.

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

8.29.3 Specimens. A total of three specimens of each hardware type shall be tested.

8.29.4 Procedure.

8.29.4.1 Specimens shall be tested in accordance with ASTM B117, *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.

8.29.4.2 Immediately following the storage specified in 8.29.4.1 and prior to examination, specimens shall be rinsed under warm, running tap water and dried with compressed air.

8.29.4.3 Specimens shall then be examined visually with the unaided eye to determine the presence of corrosion.

8.29.4.4 The functionality of each specimen shall be evaluated.

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

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

8.29.7 Specific Requirements for Testing Garment and Glove Hardware.

8.29.7.1 Samples for conditioning shall be whole hardware items.

8.29.7.2 A total of three specimens of each hardware type shall be tested.

8.29.8 Specific Requirements for Testing Helmets.

8.29.8.1 Samples for conditioning shall be whole helmets with the faceshield/goggle component attached.

8.29.8.2 A total of three different helmets shall be tested.

8.29.9 Specific Requirements for Testing Footwear.

8.29.9.1 Samples for conditioning shall be whole hardware items.

8.29.9.2 A total of three specimens of each hardware type shall be tested.

8.29.9.3 Functionality of the toe cap, sole plate, and ladder shank shall not be evaluated.

8.30 Electrical Insulation Test 1.

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

8.30.2 Samples.

8.30.2.1 Samples for conditioning shall be complete helmets.

8.30.2.2 Samples shall be conditioned as specified in 8.1.3.

8.30.3 Specimens. A minimum of three helmets shall be tested.

8.30.4 Apparatus.

8.30.4.1 The following equipment shall be provided for Procedure A:

(1) 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) Voltmeter to measure the applied voltage to within 2 percent
(4) Millimeter to measure the leakage current to within 2 percent
(5) Vessel, containing tap water, of sufficient size to submerge an inverted helmet to the dielectric test plane
(6) Frame for suspending the test specimen in water

8.30.4.2 The following equipment shall be provided for Procedure B:

(1) 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) Voltmeter to measure the applied voltage to within 2 percent
(4) Millimeter to measure the leakage current to within 2 percent
(5) Vessel, containing tap water, of sufficient size to completely submerge an inverted helmet
(6) Aluminum ISEA size 7 headform modified in accordance with Table 8.15.4.1 and Figure 8.15.4.1(a) through Figure 8.15.4.1(c)

8.30.5 Procedures.

8.30.5.1 Procedure A.

8.30.5.1.1 The helmet specimen shall be positioned according to the HPI as described in 8.1.13 on the ISO size J headform specified in Figure 8.16.4.1. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance.

8.30.5.1.2 The dielectric test plane specified in Figure 8.30.5.1.2 shall be marked as a line on the shell of the helmet. The dielectric test plane shall be the plane that passes through the point located 85 mm (3 in.) above the basic plane, where the basic plane and the midsagittal plane intersect at the front of the headform and the point located 60 mm (2 in.) above the basic plane, where the basic plane and the midsagittal plane intersect at the rear of the headform.

8.30.5.1.3 The specimen shall be inverted and the inside of the specimen shall be filled with fresh tap water up to the dielectric test plane. The specimen shall then be submerged in the same type of water up to the same level as the water on the inside of the helmet. Care shall be taken to keep the unsubmerged portion of the test specimen dry so that flashover will not occur when voltage is applied.

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

8.30.5.2 Procedure B.

8.30.5.2.1 The specimen and retention system shall be completely submerged in tap water for a period of 15 minutes +2/−0 minutes. The specimen shall be removed from the tap water and allowed to drain for not longer than 2 minutes.

8.30.5.2.2 The specimen shall then be positioned according to the HPI as described in 8.1.13 on the modified ISEA aluminum size 7 headform, with the chinstrap firmly secured to the headform by means of the conductive terminal junction bolt. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

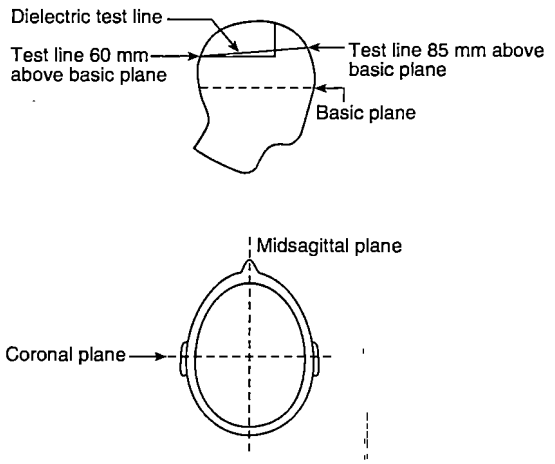
8.30.5.2.3 A lead carrying 60 Hz alternating voltage shall be attached to all metal parts on the helmet's exterior, at or above the brim edge. A second pickup lead shall be attached to the terminal junction bolt. Voltage shall be applied to the external helmet shell lead and increased to 2200 volts ± 2 percent, volts. The voltage shall be maintained for 15 seconds.

8.30.6 Report. Any current leakage or evidence of breakdown shall be recorded and reported for each helmet.

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

8.31 Electrical Insulation Test 2.

8.31.1 Application. This test shall apply to protective footwear.



Δ FIGURE 8.30.5.1.2 Test Setup.

8.31.2 Samples.

8.31.2.1 Samples for conditioning shall be whole footwear.

8.31.2.2 Samples shall be conditioned as specified in 8.1.3.

8.31.3 Specimens. A minimum of three footwear elements in men's size 9D shall be tested.

Δ **8.31.4 Procedure.** Specimens shall be tested in accordance with Section 9 of ASTM F2412, *Standard Test Methods for Foot Protection,* with the following modification: Specimens shall be tested to 14,000 V (rms).

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

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

8.32 Overall Liquid Integrity Test 1.

8.32.1 Application. This test shall apply to protective gloves.

8.32.2 Samples.

8.32.2.1 Samples for conditioning shall be whole gloves.

8.32.2.2 A minimum of three glove pairs each for size 70W (wide) and 76W (wide) shall be used for testing.

8.32.3 Specimens.

8.32.3.1 Specimens shall be tested after being subjected to the procedures specified in 8.1.12 and then conditioned as specified in 8.1.3.

8.32.3.2 Specimens shall also be tested after being subjected to the procedures specified in 8.1.5 and then conditioned as specified in 8.1.3.

8.32.4 Apparatus.

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

8.32.4.2 Water used for integrity testing shall be at a temperature of 20°C ± 3°C (68°F ± 5°F) and treated with a nonfoaming surfactant to lower its surface tension to less than 35 dynes/cm ± 5 dynes/cm.

8.32.4.3 The following equipment shall be used for the test procedure:

(1) A clear container(s) for submerging gloved hand(s)
(2) A stopwatch

8.32.5 Procedure.

Δ **8.32.5.1** 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 Figure 6.7.6.1 provided for size 70W (wide) and size 76W (wide) gloves in 6.7.6.

8.32.5.2 After the conditioning described in 8.32.3, the wrist crease location shall be marked as described in 6.7.3.5 on each specimen around the entire glove +0/−3 mm (+0/−0.25 in.), and this shall be the maximum water height line.

8.32.5.2.1 Then, in the same manner, the minimum water height line shall also be marked on each specimen 25 mm ± 3 mm (1 in. ± 0.25 in.) below (towards the fingers) the location of the wrist crease around the entire glove.

8.32.5.3 The test subject shall don the specimen(s) over the water markable glove(s).

8.32.5.4 The test subject shall then immerse the donned specimen(s) straight down into the surfactant treated water to between the minimum and maximum water height lines for 5 minutes +30/−0 seconds.

8.32.5.4.1 An observer shall be present to ensure that the specimen(s) is not immersed beyond the maximum water height line. If the test subject immerses the specimen(s) beyond the maximum water height line, the specimen(s) shall be retested after air drying and conditioning as specified in 8.1.3.

8.32.5.4.2 The test subject shall flex the specimen in a gentle, complete fist closing motion every 10 seconds with each fist closing motion taking 10 seconds ± 2 seconds to complete. A complete fist-closing motion shall be when the ends of the glove fingertips make contact with the palm surface of the glove.

8.32.5.5 The specimen(s) shall then be removed from the test subject's hand, and the water markable glove(s) shall be inspected for water marks.

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

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

8.33* Total Heat Loss (THL) Test.

8.33.1 Application.

N **8.33.1.1** This test method shall apply to structural fire fighting protective garment element and protective hood interface component composites.

N **8.33.1.2** Modifications to this test method for testing particulate barrier protective hood interface components shall be as specified in 8.33.8.

Δ **8.33.2 Samples.** Samples shall be conditioned at a temperature of 25°C ± 7°C (77°F ± 13°F) and a relative humidity of 65 percent ± 5 percent for at least 4 hours.

8.33.2.1 The minimum sample size shall be 51 cm × 51 cm (20 in. × 20 in.).

8.33.3 Specimens.

8.33.3.1 Total heat loss testing shall be conducted on at least three specimens.

8.33.3.2 Specimens shall consist of all layers in the structural fire fighting protective garment or hood composite, arranged in the order and orientation as worn.

8.33.4 Apparatus.

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

N **8.33.4.2** The dimensions for the sweating guarded hot plate shall be a 25.4 cm (10 in.) test plate with a 12.7 cm (5 in.) guard surrounding the test plate.

Δ **8.33.5* Procedure.** Testing shall be conducted in accordance with ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate,* using Part C, with the following modifications:

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

8.33.6 Report.

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

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

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

8.33.7 Interpretation.

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

8.33.7.2 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.

N **8.33.8 Specific Requirements for Testing Barrier Protective Hood Interface Components.** Specimens shall consist of all layers used in the barrier portions of the protective hood interface component composite arranged in their normal order.

8.34 Retention System Test.

8.34.1 Application. This test shall apply to protective helmets.

8.34.2 Samples.

8.34.2.1 Samples for conditioning shall be whole helmets.

8.34.2.2 Samples shall be conditioned as specified in 8.1.3.

8.34.3 Specimens. A minimum of three complete helmets shall be tested.

8.34.4 Apparatus.

8.34.4.1 An ISO size J headform conforming to the nominal dimensions in Figure 8.16.4.1 shall be used.

Δ **8.34.4.2*** A mechanical chin structure shall be designed for use with a calibrated tensile test machine. The mechanical chin structure shall consist of two rollers 13 mm (½ in.) in diameter with centers that are 75 mm (3 in.) apart.

8.34.4.3 The calibrated tensile test machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified forces.

8.34.5 Procedure.

8.34.5.1 The test shall be conducted at an ambient temperature of 20°C to 28°C (68°F to 82°F), and the relative humidity shall be 30 percent to 70 percent.

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

8.34.5.3 The headform and mechanical chin structure shall be positioned so that the vertical straight line distance between the bottom of the rollers and the crown of the headform is 210 mm ± 10 mm (8 5/16 in. ± 3/8 in.), the chinstrap shall be passed around the rollers, and the helmet shall be secured to the headform. The chin strap shall be adjusted and preloaded to 45 N ± 5 N (10 lbf ± 1 lbf). The distance between the top of the helmet and the bottom of the rollers shall be measured and recorded to the nearest 0.5 mm (1/64 in.).

8.34.5.4* 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 a rate between 9 N/sec to 45 N/sec (2 lbf/sec to 10 lbf/sec).

8.34.5.5 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).

8.34.5.6 The distance between the top of the helmet and the bottom of 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.

8.34.6 Report. The retention system elongation shall be reported and recorded for each helmet specimen.

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

8.35 Suspension System Retention Test.

8.35.1 Application. This test shall apply to protective helmets.

8.35.2 Samples.

8.35.2.1 Samples for conditioning shall be whole helmets.

8.35.2.2 Samples shall be conditioned as specified in 8.1.3.

8.35.3 Specimens. A minimum of 3 complete helmets shall be tested.

8.35.4 Apparatus.

8.35.4.1 The suspension system retention test fixtures shall consist of rigid material of sufficient thickness to facilitate firm attachment of the inverted helmet to the tensile test machine as shown in Figure 8.35.4.1.

8.35.4.2 The calibrated tensile test machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified forces.

8.35.5 Procedure.

8.35.5.1 Each helmet suspension strap shall be cut such that sufficient length of strap remains to be gripped by the movable jaw of the testing machine.

8.35.5.2 Specimens shall be positioned and secured in the tensile testing machine so that the helmet's reference plane is horizontal.

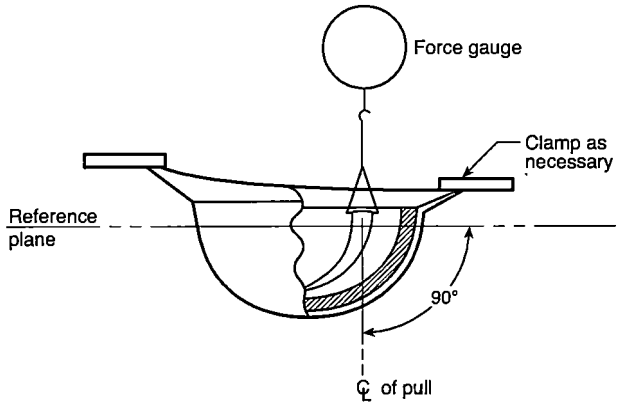


FIGURE 8.35.4.1 Suspension System Test Setup.

Δ **8.35.5.3** Each attachment point of the crown strap shall be tested by applying a pull force along the centerline of the suspension strap, perpendicular to the reference plane to a maximum load of 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 mm/min ± 5 mm/min (1 in./min ± 3/16 in./min). The entire width of the suspension strap shall be mounted within the movable jaw grip.

8.35.5.4 After application of the force is complete, the load shall be released and the suspension system shall be inspected for any separation from the helmet shell.

8.35.6 Report. The individual pass or fail results for each attachment point shall be reported and recorded.

8.35.7 Interpretation.

8.35.7.1 Separation of the helmet suspension from the helmet shall constitute failing performance.

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

8.36 Glove Donning Test.

8.36.1 Application. This test shall apply to protective gloves.

8.36.2 Samples.

8.36.2.1 A minimum of three glove pairs each for size 70W (wide) and size 76W (wide) shall be used for testing.

8.36.2.2 Samples for conditioning shall be whole gloves.

8.36.2.3 All glove opening configurations shall be considered for testing.

8.36.3 Specimens.

8.36.3.1 Specimens shall be conditioned as specified in 8.1.12 prior to testing.

8.36.3.2 Specimens shall be donned once after removal from the conditioning specified in 8.36.3.1 before beginning testing.

8.36.4 Procedure.

Δ **8.36.4.1** 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 for size 70W (wide) and size 76W (wide) gloves specified in Figure 6.7.6.1. Three test subjects shall be selected for size 70W (wide) and three for size 76W (wide).

8.36.4.2 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.

8.36.4.3 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 test subject shall be permitted to don either the right-hand glove or left-hand glove according to individual preference.

8.36.4.3.1 The glove shall be donned in accordance with the manufacturer's donning procedure.

8.36.4.3.2 The glove shall then be removed by grasping the fingertip of the middle finger and pulling the hand out of the glove.

8.36.4.3.3 The test subject shall wear the glove of the opposite hand during the test.

Δ **8.36.4.3.4** Where the glove cannot be donned because of detachment of the inner liner or moisture barrier, the trial for that glove shall be stopped. If any fingers cannot be fully inserted into the glove, the trial for that glove shall be stopped.

8.36.4.4 The dry hand donning time shall be the average of the first three dry hand donning times as determined in 8.36.4.3.

8.36.4.5 The test subject's hand shall then be completely submerged in room temperature water [21°C ± 3°C (70°F ± 5°F)] for 10 seconds before donning the glove each time.

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Δ **8.36.4.6** Immediately after the hand-wetting procedure specified in 8.36.4.5, with no time lapse, the test subject shall then don one glove of the pair specimen. The test subject shall do this wetting and donning procedure for three consecutive trials as specified in 8.36.4.4 and 8.36.4.5. The times shall be recorded.

8.36.4.7 The wet hand donning time shall be the average of the first three wet hand donning times as determined in 8.36.4.6.

N **8.36.4.8** Each test subject shall perform the test with one pair of gloves.

8.36.5 Report.

8.36.5.1 The dry hand donning time shall be recorded and reported to the nearest 0.1 second for each trial.

8.36.5.2 The wet hand donning time shall be recorded and reported to the nearest 0.1 second for each trial.

8.36.5.3 The average dry hand and wet hand donning times shall be calculated, recorded, and reported for each size.

8.36.5.4 Any inner liner or moisture barrier separations shall be recorded and reported.

8.36.5.5 Any glove digits that do not allow full insertion shall be recorded and reported.

8.36.6 Interpretation.

8.36.6.1 Pass or fail determinations shall be made using the average dry hand and wet hand donning times for size 70W (wide) and size 76W (wide).

8.36.6.2 Failure of either size shall constitute failure of the test.

8.36.6.3 Any detachment of the inner liner and/or moisture barrier shall constitute failing performance.

8.36.6.4 Any glove digits that do not allow full insertion shall constitute failing performance.

8.37 Glove Hand Function Test.

8.37.1 Application. This test shall apply to gloves.

8.37.2 Samples.

8.37.2.1 Samples for conditioning shall be whole glove pairs.

8.37.2.2 Glove pair samples shall be conditioned as specified in 8.1.3.

8.37.3 Specimens.

8.37.3.1 A minimum of three glove pair specimens each for size 70W (wide) and size 76W (wide) shall be used for testing.

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

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

8.37.4 Apparatus. The apparatus shall be as specified in ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test*, with the modification that the stainless steel pins shall have a medium knurled 30 degree (25 teeth/in.) surface.

8.37.5 Procedures. The testing procedures shall be as specified in ASTM F2010/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test.*

8.37.6 Report.

8.37.6.1 The average percentage of bare-handed control shall be recorded and reported for each test subject.

8.37.6.2 The average percentage of bare-handed control for all test subjects shall be recorded and reported for each size.

8.37.7 Interpretation.

8.37.7.1 The average percentage of bare-handed control for size 70W (wide) and size 76W (wide) shall be used to determine pass or fail performance.

8.37.7.2 Failure of either size shall constitute failure of the test.

8.38 Grip Test.

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

8.38.2 Samples.

8.38.2.1 Samples for conditioning shall be whole glove pairs.

8.38.2.2 Sample glove pairs shall be wet conditioned as specified in 8.1.3.

8.38.3 Specimens.

8.38.3.1 A minimum of three glove pair specimens each for size 70W (wide) and 76W (wide) shall be used for testing.

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

8.38.3.3 Specimen glove pairs shall be tested for each material and construction combination.

8.38.3.4 Specimen glove pairs shall be tested after being wet conditioned as specified in 8.1.10.

8.38.4 Apparatus.

8.38.4.1 Pulling Device. The pulling device shall be a 32 mm (1¼ in.) diameter fiberglass pole attached to an overhead calibrated force measuring device in such a fashion that pulls on the pole will be perpendicular to the ground and downward in direction. This pole shall be used until surface degradation occurs. The force measuring system shall provide a graphical plot of force versus time.

8.38.5 Procedure.

Δ **8.38.5.1** 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 Figure 6.7.6.1 for size 70W (wide) and size 76W (wide) gloves. At least three test subjects shall be selected for both size 70W (wide) and size 76W (wide).

8.38.5.2 The gloves shall be conditioned by the wetting procedure specified in 8.1.10 before each set of three pulls by the test subject as described below.

8.38.5.3 The pulling device shall be wet conditioned before each individual pull by wiping with a damp rag.

Δ **8.38.5.4** The test subject and the test subject's hand shall be positioned as shown in Figure 8.38.5.4(a) and Figure 8.38.5.4(b) and as described in the paragraphs that follow.

8.38.5.4.1 The test subject shall stand facing the pole with feet shoulder width apart.

8.38.5.4.2 While wearing specimen gloves, the test subject shall grasp the pole with the bottom of the bottom hand at a height equal to the height of the test subject.

8.38.5.4.3 The test subject's hands shall be stacked on each other and the thumbs shall not overlap the fingers.

8.38.5.4.4 The test subject's body shall be distanced from the pole so that the forearms are approaching vertical and are in plane with the pole.

8.38.5.4.5 The test subject's elbows shall be shoulder width apart, rotated neither fully in (arms parallel to the pole) nor fully out (arms perpendicular to the pole).

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N **8.38.5.5** The test subject shall pull the pole with as much pulling force as possible in a smooth, steady, swift, and nonjerking action for 5 seconds, +1/−0 seconds. The test subject shall minimize forward or backward movement during the pull as much as possible. The test subject shall not bend their knees or pull down with body weight during the pull. The test subject

N FIGURE 8.38.5.4(a) Position of Test Subject's Body, Arms, and Hands with Respect to Pole. *(Photo courtesy of Intertek Testing Services. Used by permission.)*

N FIGURE 8.38.5.4(b) Close-up of Position of Test Subject's Hands on Pole. *(Photo courtesy of Intertek Testing Services. Used by permission.)*

shall continue to pull until the test facilitator instructs the test subject to end the pull at 5 seconds, +1/−0 seconds.

N **8.38.5.6** The test subject shall repeat the pull described above for a total of three pulls.

8.38.6 Report. Any drop in force of greater than 30 percent in any 0.2-second interval, as measured in the graphical plot of force versus time, shall be recorded and reported.

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8.38.7 Interpretation. Any drop in force greater than 30 percent in any 0.2-second interval shall constitute failing performance.

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8.39 Ladder Shank Bend Resistance Test.

8.39.1 Application. This test shall apply to protective footwear.

8.39.2 Samples.

8.39.2.1 Samples for conditioning shall be whole footwear,

8.39.2.2 Ladder shanks or whole sole equivalents shall be conditioned as specified in 8.1.3.

8.39.3 Specimens. A minimum of three footwear ladder shank specimens, or whole sole equivalent specimens, shall be tested.

8.39.4 Apparatus. The apparatus shall consist of a tensile-testing machine, such as an Instron® or equivalent, that challenges a specimen with a simulated ladder rung. A 32 mm diameter × 50 mm long (1¼ in. diameter × 2 in. long) noncompressible probe shall be mounted on the movable arm. The specimen support assembly shall consist of two 50 mm × 25 mm × 25 mm (2 in. × 1 in. × 1 in.) noncompressible blocks placed 50 mm (2 in.) apart as shown in Figure 8.39.4.

8.39.5 Procedure. The specimen of the ladder shank or whole sole equivalent shall be placed on mounting blocks as it would be oriented toward the ladder, where the shank or whole sole equivalent is affixed into the protective footwear and subjected to force on its center with the test probe operated at 50 mm/min (2 in./min).

8.39.6 Report.

8.39.6.1 Deflection at 182 kg (400 lb) shall be recorded and reported to the nearest 1 mm (0.05 in.).

8.39.6.2 The average deflection shall be calculated, recorded, and reported to the nearest 1 mm (0.05 in.).

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

8.40 Slip Resistance Test.

8.40.1 Application. This test method shall apply to footwear.

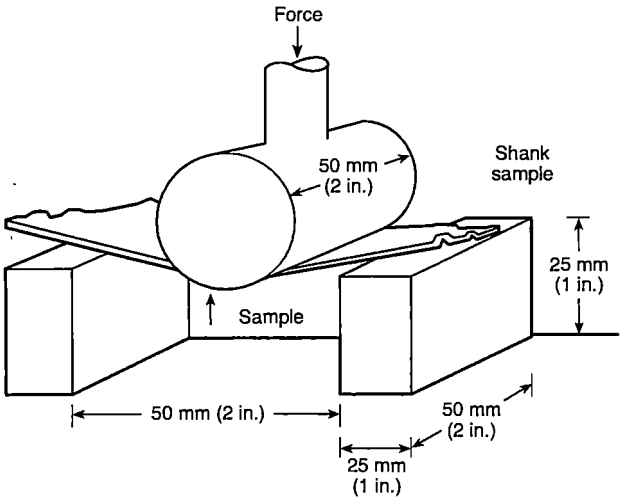


FIGURE 8.39.4 Shank Bend Test Setup.

8.40.2 Sample Preparation.

Δ **8.40.2.1** Samples shall be the whole footwear items in men's size 9D.

Δ **8.40.2.2** Samples shall be conditioned as specified in ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester.*

8.40.3 Specimens.

8.40.3.1 Specimens shall be the whole footwear in men's size 9D.

8.40.3.2 At least three specimens shall be tested.

Δ **8.40.4 Procedure.** Slip resistance shall be performed in accordance with ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester,* in the following configurations. References to any other flooring and/or contaminate within ASTM F2913 shall not apply.

(1) Footwear shall be tested both in the forepart and heel positions.
(2) Footwear shall be tested in the wet condition.
(3) Footwear shall be tested on a quarry tile surface that meets the specifications of ASTM F2913 and shall be calibrated in accordance with ASTM F2913. The calibration frequency of 10 tests specified in ASTM F2913 shall be equivalent to 50 test runs.

8.40.5 Report.

8.40.5.1 The coefficient of friction of each specimen shall be reported.

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

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

8.41 Label Durability and Legibility Test 1.

8.41.1 Application.

8.41.1.1 This test method shall apply to labels on protective garments, hoods, gloves, and boots.

8.41.1.2 Modifications to this test method for testing garment labels shall be as specified in 8.41.7.

8.41.1.3 Modifications to this test method for testing hood labels shall be as specified in 8.41.8.

8.41.1.4 Modifications to this test method for testing glove labels shall be as specified in 8.41.9.

8.41.1.5 Modifications to this test method for testing footwear labels shall be as specified in 8.41.10.

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

8.41.3 Specimens.

8.41.3.1 A minimum of three specimens of each type of label for each element shall be tested in each test.

8.41.3.2 Where labels have areas of "write-in" information, two additional specimens shall be tested that include those areas with sample information written in.

8.41.4 Procedures.

8.41.4.1 Laundering Durability Test.

8.41.4.1.1 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.*

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

8.41.4.1.3 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.

8.41.4.2 Abrasion Durability Test.

8.41.4.2.1 Specimens shall be subjected to abrasion in accordance with ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Test Method),* 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) Specimens shall be subjected to 200 cycles, 3200 revolutions, of the test apparatus.
(3) Standard abrasive fabric shall only be used for 200 cycles.

8.41.4.2.2 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.

8.41.4.3 Heat Durability Test.

8.41.4.3.1 Specimens shall be subjected to convective heat as specified in 8.1.5.

8.41.4.3.2 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.

8.41.5 Report. The legibility for each specimen shall be recorded and reported as acceptable or unacceptable.

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

8.41.7 Specific Requirements for Testing Garment Labels.

8.41.7.1 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.*

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

8.41.7.3 For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 380 mm ± 13 mm (15 in. ± ½ in.) square of material that meets the outer shell requirements of this standard.

8.41.7.4 Sample conditioning shall be the same conditioning as specified for the respective tests.

8.41.7.5 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.41.4.1, 8.41.4.2, and 8.41.4.3, respectively.

8.41.8 Specific Requirements for Testing Hood Labels.

8.41.8.1 For testing label legibility after laundering, specimens shall include complete hoods with labels attached.

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

8.41.8.3 For testing label legibility after convective heat exposure, specimens shall include individual labels sewn onto a separate 380 mm ± 13 mm (15 in. ± ½ in.) square of hood material that meets the hood material requirements of this standard.

8.41.8.4 Sample conditioning shall be the same conditioning as specified for the respective tests.

8.41.8.5 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.41.4.1, 8.41.4.2, and 8.41.4.3, respectively.

8.41.9 Specific Requirements for Testing Glove Labels.

8.41.9.1 For testing label legibility after laundering and convective heat exposure, specimens shall include complete gloves with labels attached.

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

8.41.9.3 Sample conditioning shall be the same conditioning as specified for the respective tests.

8.41.9.4 Specimens shall be tested separately for legibility after laundering, abrasion, and heat durability tests as specified in 8.41.4.1, 8.41.4.2, and 8.41.4.3, respectively.

Δ **8.41.9.5** For the drying cycles of the laundering durability test specified in 8.41.4.1.1, gloves shall be tumble dried for 60 minutes and shall be removed immediately at the end of the drying cycle. At the conclusion of the final drying cycle, the gloves shall be direct dried on a forced-air, non-tumble-drying mechanism operated at 10°C ± 5°C (18°F ± 9°F) above current room temperature until dry but not less than 8 hours.

8.41.10 Specific Requirements for Testing Footwear Labels.

8.41.10.1 For testing label legibility after convective heat exposure, specimens shall include complete footwear items with the labels attached or representative sections of the footwear with labels attached.

N **8.41.10.2** For testing label legibility after abrasion, specimens shall be individual labels.

8.41.10.3 Sample conditioning shall be the same conditioning as specified for the respective tests.

8.41.10.4 Specimens shall be tested separately for legibility after abrasion and heat durability tests as specified in 8.41.4.2 and 8.41.4.3, respectively.

8.42 Label Durability and Legibility Test 2.

8.42.1 Application. This test method shall apply to labels on helmets.

8.42.2 Samples.

8.42.2.1 Samples for conditioning shall be whole helmets with the labels attached.

8.42.2.2 Samples shall be conditioned as specified in 8.1.3, 8.1.4, 8.1.6, and 8.1.7.

8.42.3 Specimens. A minimum of three labels for each condition specified shall be tested.

8.42.4 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.

8.42.5 Report. The legibility for each label specimen shall be recorded and reported as acceptable or unacceptable.

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

8.43 Shell Retention Test.

8.43.1 Application. This test shall apply to protective helmets.

8.43.2 Samples.

8.43.2.1 Samples for conditioning shall be whole helmets.

8.43.2.2 Samples shall be conditioned as specified in 8.1.3.

8.43.3 Specimens. A minimum of three complete helmets shall be tested.

8.43.4 Apparatus.

8.43.4.1* The shell retention test fixtures shall consist of rigid material of sufficient thickness to facilitate firm attachment of the helmet shell while attached to the chinstrap tensile testing machine specified in 8.35.4.1.

8.43.4.2 The calibrated tensile test machine shall be capable of measuring the force applied to the retention system within 2 percent at the specified forces.

8.43.5 Procedure.

8.43.5.1 Specimens shall be positioned and secured in the tensile testing machine so that the helmet's reference plane is horizontal.

8.43.5.2 A pull force shall be applied to the helmet shell perpendicular to the reference plane. The force shall be applied to a maximum load of 356 N (80 lbf) within 30 seconds and shall be held at the maximum load for 1 minute, $+5/_{-0}$ seconds.

8.43.6 Report.

8.43.6.1 Separation of the helmet shell from the helmet suspension system or the helmet retention system shall be recorded and reported.

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

8.43.7 Interpretation. Any one specimen failing the test shall constitute failing performance for the item being tested.

8.44 Luminous (Visible) Transmittance Test.

8.44.1 Application. This test shall apply to faceshield/goggle component lenses.

8.44.2 Samples.

8.44.2.1 Samples for conditioning shall be complete faceshield/goggle components.

8.44.2.2 Samples shall be conditioned as specified in 8.1.3.

8.44.3 Specimens. A minimum of three faceshield/goggle component lenses shall be tested.

8.44.4 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.

8.44.5* 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 haze meter and the standards of luminous transmittance maintained by the National Bureau of Standards

8.44.6 Report.

8.44.6.1 The percentage of light transmission shall be recorded and reported for each specimen.

8.44.6.2 The average light transmission of all specimens tested shall be calculated, recorded, and reported.

8.44.7 Interpretation. Pass or fail performance shall be based on the average light transmission measured.

8.45 Retroreflectivity and Fluorescence Test.

8.45.1 Application.

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

8.45.1.2 Trim materials shall be tested for each procedure specified in 8.45.4.

8.45.2 Samples.

8.45.2.1 Samples for conditioning shall include 305 mm (12 in.) long sections of trim.

8.45.2.2 Samples shall be conditioned as specified in 8.1.3.

8.45.3 Specimens.

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

8.45.3.2 Each trim test specimen shall be 100 mm (4 in.) in length by the width of the finished trim product.

8.45.3.3 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.

8.45.4 Procedures.

8.45.4.1 Measurement of Coefficient of Retroreflection.

8.45.4.1.1 The coefficient of retroreflection (R_a) shall be determined in accordance with ASTM E809, *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 +5 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.

8.45.4.1.2 The coefficient of retroreflection (R_a) shall be calculated by the following equation:

N

[8.45.4.1.2]

$$Ra = \frac{R_I}{A_r}$$

where:
R_I = coefficient of luminous intensity measured as specified in 8.45.4.1.1
A_r = only the retroreflective surface area of the trim test specimen's surface area

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

8.45.4.2 Evaluation of Fluorescence.

8.45.4.2.1 Trim fluorescence shall be determined by its colorimetric properties. The color shall be measured in accordance with the procedures defined in ASTM E991, *Standard Practice for Color Measurement of Fluorescent Specimens*, ASTM E1164, *Standard Practice for Obtaining Spectrometric Data for Object Color Evaluation*, ASTM E2152, *Standard Practice for Computing the Colors of Fluorescent Objects from Bispectral Photometric Data*, and ASTM E2153, *Standard Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color* using the following test specifications:

(1) A polychromatic illumination of D65
(2) A 45 degree/0 degree (or 0 degree/45 degree) geometry
(3) A 2 degree standard observer
(4) A black underlay with a Cap Y, luminance factor, less than 4

8.45.4.2.2 The chromaticity shall be within one of the areas defined in Table 8.45.4.2.2, and the Cap Y, luminance factor, shall be not less than the corresponding minimum for the respective color.

8.45.4.3 Rainfall Test.

8.45.4.3.1 Specimens of trim shall be tested when wet for retroreflectivity at a rate of 110 mm/hr (4 3/16 in./hr) as specified in Appendix A, "Method of Measuring Wet Performance of Retroreflective Material," of ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel and Accessories.*

8.45.4.3.2 The coefficient of retroreflectivity (R_a) shall be measured as specified in 8.45.4.1, 2 minutes ± 15 seconds, after the rainfall exposure has been started.

8.45.4.4 Convective Heat Exposure Test.

8.45.4.4.1 Specimens of trim shall be tested for retroreflectivity after convective heat exposure as specified in 8.1.5.

8.45.4.4.2 The coefficient of retroreflectivity (R_a) shall be measured as specified in 8.45.4.1.

8.45.4.4.3 The fluorescence shall be evaluated as specified in 8.45.4.2.

Δ Table 8.45.4.2.2 Color Requirements

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	

8.45.5 Report.

8.45.5.1 The coefficient of retroreflectivity (R_a) shall be recorded and reported for each specimen.

8.45.5.2 The average R_a of all specimens shall be calculated, recorded, and reported separately for each of the test procedures specified in 8.45.4.1, 8.45.4.3, and 8.45.4.4.

8.45.5.3 The number of fluorescent and nonfluorescent specimens shall be recorded and reported separately for each of the test procedures specified in 8.45.4.2 and 8.45.4.4.

8.45.6 Interpretation.

8.45.6.1 For trim retroreflectivity, pass or fail performance shall be determined using the average coefficient of retroreflection (R_a) reported for each group of specimens for each of the procedures specified in 8.45.4.1, 8.45.4.3, and 8.45.4.4.

8.45.6.2 For trim fluorescence, specimens that do not meet the chromaticity and luminance factor requirements shall be designated as nonfluorescent.

N 8.46 Adhesion of Reflective Coating on Proximity Faceshield — Tape Method.

N 8.46.1 Application.

N 8.46.1.1 This test method shall apply to proximity fire fighting protective faceshields.

N 8.46.1.2 This test shall apply only to coated materials of the noted element components.

N 8.46.2 Samples. The samples shall be complete proximity faceshields or reflective coated faceshield material.

N 8.46.3 Specimens.

N 8.46.3.1 A minimum of two proximity faceshield component lenses shall be selected.

N 8.46.3.2 Five specimens shall be chosen from a minimum of two lenses. Two specimens shall be taken from the left viewing area and three specimens shall be taken from the right viewing area. One of the three specimens taken from the right viewing area shall be used as the setup sample.

N 8.46.3.3 All test specimens shall be as described in ASTM D3359, *Standard Test Method for Measuring Adhesion by Tape Test Method B — Cross-Cut Tape Test.*

N 8.46.4 Apparatus. The proximity faceshield adhesion test apparatus and equipment shall be in accordance with ASTM D3359, *Method B — Cross-Cut Tape Test.*

N 8.46.5 Procedure.

N 8.46.5.1 The proximity faceshield adhesion test procedure shall be in accordance with ASTM D3359, *Method B — Cross-Cut Tape Test.*

N 8.46.5.2 Adhesion value of the tape shall be determined in accordance with 8.54.4.6.

N 8.46.6 Report. The proximity faceshield report shall be in accordance with ASTM D3359, *Method B — Cross-Cut Tape Test.*

N 8.46.7 Interpretation. The failure of any one specimen to the number 2B classification of ASTM D3359, *Method B — Cross-Cut Tape Test*, shall constitute failure of the test.

8.47 Hood Opening Size Retention Test.

8.47.1 Application.

8.47.1.1 This test shall apply to the face openings or SCBA facepiece interface openings of protective hoods.

8.47.1.2 Protective hoods with either elastic face openings or manually adjustable face openings shall be tested by the procedure specified in 8.47.4.

8.47.1.3 Protective hoods designed for interface with a SCBA facepiece(s) shall be tested by the procedure specified in 8.47.5.

8.47.2 Samples.

8.47.2.1 Samples for conditioning shall be whole hoods.

8.47.2.2 Samples shall be conditioned as specified in 8.1.3.

8.47.3 Specimens. A minimum of three whole hoods shall be tested.

8.47.4 Procedure for Hoods with Elastic or Manually Adjustable Face Openings.

Δ **8.47.4.1** Specimen face openings shall be placed over a hood measuring device as shown in Figure 8.6.16.4. Specimen face openings in the relaxed state shall slide freely over the top half of the device where the circumference measures 45.6 cm ± 0.6 cm (18.0 in. ± 0.25 in.). Specimen face openings shall then be placed around the lower half of the device where the circumference measures 54.5 cm ± 0.6 cm (21.5 in. ±0.25 in.). Specimens shall then be visually inspected for gaps between the hood and the measuring device surface.

8.47.4.2 Upper and lower half drum mounting fixtures shown in Figure 8.47.4.2 shall be mounted on a tensile testing machine.

N **8.47.4.3** A 115 mm (2⅛ in.) gauge length separation shall be set between half drum fixtures on the tensile testing machine.

N **8.47.4.4** Place the hood specimen on the half drum fixtures such that the face opening expands around the upper and lower drums and the bottom of the hood drapes downward as shown in Figure 8.47.4.4. The opening shall be placed beyond the lips on the edge of the half drum fixtures to keep it in position during the testing.

N **8.47.4.5** The elongation of the tensile testing machine shall be started at an elongation of 508 mm/min (20 in./min).

N **8.47.4.6** The crosshead movement of the hood specimen on the drum fixtures shall be stopped after a total movement of 89 mm (6.5 in.) and returned to the zero position of 115 mm (2 ⅛ in.) gauge separation.

N **8.47.4.7** The hood specimen shall elongated and returned to the zero position a total of 50 times.

8.47.4.8 Following the 50 cycles, the hood shall be removed from the headform, and the hood shall be allowed to relax for 1 minute.

8.47.4.9 Specimens shall be examined as described in 8.47.4.1.

• **8.47.5 Procedure for Hoods with SCBA Facepiece Interface Openings.**

8.47.5.1 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.

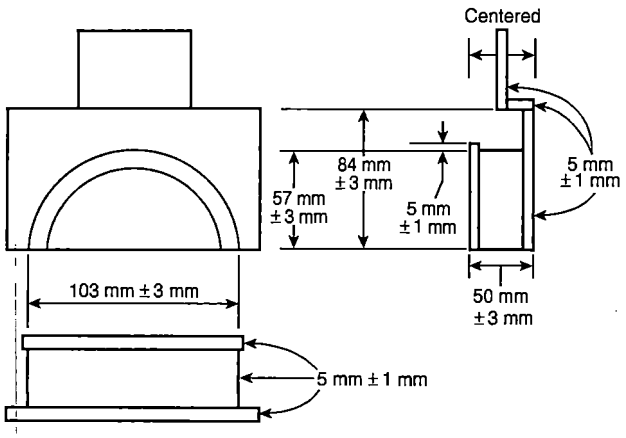
8.47.5.2 The hood shall then be donned on the headform, placing it over the SCBA facepiece.

8.47.5.3 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 Upper and lower half drum mounting fixtures shown in Figure 8.47.4.2 shall be mounted on a tensile testing machine.

N **8.47.5.5** A 115 mm (2⅛ in.) gauge length separation shall be set between half drum fixtures on the tensile testing machine.

N **8.47.5.6** Place the hood specimen on the half drum fixtures such that the face opening expands around the upper and lower drums and the bottom of the hood drapes downward as



N **FIGURE 8.47.4.2 Upper and Lower Half Drum Mounting Fixtures.**

Δ **FIGURE 8.47.4.4 Hood Face Opening Gauge.**

shown in Figure 8.47.4.4. The opening shall be placed beyond the lips on the edge of the half drum fixtures to keep it in position during the testing. Where the hood is designed to be manually adjustable around the hood face opening/SCBA facepiece interface area, the manual adjustment shall be made prior to commencing the elongation.

N **8.47.5.7** The elongation of the tensile testing machine shall be started at an elongation of 508 mm/min (20 in./min).

N **8.47.5.8** The crosshead movement of the hood specimen on the drum fixtures shall be stopped after a total movement of 89 mm (6.5 in.) and returned to a to the zero position of 115 mm (2⅛ in.) gauge separation.

N **8.47.5.9** The hood specimen shall be elongated and returned to the zero position a total of 50 times. Where the hood is designed to be manually adjustable around the hood face opening/SCBA facepiece interface area, the manual adjustment shall be opened and secured between each cycle.

8.47.5.10 Following the 50 cycles, the hood shall be removed from the headform, and the hood shall be allowed to relax for 1 minute.

8.47.5.11 The hood shall then be donned on the headform, placing it over the SCBA facepiece.

8.47.5.12 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.

8.47.5.13 The amount of overlap shall be measured.

8.47.6 Report for Hoods with Elastic or Manually Adjustable Face Openings.

8.47.6.1 Observations shall be recorded and reported of the ability of the face opening to slide freely over the top half of the hood measuring device and of gaps between the hood face opening and the bottom half of the hood measuring device before and after donning and doffing.

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8.47.7 Report for Hoods with SCBA Facepiece Interface Openings.

8.47.7.1 The amount of overlap shall be recorded and reported for each location.

8.47.7.2 The average amount of overlap shall be recorded and reported for each specimen.

8.47.8 Interpretation for Hoods with Elastic or Manually Adjustable Face Openings.

8.47.8.1 Pass or fail performance shall be based on the individual face openings being able to slide freely in the relaxed state over the top half of the hood measuring device and any observations of gaps between the hood face opening and the hood measuring device before and after donning and doffing.

8.47.9 Interpretation for Hoods with SCBA Facepiece Interface Openings. Pass or fail performance shall be based on the average amount of overlap for each specimen. One or more hood specimens failing this test shall constitute failing performance.

8.48 Whole Garment and Ensemble Liquid Penetration Test.

8.48.1 Application.

8.48.1.1 This test method shall apply to protective garments, protective coats with an integrated garment-glove interface, protective trousers with integrated booties, and entire ensembles that are being evaluated for the optional liquid and particulate contaminant protection.

8.48.1.2 Modifications to this test method for testing protective coats and protective coats with an integrated garment-glove interface shall be as specified in 8.48.9.

8.48.1.3 Modifications to this test method for testing protective trousers and protective trousers with integrated booties shall be as specified in 8.48.10.

8.48.1.4 Modifications to this test method for testing protective coat and trouser sets or protective coveralls shall be as specified in 8.48.11.

8.48.1.5 Modifications to this test method for testing proximity fire fighting ensemble garment elements shall be as specified in 8.48.12.

8.48.1.6 Modifications to this test method for testing entire ensembles for optional liquid and particulate contaminant protection shall be as specified in 8.48.13.

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 8.1.3.

8.48.3 Specimens.

8.48.3.1 A minimum of three specimens shall be tested. Specimens shall consist of individual coats, trousers, or coverall elements; sets of coats and trousers elements, or entire ensembles for liquid and particulate contaminant 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 manikin for proper fit of the specimen on the manikin in accordance with the manufacturer's sizing system. The size of the elements comprising the specimen shall be the same size as the manikin in chest circumference, waist circumference, and inseam height.

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

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8.48.4 Sample Preparation.

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

8.48.4.2 Samples to be conditioned shall be complete garments.

8.48.5 Apparatus. The apparatus and supplies for testing shall be those specified in ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin*, with the following modifications:

(1) The surface tension of the water used in testing shall be 35 dynes/cm ± 5 dynes/cm.

(2)* The manikin used in testing shall be fully upright and shall have straight arms and legs with the arms positioned at the manikin's side.

8.48.6 Procedure. Liquid penetration testing of garments shall be conducted in accordance with ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin*, with the following modifications:

(1) Procedure B shall be used with an overall exposure period of 10 minutes with 2.5 minutes in each of the four orientations.

(2) Blocking of the specimen shall be as specified in 8.48.8, 8.48.9, and 8.48.10, as appropriate, for the type of specimen being tested.

(3) The method used for mounting of the manikin 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 manikin.

(6) The manikin shall be positioned so that the manikin body is in a full vertical orientation with the manikin head looking forward, manikin legs straight, and manikin arms pointing downward by the sides of the manikin torso. The manikin joints shall be tightened to ensure that the manikin maintains this position during testing.

Δ **8.48.7* Report.** A diagram shall be prepared for each test that identifies the locations of any liquid leakage detected on the liquid-absorptive garment.

8.48.8 Interpretation.

N **8.48.8.1** Any evidence of liquid on the liquid-absorptive garment, as determined by visual, tactile, or absorbent toweling, shall constitute failure of the specimen.

N **8.48.8.2** In determining the compliance of the specific garments or ensemble being evaluated, one of the three specimens shall be permitted to display leakage on the liquid-absorptive garment of an area that is collectively not greater than 20 cm^2 (3.1 $in.^2$).

8.48.9 Specific Requirements for Testing Coats and Coats with an Integrated Garment-Glove Interface.

8.48.9.1 The liquid-absorptive garment shall only cover the upper torso and arms of the manikin from the middle of the manikin's neck, down to the manikin's waistline, and down to the manikin's wrist crease.

8.48.9.2 The coat shall be donned on the manikin in accordance with the manufacturer's instructions for proper wearing.

8.48.9.3 The coat collar shall be placed in the up position on the manikin with the collar closure system fastened in the closed position. The head of the manikin 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.

8.48.9.4 The test shall be conducted with the manikin'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's outer shell sleeve hem. The tape shall be duct tape or similar waterproof tape.

8.48.9.4.1 Where garments are supplied with an integrated garment-glove interface, the manikin's hands shall not be removed. The garment-glove combination shall be donned on the manikin in accordance with the manufacturer's instructions for proper wearing.

Δ **8.48.9.5** The coat shall be tested in conjunction with the protective trousers specified by the manufacturer, even where the trousers are not specifically evaluated in this test.

8.48.10 Specific Requirements for Testing Trousers.

Δ **8.48.10.1** The liquid-absorptive garment shall cover only the lower torso and legs of the manikin from the manikin's waistline down to the manikin's ankles.

8.48.10.2 The trousers shall be donned on the manikin in accordance with the manufacturer's instructions for proper wearing.

Δ **8.48.10.3** Trousers shall be tested in conjunction with the protective coat specified by the manufacturer, even where the coat is not specifically evaluated in this test.

8.48.10.4 Absorbent toweling or similar material shall be placed underneath the manikin in order to prevent water splashing up inside the trouser leg.

8.48.10.5 Where trousers are provided with integrated booties, outer footwear specified to be worn with the booties shall be donned on the manikin in accordance with the manufacturer's instructions for proper wearing.

8.48.11 Specific Requirements for Testing Coveralls.

8.48.11.1 The liquid-absorptive garment shall only cover the torso, arms, and legs of the manikin from the middle of the manikin's neck, down to the manikin's wrist crease, and down to 200 mm (8 in.) above the bottom of the heel.

8.48.11.2 The coverall or set of coat and trousers shall be donned on the manikin in accordance with the manufacturer's instructions for proper wearing.

8.48.11.3 The coat collar shall be placed in the up position on the manikin with the collar closure system fastened in the closed position. The head of the manikin 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.

8.48.11.4 The test shall be conducted with the manikin's hands removed. The knit wristlet shall be tucked up inside the sleeve to prevent the water from absorbing into the wristlet.

8.48.11.4.1 Where garments are supplied with an integrated garment-glove interface, the manikin's hands shall not be removed. The garment-glove combination shall be donned on

the manikin in accordance with the manufacturer's instructions for proper wearing.

8.48.11.5 Absorbent toweling or similar material shall be placed underneath the manikin to prevent water splashing up inside the trouser leg.

8.48.11.6 Where trousers are provided with integrated booties, outer footwear specified to be worn with the booties shall be donned on the manikin in accordance with the manufacturer's instructions for proper wearing.

8.48.12 Specific Requirements for Testing Proximity Fire Fighting Ensemble Garment Elements.

8.48.12.1 Garment element specimens shall be complete proximity fire fighting protective coats, protective trousers, or protective coveralls.

8.48.12.2 Specimens shall be conditioned as specified in 8.1.3.

8.48.12.3 Where the proximity fire fighting garment design has passed the liquid penetration requirements specified for structural fire fighting garments and the only change to the proximity garment is from a structural garment outer shell to a proximity garment outer shell, at least one specimen shall be tested.

8.48.12.4 Where the proximity fire fighting garment design has not been tested for structural fire fighting garment liquid penetration requirements, then a minimum of three specimens shall be tested.

8.48.13 Specific Requirements for Testing Ensembles for Optional Liquid and Particulate Contaminant Protection.

8.48.13.1 Specimens for testing shall consist of liquid and particulate contaminant protective ensembles, including 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 liquid and particulate contaminant protective ensemble garment elements.

8.48.13.2 A total of three different ensemble specimens shall be evaluated.

8.48.13.3 Garment, glove, and hood elements shall be conditioned as specified in 8.1.11.

Δ **8.48.13.4** Where the ensemble garment element does not include booties, footwear shall be conditioned by flexing for 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:

(1) Water shall not be used.
(2) The flex speed shall be 60 cycles per minute, ± 2 cycles per minute.

N **8.48.13.4.1** Alternative flexing equipment shall be permitted to be used when the flexing equipment meets the following parameters:

(a) Provides the angle of flex as described in FIA 1209.
(b) Capable of a flex speed of 60 cycles per minute, ± 2 cycles per minute.
(c) Provides a means of securing the footwear during flexing.

8.48.13.5 The liquid-absorptive garment shall be a hooded coverall made of fabric meeting the requirements specified in ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*. The liquid-absorptive garment shall not interfere with the correct wearing of the ensemble. In addition to the liquid-absorptive garment, the manikin's hands shall be covered with suitably sized, 100 percent cotton gloves and the manikin's feet covered with suitably sized, 100 percent cotton socks.

8.48.13.6 Specimens provided in 8.48.13.1 shall be donned on the manikin in accordance with manufacturer's specifications.

8.48.13.7 The taping, blockage, coverage, or provision of absorbent toweling of or to any part of any interface or element on the ensemble shall not be permitted.

8.48.13.8 The manikin with ensemble in place shall be evaluated using Procedure A as specified in ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, and exposed to the liquid spray 5 minutes in each of the four manikin orientations for a total of 20 minutes.

8.48.13.9 Following the test, the liquid-absorptive garment, inner cotton gloves, and inner cotton socks worn on the manikin shall be inspected to determine evidence of liquid leakage.

8.49 Eyelet and Stud Post Attachment Test.

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

8.49.2 Samples.

8.49.2.1 Samples for conditioning shall be whole footwear.

8.49.2.2 The eyelet and stud post samples shall be conditioned as specified in 8.1.3.

8.49.3 Specimens.

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

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

8.49.4 Apparatus.

8.49.4.1 A tensile-testing machine shall be used with a traverse rate of 50 mm/min (2 in./min).

8.49.4.2 Clamps measuring 25 mm × 38 mm (1 in. × 1½ in.) shall have gripping surfaces that are parallel, flat, and capable of preventing slippage of the specimen during the test.

8.49.5 Procedure.

8.49.5.1 The stud post or eyelet puller shall be inserted or attached to the upper position of the tensile-testing machine.

8.49.5.2 The traverse rate shall be set at 50 mm/min (2 in./min).

8.49.5.3 The test eyelet or stud post shall be attached using the appropriate puller fixture.

8.49.5.4 The eyelet stay shall be clamped, but clamping the metal portion of the eyelets or stud hook in the lower clamps shall not be permitted.

8.49.5.5 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.).

8.49.5.6 The test shall then be started.

8.49.6 Report.

8.49.6.1 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.

8.49.6.2 The average force shall be calculated, recorded, and reported.

8.49.7 Interpretation. The average force shall be used to determine pass or fail.

8.50 Breaking Strength Test.

8.50.1 Application. This test shall apply to garment outer shell and collar lining materials used in protective garments.

8.50.2 Samples.

8.50.2.1 Samples for conditioning shall be 1 m (1 yd) square of material.

8.50.2.2 Samples shall be conditioned to the procedure specified in 8.1.2 at 10 cycles.

8.50.3 Specimens. Five specimens in each of the warp and filling directions shall be tested from each sample.

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

8.50.5 Report.

8.50.5.1 The breaking strength of each specimen shall be recorded and reported.

8.50.5.2 The average breaking strength shall be calculated, recorded, and for the warp and filling directions.

8.50.6 Interpretation.

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

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

8.51 Conductive and Compressive Heat Resistance (CCHR) Test.

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

8.51.2 Samples.

8.51.2.1 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 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 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 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 All samples shall first be conditioned as specified in 8.1.2.

8.51.3 Specimens.

8.51.3.1 A minimum of six specimens for testing shall be taken from the samples after the conditioning specified in 8.51.2.3.

8.51.3.2 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 Specimens for both wet condition testing and dry condition testing shall then be conditioned as specified in 8.1.3.

8.51.3.4 Specimens shall be conditioned for wet condition testing as specified in 8.51.3.5.

8.51.3.5 For wet testing, 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 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 reassembled with all layers arranged in the same order and orientation as intended to be worn.

8.51.3.6 A minimum of three specimens shall be tested for shoulder areas in the wet condition. A minimum of three specimens shall be tested for knee areas in the wet condition.

8.51.4 Apparatus. The test apparatus shall be in accordance with ASTM F1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact,* with the following modifications:

(1) For the shoulder area CCHR rating, the sensor assembly shall be modified so that the pressure applied to the test

specimens shall be 140 g/cm² ± 1.4 g/cm² (2 psi ± 0.2 psi).

(2) For the knee area CCHR rating, the sensor assembly shall be modified so that the pressure applied to the test specimens shall be 562 g/cm² ± 56 g/cm² (8 psi ± 0.8 psi).

8.51.5 Procedure. Specimens shall be tested in accordance with ASTM F1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, with the following modifications:

(1) Specimens shall be tested using an exposure temperature of 280°C, + 3/−0°C (536°F, +5/−0°F).
(2) Time "zero" shall be the time that the sensor and specimen are placed in direct contact with the exposure surface.
(3) A determination shall be made if the time to second-degree burn is equal to or exceeds 25.0 seconds.
(4) Specimens showing a second degree burn time that is equal to or greater than 25 seconds shall be considered to have demonstrated passing performance. Specimens that have a second-degree burn time that is less than 25 seconds shall be considered to have demonstrated failing performance.
(5) Calibration shall be performed at 280°C, +3/−0°C (536°F, +5/−0°F), using a calibration media that produces between 6- to 7-second time to pain values and between 10- to 12-second time to second-degree burn.

8.51.6 Report. The number of specimens demonstrating passing performance and the number of specimens showing failing performance shall be reported separately for the shoulder area and the knee area under both dry and wet conditions.

8.51.7 Interpretation. Shoulder area and knee area composites shall be considered to have demonstrated passing performance when there are no reported failures for any specimen under either dry or wet conditions.

8.52 Radiant Protective Performance Test.

8.52.1 Application.

8.52.1.1 This test method shall apply to garment outer shell materials, glove outer shell materials, helmet faceshields, helmet outer covers, and helmet shrouds.

8.52.1.2 Modifications to this test method for testing garment outer shell and glove outer shell materials shall be as specified in 8.52.7.

8.52.2 Samples. Samples for conditioning shall be garment and glove outer shell materials, helmet faceshields, helmet outer covers, and helmet shrouds.

8.52.3 Specimens.

8.52.3.1 Five specimens of each sample shall be conditioned in accordance with 8.1.3 prior to testing.

8.52.3.2 Test specimens shall be 75 mm × 250 mm (3 in. × 10 in.).

8.52.3.3 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 5 minutes after removal from conditioning.

8.52.3.4 All specimens shall be conditioned on an oscillating drum abrasion apparatus as specified in ASTM D4157, *Standard Test Method for Abrasion Resistance of Textile Fabric (Oscillatory Cylinder Method)*. The specimens shall be mounted on the oscillating drum of the apparatus. The abradant shall be No. 6 hard-textured cotton duck conforming to the construction, weight, and strength of Type I of Federal Specification CCC-C-419, *Cloth, Duck, Unbleached, Plied-Yarns, Army and Numbered*, and shall be cut into strips 45 mm (1⅞ 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 F1939, *Standard Test Method for Radiant Heat Resistance of Flame Resistant Clothing Materials with Continuous Heating*.

8.52.4.2 The selected test exposure shall be 2 cal/cm² as provided for in the test method.

8.52.4.3 The following provisions of ASTM F1939 shall not be required:

(1) Section 8.2, Laundering of Laboratory Samples
(2) Section 8.5, Determination of Test Specimen Average Thickness
(3) Section 8.6, Determination of Test Specimen Average Surface Density

8.52.5 Report.

8.52.5.1 Five specimens shall be tested, and the intersect time shall be determined.

8.52.5.2 The average intersect time of the five specimens shall be calculated, recorded, and reported.

8.52.6 Interpretation. The average intersect time of all specimens of an item shall be used to determine pass or fail performance.

8.52.7 Modifications for Testing Garment Outer Shell and Glove Outer Shell Materials.

8.52.7.1 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 Specimens shall be tested as specified in 8.52.2 through 8.52.7.

8.52.8 Modifications for Testing Helmet Faceshields.

8.52.8.1 The specimen holder assembly plates shall have a thickness of 3 mm ± 0.1 mm to minimize deformation of the holder by the specimen.

8.52.8.2 The specimen holder assembly front plate shall have a center cut-out of 64 mm × 125 mm (2½ in. × 5 in.).

8.52.8.3 The test specimen shall be a minimum of 100 mm × 137 mm (4 in. × 5½ in.). The test specimen shall be cut from a faceshield with the long dimension representing the vertical direction as worn.

N **8.52.8.4** The faceshield shall be mounted with only enough force to secure the faceshield in the sample holder. The mounting screws shall not be tightened to the point of distorting the faceshield or sample holder.

8.53 Radiant Heat Resistance Test 3.

8.53.1 Application. This test shall apply to helmet shell systems.

8.53.2 Samples.

8.53.2.1 One sample helmet shell shall be used.

8.53.2.2 The sample helmet shall have any reflective outer covering in place as intended for use, but shall have all shock absorbing and thermally insulating materials removed from the interior.

8.53.3 Specimens. Specimens shall be conditioned as specified in 8.1.3.2.

8.53.4 Apparatus.

8.53.4.1 The test apparatus shall be the radiant exposure chamber as specified in 8.1.6.

8.53.4.2 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 Calibration Procedure. The chamber shall be calibrated according to the calibration procedure specified in 8.1.6 to obtain a stable uniform irradiance of 1.0 W/cm^2 ± 0.1 W/cm^2.

8.53.6 Procedure.

8.53.6.1 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 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 the shell and the intersection of the bitragion coronal meet. There shall be no internal or external projections greater than 2 mm ($\frac{1}{16}$ 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 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 W/cm^2 ± 0.1 W/cm^2 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 The specimen shall be exposed to an irradiance of 1.0 W/cm^2 ± 0.1 W/cm^2 for 180 seconds.

8.53.6.5 Thermocouple temperatures shall be recorded at the beginning and at the end of the 180 seconds.

8.53.7 Report. The difference of the initial temperature and the temperature at 180 seconds shall be recorded and reported.

8.53.8 Interpretation. Any rise in temperature greater than 25°C (78°F) shall constitute failure of this test.

8.54 Wet Flex Test.

8.54.1 Application. This test method shall apply to garment outer shell materials, glove outer shell materials, helmet faceshields, footwear, helmet outer covers, and helmet shrouds.

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

8.54.3 Specimens. 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.

8.54.3.1 Five (5) specimens from each sample unit shall be tested with no two specimens containing the same yarns.

8.54.3.2 The specimens shall be immersed in water at 60°C ± 3°C (140°F ± 5°F), for 15 minutes.

8.54.3.3 Upon removal from the water, the test specimen shall be placed on two layers of absorbent-type blotters and covered by two additional layers.

8.54.3.4 The blotting paper shall conform to the requirements in AATCC 35, *Water Resistance: Rain Test.*

8.54.3.5 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.

8.54.3.6 The specimen shall be removed from between the blotters and placed in the flexing device as specified in 8.54.3.4.

8.54.4 Apparatus.

8.54.4.1 The flexing device as shown in Figure 8.54.4.1(a) and Figure 8.54.4.1(b) shall be used.

8.54.4.2 The flexing 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.

8.54.4.3 The tensioning jaw or clamp shall be so located that, with the 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.

8.54.4.4 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.

8.54.4.5 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 material particles after each test.

8.54.4.6 A motor-driven apparatus shall be permitted to be used in lieu of the manual device specified.

8.54.5 Procedure.

8.54.5.1 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.

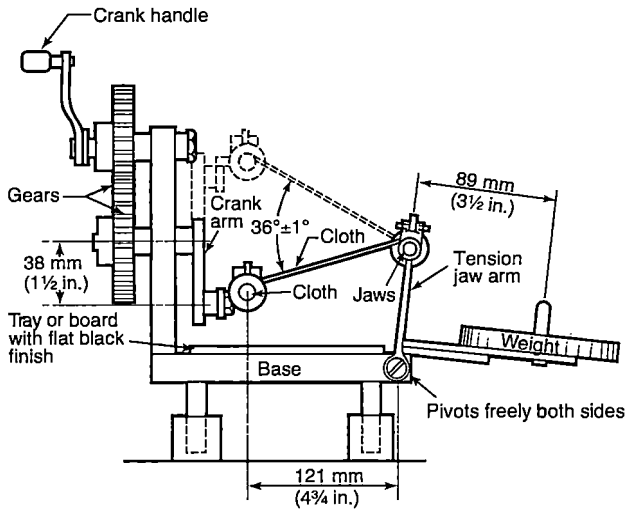
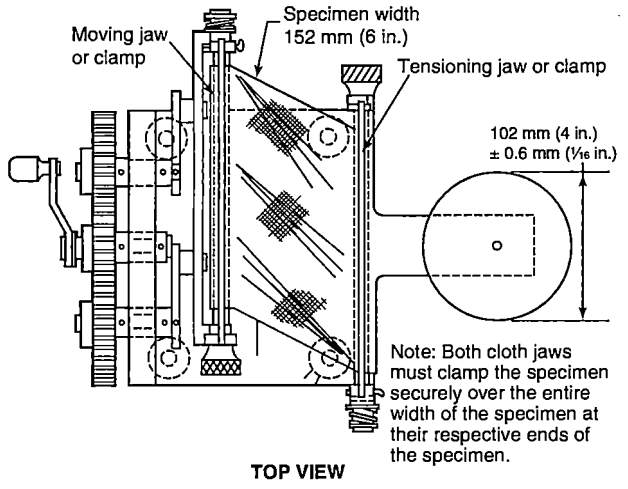


FIGURE 8.54.4.1(a) End View of Flexing Device.



Δ FIGURE 8.54.4.1(b) Top View of Flexing Device.

8.54.5.2 The distance between jaw lines shall be 135 mm (5¼ in.).

8.54.5.3 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.

8.54.5.4 Each jaw shall clamp the specimen across the entire width.

8.54.5.5 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.

8.54.5.6 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 Report. Evidence of any cracking or delamination shall be identified and defined and shall be recorded and reported.

8.54.7 Interpretation.

8.54.7.1 Any cracking or delamination closer than 22 mm (⅞ in.) from either jaw line shall not be considered.

8.54.7.2 Failure of any one specimen shall constitute failure of sample unit.

8.55 Adhesion After Wet Flex–Tape Method Test.

8.55.1 Application.

8.55.1.1 This test method shall apply to the following proximity fire fighting protective ensemble elements: garment outer shell materials, glove outer shell materials, helmet outer covers, and helmet shrouds.

8.55.1.2 This test shall apply only to coated or laminated materials of the noted element components.

8.55.2 Samples. The same samples used in Section 8.54, Wet Flex Test, shall be the samples used for this test.

8.55.3 Specimens. The same specimens specified in 8.54.3 shall be the specimens used for this test.

8.55.4 Apparatus.

8.55.4.1 The tensile-testing machine described in ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, shall be used with the modification that all machine attachments for determining maximum load shall be disengaged and the speed of the pulling clamp shall be 505 mm/min (20 in./min).

8.55.4.2 Five 50 mm × 100 mm (2 in. × 4 in.) steel plates conforming to Class 301 or Class 304 of ASTM A666, *Standard Specification for Annealed or Cold Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar*, which have been polished to a No. 4 finish shall be used.

8.55.4.3 A 38 mm (1½ in.) wide steel roller weighing 4.53 kg ± 0.06 kg (10 lb ± 2 oz), shall be used.

8.55.4.4 A pressure sensitive tape used for testing the adhesion of the coating or the laminate shall be used and shall have the required adhesion value specified in 8.55.4.6.11.

8.55.4.5 Candidate pressure sensitive tapes, for potential use in testing the adhesion of coatings or laminates, shall have the adhesion value of the candidate tapes be determined by the procedure specified in 8.55.4.6.12.

8.55.4.6 Procedure for Determining Adhesion Value of Candidate Pressure Sensitive Tapes.

8.55.4.6.1 The equipment specified in 8.55.4.1, 8.55.4.2, and 8.55.4.3 shall be used in the procedure for adhesion value determination.

8.55.4.6.2 Prior to each adhesion value determination procedure, the steel plates specified in 8.55.4.2 shall be thoroughly cleaned with diacetone alcohol, methyl alcohol, or methyl ethyl ketone, using a clean piece of lint-free wiping tissue.

8.55.4.6.3 Five specimens from the same production batch of each candidate pressure sensitive tape shall be tested. Each

candidate tape specimen shall measure 25 mm × 200 mm (1 in. × 8 in.).

8.55.4.6.4 Each of the five tape specimens of one candidate tape sample, specified in 8.55.4.6.3, shall be applied to the clean surface of each of the five steel plates, specified in 8.55.4.2, so that it covers the entire length of the plate and extends 100 mm (4 in.) beyond one end of the plate.

8.55.4.6.5 Each candidate tape specimen shall be pressed down by passing the roller, specified in 8.55.4.3, over the tape six times, three times in each direction.

8.55.4.6.6 The free end of the candidate tape specimen shall be doubled back over the specimen 180 degrees, and 25 mm (1 in.) of the tape shall be peeled off the plate.

8.55.4.6.7 Each plate, with the candidate tape specimen affixed, shall be tested separately for adhesion value determination.

8.55.4.6.8 The plate shall be inserted and clamped in the bottom jaw of the tensile-testing machine, specified in 8.55.4.1, with the free end of the candidate tape specimen oriented downward.

8.55.4.6.9 The free end of the candidate tape specimen shall be looped upward and inserted and clamped in the upper jaw so as to peel the tape specimen from the plate when the jaw motion is started.

8.55.4.6.10 The minimum tension required to remove the remainder of the candidate tape specimen from the steel plate, excluding the final 25 mm (1 in.), shall be recorded by an autographic recording device.

8.55.4.6.11 The recorded minimum tension value of the candidate tape specimen shall be the adhesion value.

8.55.4.6.12 All five specimens of the candidate tape shall have an adhesion value of not less than 4.8 N/cm (2¾ lb/in.) width, and not more than 6.2 N/cm (3½ lb/in.) width for the pressure sensitive tape to be selected for use in testing the adhesion of the coating or the laminate.

8.55.5 Procedure.

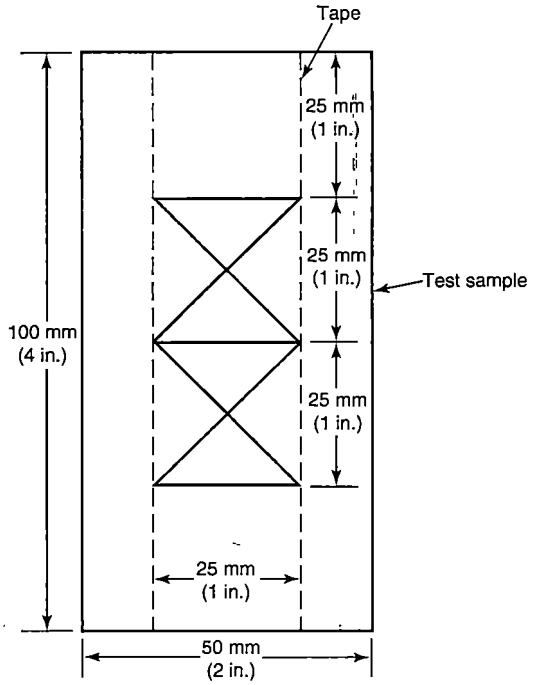
8.55.5.1 Immediately after each of the five specimens has completed the testing specified in Section 8.54, Wet Flex Test, the five specimens shall be tested and evaluated for adhesion.

8.55.5.2 A razor cut design shall be symmetrically centered within the 100 mm × 200 mm (4 in. × 8 in.) of each of the five specimens. The cut design shall be two X cuts and three horizontal cuts and shall be made as shown in Figure 8.55.5.2. The cuts shall be made with a sharp razor blade through the coating or laminate and adhesive layers, but shall not cut through the base cloth.

8.55.5.3 Five 25 mm × 200 mm (1 in. × 8 in.) pieces of pressure sensitive tape, taken from a lot of material that has qualified for use in testing the adhesion of coatings or laminates by the procedure specified in 8.55.4.6, shall be used for adhesion testing.

8.55.5.4 One piece of the pressure sensitive tape, specified in 8.55.5.3, shall be used for each of the specimens.

8.55.5.5 The pressure sensitive tape shall be applied to the specimens so that it covers the entire length of the specimen, centered over the X cuts and horizontal cuts as shown in Figure 8.55.5.2, and extending 100 mm (4 in.) beyond one end of the specimen.



Note: Solid lines indicate cut lines.

FIGURE 8.55.5.2 Cuts.

8.55.5.6 The pressure sensitive tape shall be pressed onto the specimen by passing the roller over the specimen six times, three times in each direction.

8.55.5.7 The free end of the pressure sensitive tape shall be doubled back over the specimen 180 degrees, and 25 mm (1 in.) of the pressure sensitive tape shall be peeled off the specimen.

8.55.5.8 The specimen shall then be inserted and clamped in the bottom jaw of the tensile-testing machine, specified in 8.55.4.1, with the free end of the pressure sensitive tape downward.

8.55.5.9 The free end of the tape shall be looped upward and inserted and clamped in the upper jaw of the tensile-testing machine so as to peel the pressure sensitive tape from the specimen when the jaw motion is started.

8.55.5.10 The jaw motion of the tensile-testing machine shall be engaged to peel the pressure sensitive tape from the specimen.

8.55.5.11 Following removal of the pressure sensitive tape, the tape and specimen shall be visually examined for compliance.

8.55.6 Report.

8.55.6.1 Evidence of any delamination shall be recorded and reported.

8.55.6.2 Evidence of any particulate on the pressure sensitive tape adhesive from the coating shall be recorded and reported.

8.55.7 Interpretation.

8.55.7.1 A moderate number of specks on the pressure sensitive tape adhesive from the coating shall not constitute failure.

8.55.7.2 Evidence of separation or removal of the surface coating shall constitute a failure.

8.55.7.3 The failure of any one specimen shall constitute failure of the test.

8.56 Flex at Low Temperature Test.

8.56.1 Application. This test method shall apply to garment outer shell materials, glove outer shell materials, helmet faceshields, footwear, helmet outer covers, and helmet shrouds.

8.56.2 Samples.

8.56.2.1 Samples shall be taken from the fabric lot used in the construction of the garment.

8.56.2.2 Samples shall be conditioned as specified in 8.1.3.

8.56.3 Specimens.

8.56.3.1 A minimum of five specimens shall be tested.

8.56.3.2 Specimens shall measure 25 mm × 100 mm (1 in. × 4 in.), with the long dimension in the warp or wale direction.

8.56.4 Apparatus. The test jig as shown in Figure 8.56.4 shall be used.

8.56.5 Procedure.

8.56.5.1 The test samples and test jig, as shown in Figure 8.56.4, shall be conditioned for 4 hours at a temperature of −32°C (−25°F).

8.56.5.2 At the end of the conditioning period, with the jig and the test specimens still in the test atmosphere, the specimen 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.

8.56.5.3 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.

8.56.5.4 The tested fabric shall be examined without magnification.

8.56.6 Interpretation. Failure of any one specimen shall constitute failure of sample unit of production.

8.57 Resistance to High-Temperature Blocking Test.

8.57.1 Application. This test method shall apply to proximity fire fighting garment outer shell materials, proximity fire fighting glove outer shell materials, proximity fire fighting helmet outer covers, and proximity fire fighting helmet shrouds.

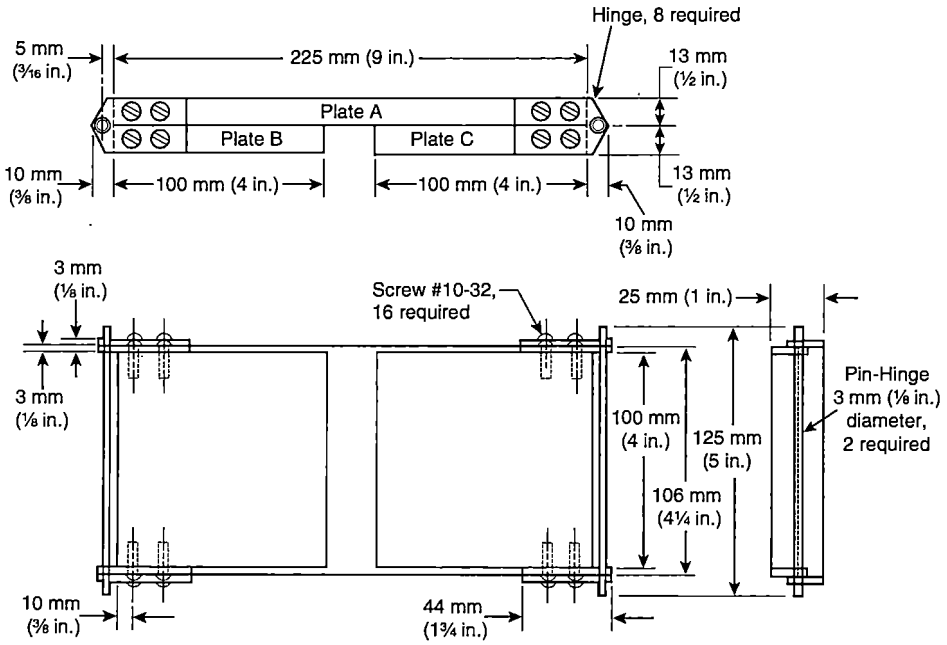
8.57.2 Specimens. Specimens shall be tested after being subjected to the procedure specified in 8.1.3.

8.57.3 Procedure.

8.57.3.1 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*.

8.57.3.2 Following each test procedure the test specimen shall be examined to determine pass or fail performance.

8.57.4 Report. Any evidence of blocking shall be recorded and reported.



Material: Plates and hinges — aluminum alloy.
Hinge pins — steel rod.
Smooth machine finish all over.

FIGURE 8.56.4 Jig Assembly — Resistance to Low Temperature Test.

8.57.5 Interpretation. Failure of 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, splices, and joints.

8.58.1.2 Modifications to this test method for testing DRD seams, splices, and joints shall be as specified in 8.58.7.

8.58.2 Samples.

8.58.2.1 Five samples shall be taken from each different DRD material.

8.58.2.2 Five samples shall be taken from each different type of DRD seam, splice, and joint.

8.58.2.3 Samples for conditioning shall be at least 1 m (1 yd) lengths of material including seams for seam testing.

8.58.3 Specimens.

8.58.3.1 Specimens shall be tested after being subjected to the conditioning specified in 8.1.2.

8.58.3.2 A total of five material specimens representative of the DRD materials shall be tested for each material type.

8.58.3.3 A minimum of five seam, splice, and joint specimens representative of the DRD seams, splices, and joints shall be tested for each seam, splice, and joint type.

8.58.4 Procedure. Specimens shall be tested for breaking strength only as specified in ASTM D6775, *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, Splices, and Joints.

8.58.7.1 The test specimen shall be as specified in ASTM D6775, *Standard Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material,* and shall include the seam, splice, and joint 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 (DRD) Function Test.

8.59.1 Application. This test shall apply to DRD installed in protective coats and protective coverall elements.

8.59.2 Samples.

8.59.2.1 Samples shall consist of complete protective coats or protective coveralls with DRD installed.

8.59.2.2 Samples shall be conditioned as specified in 8.1.3.

8.59.3 Specimens.

8.59.3.1 Specimens for testing shall be complete coat or complete coverall garment elements with DRD.

8.59.3.2 A minimum of three specimens shall be tested for each garment element type.

8.59.3.3 Each specimen shall have all garment layers in place.

8.59.4 Apparatus.

8.59.4.1 One pair of protective gloves shall be provided.

8.59.4.1.1 The gloves shall be certified as compliant with this standard and shall be properly sized to fit the test technician.

8.59.4.1.2 For structural fire fighting ensembles, the protective gloves shall be structural fire fighting gloves.

8.59.4.1.3 For proximity fire fighting ensembles, the protective gloves shall be proximity fire fighting gloves.

8.59.4.2 One IAFF "Rescue Randy" Model 1475 mannequin, or equivalent, shall be provided as the test mannequin.

8.59.4.3 One open-circuit SCBA shall be provided.

Δ **8.59.4.3.1** The SCBA shall be certified as compliant with NFPA 1981.

8.59.4.3.2 The SCBA shall be equipped with an empty 60-minute rated breathing air cylinder.

8.59.5 Procedure.

8.59.5.1 The DRD shall be inspected to insure correct installation within the garment element in accordance with manufacturer's instructions.

8.59.5.2 The DRD shall be in the secured, non-deployed, position.

8.59.5.3 The size of the specimen shall properly fit the mannequin by conforming to the dimensions of the mannequin chest circumference in accordance with the manufacturer's sizing system.

8.59.5.4 The test specimen shall be donned on the test mannequin in accordance with the manufacturer's instructions for proper wearing, and shall be tested with an SCBA.

8.59.5.5 The SCBA shall be donned in accordance with the SCBA manufacturer's instructions over the specimen.

8.59.5.6 The test mannequin shall be placed on its side on a concrete surface.

8.59.5.7 With the test mannequin in position, the test technician shall don the gloves specified in 8.59.4.1.

8.59.5.8 The test technician shall deploy the DRD according to the manufacturer's instructions.

8.59.5.9 Deployment time shall be measured beginning when the test technician touches the mannequin and shall stop when the dragging motion begins.

8.59.5.10 The test technician shall drag the mannequin in a straight line using the DRD, in accordance with the manufacturer's instructions, for a distance of 2.5 m, +0.5/–0 m (8 ft, +1½/–0 ft).

8.59.5.11 The deployment of the DRD and the dragging of the mannequin shall be observed to determine if the SCBA is dislodged from the "as donned position."

8.59.6 Report.

8.59.6.1 The deployment time of the DRD shall be recorded and reported.

8.59.6.2 The ability to drag the mannequin the required distance shall be recorded and reported.

8.59.6.3 Change in the position of the SCBA during either the deployment of the DRD or the dragging of the mannequin shall be recorded and reported.

8.59.7 Interpretation.

8.59.7.1 The inability to deploy the device in 10 seconds or less, or the inability to drag the mannequin 2.5 m (8 ft) shall constitute failing performance.

8.59.7.2 Failure of one or more specimens shall constitute failing performance.

8.60 Conductive Heat Resistance Test 3.

8.60.1 Application. This test method shall apply to proximity footwear upper material.

8.60.2 Samples.

8.60.2.1 Samples for conditioning shall be whole footwear.

8.60.2.2 There shall be at least three samples of footwear.

8.60.3 Specimens.

8.60.3.1 A total of three specimens of footwear shall be tested.

8.60.3.2 Footwear specimens shall be cut from portions of the footwear upper or from a composite that is representative of footwear upper construction at the thinnest part. Specimens shall consist of each composite of footwear upper used in the actual footwear construction, including the tongue but excluding the gusset, with the layers arranged in proper order. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be tested.

8.60.3.3 Specimens shall be conditioned as specified in 8.1.3.

8.60.4 Procedure. Specimens shall be tested in accordance with ASTM F1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, with the following modifications:

(1) Specimens shall be tested using an exposure temperature of 100°C (212°F). The pressure applied during the test shall be 3.45 kPa, ±0.35 kPa (0.5 psi, ±0.05 psi).
(2) The test exposure duration shall be 10 minutes.

8.60.5 Report. The maximum temperature during the 10-minute exposure shall be recorded and reported.

8.60.6 Interpretation. Pass/fail determinations shall be based on the average temperature of all specimens tested.

8.61 Radiant Heat Resistance Test 2.

8.61.1 Application. This test method shall apply to proximity protective footwear.

8.61.2 Samples. Samples for conditioning shall be complete footwear.

8.61.3 Specimen Preparation.

8.61.3.1 A minimum of three complete footwear items shall be tested.

8.61.3.2 Specimens shall be conditioned in accordance with 8.1.3.

Δ **8.61.4 Apparatus.** The apparatus shall consist of the following:

(1) Radiometer of the Schmidt-Boelter or Gardon type with radiant heat flux transducer with a diameter of 25 mm (1 in.), a minimum viewing angle of 150 degrees, a minimum spectral response flat within 3 percent over a range of at least 1.0 µm to 10.0 µm, and an overall accuracy of at least ±5 percent of the reading.
(2) 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 1000K ± 200K (1340°F ± 360°F)
(3) Thermocouple with meter
(4) Test chamber that prevents interference from air movement
(5) A means of holding the boot in place so that boot material shrinkage does not cause movement of the boot away from the panel

8.61.5 Procedure.

8.61.5.1 Tests shall be done on each area of the footwear upper, including the tongue but excluding the gusset, which consists of a different composite. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s).

8.61.5.2 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 4.0 W/cm^2, +0.4/−0.0 W/cm^2 (1.0 cal/cm^2/sec, +0.01/−0.0 cal/cm^2/sec), 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.

8.61.5.3 The thermocouple shall be affixed with thermally conductive adhesive 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 100 seconds, +5/−0 seconds.

8.61.5.4 The thermocouple temperature shall be recorded at 100 seconds of exposure.

8.61.6 Report.

8.61.6.1 The temperature at 100 seconds of exposure shall be reported for each specimen.

8.61.6.2 The average temperature at 100 seconds of exposure for all specimens shall also be calculated and reported.

8.61.7 Interpretation. The average temperature at 100 seconds of exposure for all specimens tested shall be used to determine pass/fail performance.

8.62 Light Degradation Resistance Test.

Δ **8.62.1 Application.** This test method 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 woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber, the moisture barrier, a layer of 3.8 oz ± 0.3 oz, aramid needle punched nonwoven, quilted to a 3.4 oz ± 0.2 oz, aramid woven plain weave thermal barrier material, and another layer of 7.5 oz woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber. 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 conditioned 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 conditioning 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 conditioned according to 8.62.2.2.

8.62.3 Sample Preparation. Sample composites shall be subjected to two cycles of the following conditioning:

(1) The sample shall first be subjected to the procedure specified in 8.1.2.
(2) The sample shall then be conditioned as specified in 8.1.3.
(3) The sample shall then be conditioned as specified in 8.1.5.
(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 150 mm (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 G155, *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, a piece of cardstock shall be cut in equal dimensions to the specimen. The specimen shall be stapled to the cardstock at each corner with the film side of the specimen away from the cardstock. The cardstock-backed specimen shall be clipped 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 D751, *Standard Methods for Testing Coated Fabrics, Hydrostatic Resistance*, Procedure B – Rising Column Water Method, Procedure 2, Sections 46–49, with the following modifications:

(1) Alternative test apparatus shall be permitted provided that the exposed area of the specimen is at least 108 mm (4¼ in.) in diameter and the pressure can be applied uniformly over the exposure period at a precision of ± 0.1 kPa (± 0.2 psi).
(2) The applied pressure shall be 13.8 kPa (2 psi) for an exposure period of 1 minute.
(3) Restraining materials shall not be used.
(4) 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.

8.62.5.5.1 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. 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 each for size 70W (wide) and size 76W (wide) 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 25 N (5½ 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 Reserved.

8.65 Reserved.

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N 8.66 Particle Inward Leakage Test.

N 8.66.1 Application. This test shall apply to liquid and particulate protective ensembles.

N 8.66.2 Samples.

N 8.66.2.1 Samples shall consist of liquid and particulate protective ensembles, including 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 liquid and particulate protective ensemble garment elements.

N 8.66.2.2 The ensemble shall be tested with each style of the SCBA specified by the manufacturer.

N 8.66.2.3 Garment, glove, and hood elements shall be conditioned as specified in 8.1.11.

N 8.66.2.4 Where the ensemble garment element does not include attached booties, the footwear shall be conditioned by flexing for 100,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, with the following modifications:

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

N 8.66.2.5 Samples shall be conditioned at 21°C ± 6°C (70°F ± 11°F) and 50 percent ± 30 percent relative humidity for at least 4 hours.

N 8.66.3 Specimens.

N 8.66.3.1 Specimens shall consist of the garment, helmet, glove, and footwear elements, and the respirator specified for the ensemble by the ensemble manufacturer. The hood interface component shall also be tested where the hood is not part of the liquid and particulate protective ensemble garment elements.

N 8.66.3.2 A minimum of three specimens shall be tested.

N 8.66.3.3 Specimens shall be provided to fit or be adjustable to fit the selected test subjects in accordance with the manufacturer's sizing provisions that are specific to each ensemble.

N 8.66.3.4 None of the ensembles or components of the ensemble to be tested shall have been previously subjected to particle inward leakage testing unless it can be demonstrated that the ensemble or components are free of contamination.

N 8.66.4 Apparatus.

N 8.66.4.1 The test shall be conducted in a chamber large enough to conduct testing on at least one test subject.

N 8.66.4.2 The test chamber shall have a system capable of providing a stable, uniform airflow directed at the test subject.

N 8.66.4.3 The test chamber shall prevent significant aerosol contact with any areas of the facility not intended as exposure areas, to prevent contamination.

N 8.66.4.4 The test chamber shall have an aerosol generator capable of maintaining the aerosol mass concentration as specified in the procedure.

N 8.66.4.5 The challenge aerosol shall be a combination of amorphous silica, 50 percent by weight; tetraethylene glycol, 42 percent by weight; uranine, 6 percent by weight; and Tinopal™, 2 percent by weight.

N 8.66.4.6 Test subjects shall wear a close-fitting, one- or multiple piece full-body garment made of black synthetic material that is sized to the individual test subject. The bodysuit must be clean and free of visible lint, to the extent practicable, prior to donning the candidate garment ensemble.

N 8.66.4.7 Visual inspection of the test participant, while wearing the indicator garment, shall be performed under illumination by black light in a dark room after doffing the candidate garments. Inspection shall be performed while the test participant is fully illuminated by black light with a wavelength of 365 nm.

N 8.66.4.8* A separate handheld black light with a wavelength of 365 nm and an intensity of 1200 $\mu W/cm^2$ at 380 nm shall be used to inspect areas where the presence of fluorescent particles could be unclear.

N 8.66.4.9 A 35 mm camera or digital equivalent with the appropriate capabilities and settings for taking photographs under UV light shall be provided for documenting the visual condition of the test subject before and after exposure to the aerosol.

N 8.66.4.10 The test facility shall have separate garment storage, donning, doffing, and control room areas to prevent contamination.

N 8.66.4.11 All test subjects shall have a medical doctor's certificate that substantiates that they are medically and physically suitable to perform these tests without danger to themselves. The medical certificate shall have been issued within 12 months prior to testing.

N 8.66.4.12 Test subjects shall be familiar with the use of structural fire fighting protective clothing and equipment and with the selected respirator.

N 8.66.5 Procedure.

N 8.66.5.1 The test chamber shall be stabilized with the following conditions:

(1) Average wind speed shall be 47 m/sec ± 0.89 m/sec (10.0 mph ± 2 mph) at the fan outlet airflow station.
(2) Temperature shall be 21°C ± 6°C (70°F ± 5°F).
(3) Relative humidity shall be 45 percent ± 15 percent.
(4) Average aerosol concentration shall be 160 mg/m^3, ±25/–0 mg/m^3.
(5) Aerosol aerodynamic mass median diameter shall be 2.5 µm ± 0.5 µm.

N 8.66.5.2 The test subject shall don black indicator garments that cover the wearer's torso, arms, hands, legs, ankles, and head excluding the face. The indicator garments shall provide a dark uniform appearance under black light illumination.

N 8.66.5.3* At least 10 specific areas of the indicator garment shall be masked with a suitable tape or masking product that will remain in place during testing and not affect the appearance of the indicator garment under black light illumination.

N 8.66.5.3.1 At least 10 masked areas, with minimum dimensions of 25 mm × 50 mm (1 in. × 2 in.) shall be distributed over the indicator garment.

N 8.66.5.4 The test subject shall don the protective ensemble and respirator in accordance with the manufacturer's instructions in a clean area separate from the test chamber.

N 8.66.5.5 Once the test chamber has reached the conditions stated in 8.66.5.1, the test subject will enter the chamber and be properly positioned in the wind.

N 8.66.5.6 The 30-minute test period begins when the test subject is positioned in the wind.

N 8.66.5.7 During the 30-minute test period, the test subject shall perform the three stationary exercises as specified in Table C.2 of Test Operations Procedure (TOP) 10-2-022, *Chemical Vapor and Aerosol System-Level Testing of Chemical/Biological Protection Suits.*

N 8.66.5.8 At the conclusion of the 30-minute test period, the test subject shall exit the test chamber and enter the doffing area.

N 8.66.5.9 The test subject shall then be assisted to doff the ensemble to prevent contact of the outside surface of the ensemble with the subject's skin or indicator garment.

N 8.66.5.10 After doffing, the masked areas shall be unmasked and the test subject shall be examined under black light in the viewing area for evidence of particulate inward leakage.

N 8.66.5.11 Photographs shall be taken of the test subject under black with the following minimum positions:

(1) Front, right, back, and left side of test subject's neck and head
(2) Front, right, back, and left side of test subject's upper torso
(3) Front, right, back, and left side of test subject's lower torso

N 8.66.5.12* A separate black light shall be used to inspect any areas where the presence of fluorescent particles might be unclear..

N 8.66.5.12.1 The exposure of the black light shall be bracketed to provide photographs with varying contrast to permit documentation of any observed fluorescence.

N 8.66.5.13 The laboratory shall be permitted, but is not required, to further sample any areas that are suspect for particle contamination using the procedures established in 8.66.5.7. These procedures, when used, shall be employed for documentation purposes only and shall not be used for interpreting compliance with the performance requirement.

N 8.66.6 Sampling and Analysis of Black Indicator Garment.

N 8.66.6.1 The test subject's black indicator garment shall be sampled to recover aerosol that has deposited. This garment-rinse sampling shall be performed by pressing a tube against the portion of the black indicator garment to be sampled and adding 20 mL of 0.01 N sodium hydroxide (NaOH). The solution shall be washed over the black indicator garment for approximately 10 seconds, then pipetted into a clean container.

N 8.66.6.2 All samples shall be labeled appropriately before they are analyzed.

N 8.66.6.3 For each of the black indicator garment-rinse samples, approximately 5 mL of each of the samples shall be analyzed in a fluorometer to determine the mass of aerosol that is present in the sample. The results shall be recorded and verified to identify and eliminate any errors in reading or recording the data.

N 8.66.7 After each trial, upon completion of the garment-rinse sampling and black light photography, the test subject shall return to a locker room and shower.

N 8.66.8 Report. The report shall consist of the following elements:

(1) Photographic records documenting the test ensemble and results consisting of the following:
   (a) A photograph of the front head-to-toe view of the test subject in the full test ensemble immediately before entering the aerosol chamber. Additional photographs of the test subject in the ensemble showing design details shall be included as warranted.
   (b) Black light photographs of the test subject after doffing. These photographs shall cover all body locations with the test subjects wearing shorts, and, for female test subjects, a sports bra.
   (c) If the post-exposure photographs show no aerosol deposits and show only a black garment in a dark room, the following statement shall be permitted in lieu of post-exposure photographs: "No visible aerosol deposits were revealed in the photographs."
(2) The test conditions, including the following:
   (a) The challenge aerosol mass concentration averaged for the duration of the test
   (b) The average wind speed, temperature, and relative humidity for the test
   (c) Date of test and test operator
(3) Specific observations for the location of any deposited aerosol on the test subject's indicator garments as noted during visual observation under a black light
(4) Any notable observations by the test operators, especially system openings, mask breaches, or poor fits

(5) Any supplemental test data sampling and analysis of the black indicator garments provided for documentation purposes only

N **8.66.9 Interpretation.** Any evidence of particulate inward leakage on any test subject's indicator garment as determined by visual inspection under a black light shall constitute failure.

8.67 Transmitted and Stored Thermal Energy Test.

8.67.1 Application.

8.67.1.1 This test method shall apply to garment sleeve composites containing enhancements as defined in 7.2.4 exterior to the outer shell.

8.67.1.2 Modifications to this test method for testing garment sleeve composites containing enhancements exterior to the outer shell shall be specified in 8.67.7.

N **8.67.1.3** Modifications to this test method for testing the glove body composite at the back of the glove shall be as specified in 8.67.8.

8.67.2 Samples. Samples shall measure 150 mm × 150 mm ± 6 mm (6 in. × 6 in. ± ¼ in.), and shall consist of all layers representative of the item to be tested. Samples shall not be stitched to hold individual layers together during testing. Enhancements shall be sewn to the center of the outer shell of the composite if they cannot meet the sample measurement requirements.

8.67.3 Specimens.

8.67.3.1 Transmitted and stored thermal energy testing shall be conducted on five specimens.

8.67.3.2 Garment sleeve composites shall be conditioned in accordance with ASTM F2731, *Standard Test Method for Measuring the Transmitted and Stored Energy in Fire Fighter Protective Clothing Systems*, Section 9.3.

8.67.4 Procedure.

8.67.4.1 Transmitted and stored thermal energy testing shall be conducted in accordance with ASTM F2731, *Standard Test Method for Measuring the Transmitted and Stored Energy in Fire Fighter Protective Clothing Systems*, Procedure B, with the modification specified in 8.67.4.1.1.

8.67.4.1.1 For garment sleeve composites, the exposure time shall be for a period of 120 seconds, +1/−0 seconds.

8.67.5 Report. The average time to second degree burn shall be calculated and reported. If no burn injury occurs, the time to second degree burn shall be reported as "no burn."

8.67.6 Interpretation. Pass/fail determination shall be based on the average reported time to second degree burn of all specimens tested.

8.67.7 Specific Requirements for Testing Garment Sleeve Composites Containing Enhancements Exterior to the Outer Shell.

8.67.7.1 A three-layer composite shall be used to test enhancements exterior to the outer shell. The composite shall be constructed using a layer of 7.5 oz/yd^2 natural woven 93 percent meta-aramid, 5 percent para-aramid, 2 percent antistat fiber, 4.7 oz/yd^2 ± 0.2 oz/yd^2, expanded PTFE laminated to a woven aramid fabric, and a layer of 3.8 oz/yd^2 ± 0.3 oz/yd^2, aramid needle punched nonwoven, quilted to 3.4 oz/yd^2, aramid plain weave thermal barrier material. Additional layers found used in the construction of the garment shall be placed in the composite as found in the garment.

N **8.67.8 Specific Requirements for Testing Glove Body Composites at the Back of the Glove.**

N **8.67.8.1** Specimens shall be representative of the glove body composite construction at the back of the glove at the following glove areas described in 8.1.17: A-A, B-B, the 25 mm (1 in.) of C-B adjacent to the wrist crease, D-B, and E-B.

N **8.67.8.2** Glove body composites at the back of the glove shall be conditioned as specified in 8.1.9.

N **8.67.8.3** The specimens shall be tested as specified in 8.67.4 with the exception that the radiant heat exposure period shall continue until the second-degree burn point is reached. No compression period shall be used for this testing.

N **8.67.8.4** The testing shall be run on separate samples at each of the three moisture conditions specified in 8.1.9.

8.68 Torque Test.

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

8.68.2 Samples.

8.68.2.1 Samples for conditioning shall be whole gloves.

8.68.2.2 Sample glove pairs shall be conditioned as specified in 8.1.3.

8.68.3 Specimens.

8.68.3.1 A minimum of three glove specimens each for size 70W (wide) and size 76W (wide) shall be used for testing.

• **8.68.3.2** Each specimen glove shall be tested in new, as-distributed condition.

8.68.3.3 Specimen gloves shall be tested for each material and construction combination.

Δ **8.68.4 Apparatus.** The apparatus shall be as specified in ASTM F2961, *Standard Test Method for Characterizing Gripping Performance of Gloves Using a Torque Meter.*

8.68.5 Procedure. The testing procedures shall be as specified in ASTM F2961, *Standard Test Method for Characterizing Gripping Performance of Gloves Using a Torque Meter.*

• **8.68.6 Report.** The average percentage of bare-handed control value shall be recorded and reported for each specimen glove size.

8.68.7 Interpretation.

8.68.7.1 The average percentage of bare-handed control value for size 70W (wide) and size 76W (wide) shall be used to determine pass or fail performance.

8.68.7.2 Failure of either size shall constitute failure of the test.

8.69 Fastener Tape Strength Test.

8.69.1 Application. This test shall apply to fastener tape used in the construction of garments.

8.69.2 Samples.

8.69.2.1 Sample size shall be defined in the A-A 55126B, *Commercial Item Description, Fastener Tapes, Hook and Loop, Synthetic.*

8.69.2.2 Samples shall be washed for three washings as specified in AATCC 61, *Colorfastness to Laundering, Home and Commercial: Accelerated,* using the laundering conditions established for Test 3A.

8.69.3 Specimens. A minimum of four specimens shall be evaluated.

8.69.4 Procedures.

8.69.4.1 Fastener tape breaking strength shall be measured in accordance with ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test),* with the following modifications:

(1) Specimens shall be tested in the provided width only in lieu of the specified 100 mm (3.9 in.) width.
(2) Only specimens parallel to the length of the tape shall be tested.

8.69.4.2 Fastener tape shear strength shall be measured in accordance with ASTM D5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners.*

8.69.4.3 Fastener tape shear strength shall be measured in accordance with ASTM D5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners.*

8.69.5 Report. The average breaking strength, shear strength, and peel strength shall be calculated and recorded.

8.69.6 Interpretation. Pass or fail determinations shall be based on the average breaking strength, shear strength, and peel strength specified for Type 2, Class 1 and 4 fastener tapes as established in Table 1 of A-A 55126B, *Commercial Item Description, Fastener Tapes, Hook and Loop, Synthetic.*

8.70 Glove Tool Test.

8.70.1 Application. This test shall apply to gloves.

8.70.2 Samples.

8.70.2.1 Samples for conditioning shall be whole glove pairs.

8.70.2.2 Glove pair samples shall be conditioned as specified in 8.1.3.

8.70.3 Specimens.

8.70.3.1 A minimum of three glove pair specimens each for size 70W (wide) and size 76W (wide) shall be used for testing.

8.70.3.2 Each glove pair specimen shall be tested as a complete set of gloves in new as-distributed condition.

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

8.70.4 Apparatus.

8.70.4.1 Glove tool testing shall be evaluated with the use of the following apparatus:

(1) A hand tool vertical test apparatus consisting of one horizontal board with one vertical board attached in the middle of the horizontal board. The vertical board shall have holes drilled 50 mm (2 in.) apart in a "T"-shaped fashion with a row of three holes and a row of one hole directly under and in the center of the top row.
(2) Four 19 mm (2.5 in.) course thread bolts with nuts and two washers
(3) ⅜ in. drive deep-well 19 mm (2.5 in.) socket
(4) 19 mm (2.5 in.) box-end wrench
(5) ⅜ in. drive torque wrench

8.70.5 Procedure.

8.70.5.1 Three test subjects with the proper hand size shall be selected for testing size 76W (wide) gloves, and three test subjects with the proper hand size shall be selected for testing size 70W (wide) gloves.

8.70.5.2 The test subject shall be proficient with performing this test method before conducting any tests.

8.70.5.3 The test subject shall use left or right hand as is comfortable for the two sides of the board however, the test subject shall not alternate hands for the same task during the test series.

8.70.5.4 Before each test trial, the bolts with one washer already on shall be spaced apart on one side of the vertical board, and the nuts shall be spaced apart on the other side, depending on the test subject's comfort.

8.70.5.4.1 The box-end wrench shall be placed on the side with the bolts and the torque wrench shall be placed on the side with the nuts, both within close proximity to the test board.

8.70.5.4.2 The test facilitator shall hand each washer to the test subject during the test trials.

8.70.5.5 For each test trial, the test subject shall start on either end of the top row of holes as long as this procedure is repeated for all trials. The test subject shall complete all holes in order across the top row and then complete the hole in the bottom row. After completion of the bottom hole the trial shall be complete.

8.70.5.6 The stopwatch shall be started when the test subject picks up the first bolt.

8.70.5.7 In starting the test, the test subject shall pick up a bolt with washer already on with one hand and put it into the first hole.

8.70.5.8 The test facilitator shall hand the test subject the second washer on the opposite side of the board.

8.70.5.9 While holding the bolt, the test subject shall place the second washer on the bolt with the opposite hand on the other side of the board.

8.70.5.10 While holding the bolt, the test subject shall place the nut on the bolt with the opposite hand on the other side of the board.

8.70.5.11 The test subject shall hold the bolt with one hand and tighten the nut with the opposite hand until resistance is met.

8.70.5.12 The test subject shall then use the box-wrench to hold the bolt secure on one side with the same hand that was used to insert the bolt.

8.70.5.13 While securing the bolt with the box-wrench, the test subject shall use the torque wrench to tighten the nut with the opposite hand, applying 120 in. lb to simulate snug.

8.70.5.14 When the torque wrench clicks, that hole position shall be complete and the test subject shall then begin inserting the next bolt and washer already on into the next hole.

8.70.5.15 The trial shall be complete and the stopwatch shall be stopped when the torque wrench clicks on the bottom hole.

8.70.5.16 If bolts, nuts, or wrenches are dropped onto the test surface, the test subject shall pick them up. If washers are dropped onto the test surface, the test facilitator shall pick them up and hand them to the test subject. If bolts, nuts, wrenches, or washers are dropped onto the floor, then the trial shall be stopped and the full trial shall be repeated.

8.70.5.17 The time to fill all holes for each trial shall be measured for each test subject and shall be known as the dexterity test time.

8.70.5.18 The test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

8.70.5.19 The test subject shall perform at least three test trials by following the steps in 8.70.5 without gloves until the coefficient of variation (COV) of the baseline times that of the person's last three repetitions does not exceed 8 percent. The COV shall be calculated as described in 8.70.5.21.1.

8.70.5.20 The test subject shall then perform three test trials by following the steps in 8.70.5 wearing gloves on each hand until the COV of the dexterity times that of the person's fastest three repetitions does not exceed 8 percent. The test subject shall perform all three trials using only one pair of gloves. Each test subject shall receive their own pair of gloves for the test. The COV shall be calculated as described in 8.70.5.21.1.

8.70.5.21 The COV shall be calculated by dividing the standard deviation by the average of three repetitions and multiplying by 100.

8.70.5.22 The average of the last three repetitions without gloves where the COV did not exceed 8 percent shall be used as the baseline dexterity test time (DTT_b).

8.70.5.23 The average of the three fastest repetitions wearing gloves where the COV did not exceed 8 percent shall be the dexterity test time with gloves (DTT_g).

8.70.5.24 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:

N [8.70.5.24]

$$\text{Percent of bare-handed control} = \left(DTT_g / DTT_b\right) \times 100$$

where:
DTT_g = average dexterity time with gloves (sec)
DTT_b = average baseline dexterity test time (sec)

8.70.6 Report.

8.70.6.1 The average percentage of bare-handed control shall be recorded and reported for each test subject.

8.70.6.2 The average percentage of bare-handed control for all test subjects shall be recorded and reported for each size.

8.70.7 Interpretation.

8.70.7.1 The average percentage of bare-handed control for size 70W (wide) and size 76W (wide) shall be used to determine pass or fail performance.

8.70.7.2 Failure of either size shall constitute failure of the test.

N **8.71 Particulate Blocking Test.**

N **8.71.1 Application.** This test shall apply to hood particulate blocking layers or hood composites comprising the function of the particulate blocking layer.

N **8.71.2 Samples.**

N **8.71.2.1** Samples for conditioning shall measure at least 380 mm^2 (15 in.^{2}) and shall consist of composites constructed using all layers provided in the order that represents the particulate blocking function of the hood.

N **8.71.2.2** Where a seam is necessary to create the 380 mm^2 (15 in.^{2}) composite sample, a seam shall not be included in the cut conditioned specimen.

N **8.71.2.3*** A reference sample shall be prepared that consists of a composite constructed using two layers of 9.0 oz/yd^2 ± 1.0 oz/yd^2, 100 percent meta-aramid, 1 × 1 rib knit with a stitch count of 37 courses/in. ± 2 courses/in. and 21 wales/in. ± 2 wales per in.

N **8.71.3 Specimens.**

N **8.71.3.1** Particulate-blocking-layer composite specimens shall be tested both before and after being twice subjected to the following conditioning:

(1) Specimens shall be first subjected twice 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.

N **8.71.3.2** The particulate-blocking test specimens shall be cut into at least a 150 mm (6 in.) square from the preconditioned sample.

N **8.71.3.2.1** One specimen shall be taken from the center of each preconditioned sample.

N **8.71.3.3** All specimens to be tested shall be conditioned as specified in 8.1.18.

N **8.71.3.4** Reference specimens shall be conditioned as specified in 8.1.18.

N **8.71.3.5** A total of three particulate blocking layer composite specimens shall be tested. One reference specimen shall be tested.

N **8.71.4 Apparatus.**

N **8.71.4.1** The test apparatus shall be as specified in ASTM F2299/F2299M, *Standard Test Method for Determining the Initial Efficiency of Materials Used in Medical Face Masks to Penetration by Particulates Using Latex Spheres*, with the following modifications:

(1) A needle valve shall be placed between the filter holder and the air flow measurement.

(2) A recirculation line shall be placed from the optical particle counter #1 and the main flow line between the needle valve and the filter holder as illustrated in Figure 8.71.4.1.
(3) A stainless steel reinforcement screen with a mesh size of 1 mm × 1 mm (0.04 in. × 0.04 in.) shall be used adjacent to the test specimen on the downstream side.
(4) Particle detection shall be accomplished with the use of an SMPS (scanning mobility particle sizer) or an OPC (optical particle counter) capable of measuring 0.1 μ at 100 percent counting efficiency.

N 8.71.5 Procedure.

N 8.71.5.1 Specimens shall be tested in accordance with ASTM F2299/F2299M, *Standard Test Method for Determining the Initial Efficiency of Materials Used in Medical Face Masks to Penetration by Particulates Using Latex Spheres*, with the following modifications:

(1) A reference specimen as specified in 8.71.3 shall be tested prior to the commencement of a series of testing or when the test equipment is modified or repaired.
(2) The normal outer surface of the particulate-blocking layer shall be mounted such that it faces the upstream side as oriented in the hood.
(3) If the airflow is met with the specimen in place, the upstream and downstream aerosol counts shall be recorded for a minimum of 5 counts at each particle range using a 1 minute sampling time.
(4) If the downstream count is less than 100, the sampling time shall be extended until 100 counts are obtained but not longer than 5 minutes.
(5) If the airflow is not met, the needle valve shall be closed and the OPC exhaust shall be recirculated into the downstream side to maintain a pressure drop of 249 Pa (1 in. H_2O column) across the specimen.

N 8.71.5.2* The latex sphere sizes used in testing shall range from 0.1 μm to 1.0 μm and shall be created using at least eight different known particle sizes from 0.1 μm to 1.0 μm.

N 8.71.5.3 The required airflow shall be 1.7 L/min ± 0.1 L/min in 8.71.5.1(3)

N 8.71.5.4 The efficiency for each specimen shall be calculated for each sequence for conditioning using the following equation:

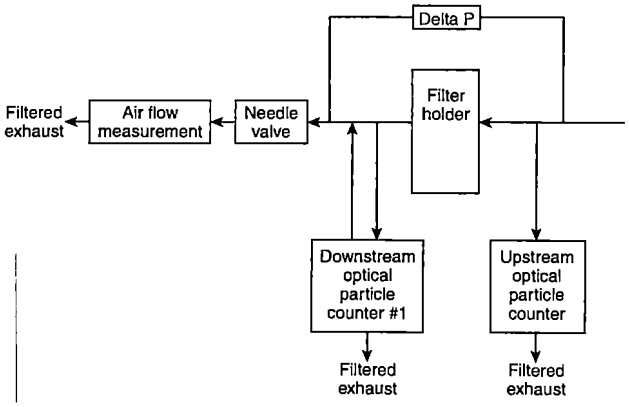

FIGURE 8.71.4.1 Diagram for Placement of the Recirculated Line.

[8.71.5.4]

%Efficiency = η = [1- (downstream counts/upstream counts)]*100

N 8.71.5.5 For each test condition, the average efficiency for each specimen shall be calculated.

N 8.71.6 Report.

N 8.71.6.1 The final measurement airflow and the pressure (ΔP) shall be recorded and reported in L/min and in Pa (in. HO column), respectively for each specimen.

N 8.71.6.2 The upstream and downstream particulate counts shall be recorded and reported from 0.1 μ to 1.0 μ.

N 8.71.6.3 The average percent efficiency shall be recorded and reported.

N 8.71.7 Interpretation. The average percent efficiency shall be used to determine pass or fail performance.

Annex A Explanatory Material

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

A.1.1 Organizations responsible for specialized functions including, but not limited to, wildland fire fighting, proximity fire fighting, 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.1.1.3 While separate requirements are specified for structural fire fighting and proximity fire fighting protective elements, the optional liquid and particulate contaminant protection requirements apply to ensembles only. Individual elements cannot be separately certified to the optional liquid and particulate contaminant protection criteria in this standard. Only complete ensembles, in which all necessary elements are specified to achieve the stated performance requirements, can be certified to the optional liquid and particulate contaminant protection criteria in this standard.

The optional liquid and particulate contaminant protection criteria are intended to address protection of fire fighters against fireground liquids and smoke particulates that carry chemical and other hazardous contaminants. Individual ensemble element requirements for protective garments, gloves, and footwear currently specify the use of a moisture barrier and/or liquid protection requirements; however, the entire ensemble is not evaluated for liquid penetration resistance performance. In particular, interfaces between individual elements are susceptible to inward leakage of liquids that can only be determined when the entire ensemble as configured by the organization is evaluated. Similarly, there are no requirements for particulate penetration resistance of ensemble elements or the overall ensemble. Ensemble elements that incorporate moisture barriers will limit particulate penetration; however, the interfaces between elements will readily permit inward penetration of particulate from smoke and other sources at the fire scene. Standard protective hood interface components have no barrier material and allow the passage of particles through the hood materials to the fire fighter's head and neck that are not covered by the SCBA facepiece.

The optional liquid and particulate contaminant protection criteria are not intended to protect against all hazardous substance exposures, but rather minimize fire fighter exposures to routine liquids, including hot, cold, or contaminated water and the bulk of particulates generated at the fire scene. Some liquids and particulate might still pass through the clothing depending on the nature of the exposure, including the exposure time and conditions. Moreover, hazardous vapors or gases could still also penetrate individual ensemble elements or interfaces leading to exposures. Ensembles that are certified to the optional liquid and particulate contaminant protection criteria are not hazardous materials protective ensembles and should not be used in place of these specialized ensembles.

Organizations responsible for first responders should use protective ensembles and protective clothing specifically designed for those hazardous materials emergencies and should use ensembles that are certified to the following standards, as appropriate:

(1) NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*
(2) NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies*
(3) NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*

Specific criteria for CBRN protective ensembles previously addressed in the 2007 and 2013 editions of NFPA 1971 were moved to NFPA 1994. NFPA 1994 establishes requirements for chemical/biological protection as part of the Class 2 requirements. The 2012 edition of NFPA 1994 specified criteria for single-use CBRN protective ensembles; however, the 2017 edition includes CBRN protection criteria for both single- and multiple-use protective ensembles.

• **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.

Δ **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 patterns, or other features related to specific elements or ensembles. Tests specified in this standard should not be deemed as defining or establishing performance levels for protection from all structural or proximity fire fighting environments.

A.1.2.3 The testing requirements in Chapter 8 of this standard are not intended to establish the limitations of the working environment for 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 firefighting protective ensemble elements, as required by this standard, can diminish as the product is worn and ages.

A.1.3.2 Specific design and performance criteria are established in this standard to demonstrate limited protection against liquid and particulate contaminant hazards to reduce the amount of contamination that passes through the ensemble onto the fire fighter's skin and to reduce the contamination that might remain in the ensemble elements as the result of the exposure. Full-scale tests are used to evaluate the resistance of complete ensembles to penetration of liquids and particulates.

A.1.3.8 See A.1.1.5.

A.3.2.1 Approved. The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property

owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

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

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

A.3.3.7 Bitragion Coronal Arc. See Figure A.3.3.7.

A.3.3.8 Bitragion Inion Arc. For test purposes, the bitragion inion arc is identified as Datum Plane 10. See Figure A.3.3.8.

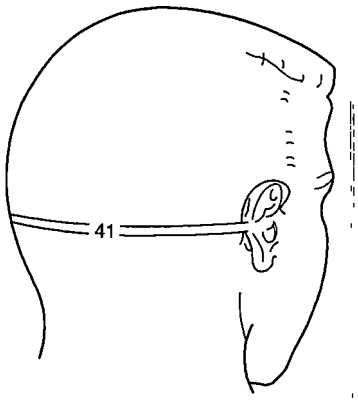

FIGURE A.3.3.8 Bitragion Inion Arc.

• Δ **A.3.3.16 CBRN Terrorism Agents.** Chemical terrorism agents include solid, liquid, and gaseous chemical warfare agents and toxic industrial chemicals. Chemical warfare agents include, but are not limited to, GB (sarin), GD (soman), HD (sulfur mustard), VX, and specific toxic industrial chemicals. Many toxic industrial chemicals, for example chlorine and ammonia, are identified as chemical terrorism agents because of their availability and the degree of injury they could inflict.

Biological agents are bacteria, viruses, or the toxins derived from biological material. Biological particles can be dispersed as aerosols and liquid-borne pathogens. Airborne biological agents could be dispersed in the form of liquid aerosols or solid aerosols (i.e., a powder of bacterial spores). Liquid-borne pathogens could be potentially encountered during a terrorism incident as a result of deliberate disposal or from body fluids released by victims of other weapons (i.e., explosives, firearms).

CBRN also includes radiological particulates dispersed as aerosols but not for radiological gases or vapors. Airborne particulates have the ability to emit alpha- and beta-particles and ionizing radiation from the decay of unstable isotopes.

A.3.3.40 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.

A.3.3.41 Faceshield. The faceshield is not intended as primary eye protection.

A.3.3.47 Footwear. See Figure A.3.3.47.

A.3.3.57 Gusset. The gusset generally lacks some layers used in the construction of the footwear upper or might include different layers for the purpose of being flexible. The gusset is

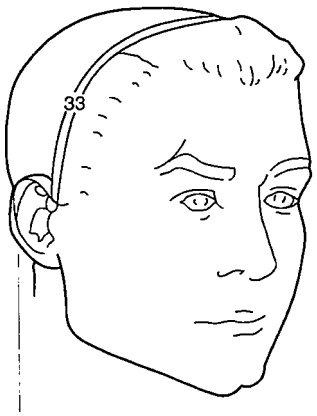

FIGURE A.3.3.7 Bitragion Coronal Arc.

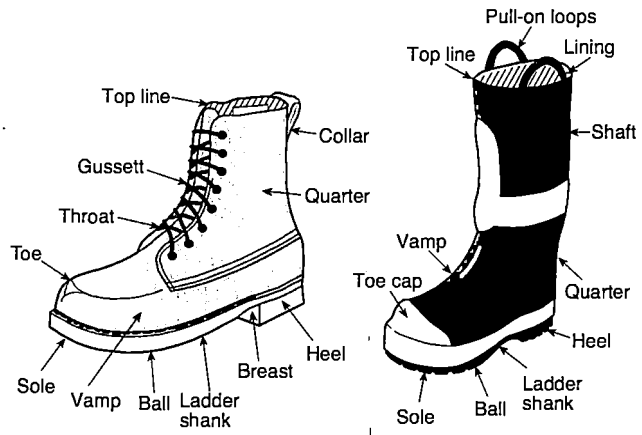

FIGURE A.3.3.47 Identification of Footwear Terms.

not observable from the front of the footwear when the footwear is donned or laced up.

N **A.3.3.85 Particulate Blocking Layer.** For the purpose of this standard, the particulate blocking layer is intended to inhibit the passage of smoke particles through the protective clothing element or interface device. The combination of the particulate blocking layer and other layers associated with the element or interface device might also contribute to this function.

A.3.3.86 Particulates. There are at least seven forms of particulate matter, as follows:

(1) *Aerosol.* A dispersion of solid or liquid particles of microscopic size in a gaseous medium such as smoke, fog, or mist.
(2) *Dust.* A term loosely applied to solid particles predominantly larger than colloidal and capable of temporary suspension in air or other gases. Derivation from larger masses through the application of physical force is usually implied.
(3) *Fog.* A term loosely applied to visible aerosols in which the dispersed phase is liquid. Formation by condensation is implied.
(4) *Fume.* Solid particles generated at condensation from the gaseous state, generally after volatilization from melted substances and often accompanied by a chemical reaction such as oxidation. Popular usage sometimes includes any type of contaminant.
(5) *Mist.* A term loosely applied to dispersion of liquid particles, many of which are large enough to be individually visible without visual aid.
(6) *Smog.* A word derived from the words smoke and fog and applied to extensive atmospheric contamination by aerosols arising from a combination of natural and human-made sources.
(7) *Smoke.* Small gasborne particles resulting from incomplete combustion and consisting predominantly of carbon and other combustible materials.

A.3.3.100 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 ensembles could be made where the incident requires additional operations for control of the incident.

A.3.3.112 Radiological Particulate Terrorism Agents. This standard only provides partial protection from certain radiation sources. By their nature, these ensembles provide protection from alpha-particles, and the element materials and distance will significantly attenuate beta-particles. These ensembles do not provide any protection from ionizing radiation, such as gamma- and x-rays, other than to keep the actual radiological particulate from direct skin contact.

A.3.3.119.2 Major A Seam. Each TC can identify the various layers in the annex if so desired.

A.3.3.130 Structural Fire Fighting Protective Ensemble. Structural fire fighting protective ensembles include, but are not limited to, garments, helmets, hoods, gloves, and footwear.

A.3.3.143 Tongue. The tongue might or might not be made of the same composite as the footwear upper. The tongue might be of a similar material composite as the footwear gusset.

A.3.3.149 Upper. See Figure A.3.3.47.

Δ **A.4.1.4** 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 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 4 and 5 of NFPA 1971 should be referenced. Also, the definitions for *Certification/Certified, Labeled,* and *Listed* in Chapter 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.

Δ **A.4.3.4** Table A.4.3.4(a) through Table A.4.3.4(k) are provided as a quick reference for conditioning and testing of elements and cannot be relied on as requirements.

A.4.3.4.1 The order of testing is from left to right in Table A.4.3.4(b). Where there is more than one environmental condition for a specific test, the order of environmental conditioning for that test is from top to bottom in Table A.4.3.4(b).

A.4.3.4.2 The order of testing is from left to right in Table A.4.3.4(g). Where there is more than one environmental condition for a specific test, the order of environmental conditioning for that test is from top to bottom in Table A.4.3.4(g).

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N **A.4.5.3** In September 2015, a revised edition of ISO 9001, *Quality management systems — Requirements*, was issued. Both the 2008 and 2015 editions of ISO 9001 are being referenced in this revision of NFPA 1971 to allow manufacturers a sufficient amount of time to transition registration of their quality management systems to the newer edition.

A.4.5.4 Subcontractors should be considered to be, 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 the compliant product or portions of the compliant product.

A.4.6.2 By definition, a hazard might involve a condition that can be imminently dangerous to the end-user. With this thought in mind, the investigation should be started immediately and completed in as timely a manner as is appropriate considering the particulars of the hazard being investigated.

A.4.6.11 The determination of the appropriate corrective action for the certification organization to initiate should take into consideration the severity of the product hazard and its potential consequences to the safety and health of end users. The scope of testing and evaluation should consider, among other things, testing to the requirements of the standard to which the product was listed as compliant, the age of the product, the type of use and conditions to which the compliant product has been exposed, care and maintenance that has been provided, the use of expertise on technical matters outside the certification organization's area of competence, and product hazards caused by circumstances not anticipated by the requirements of the applicable standard. As a guideline for determining which is more appropriate, a safety alert or a product recall, the following product hazard characteristics are provided, which are based on 42 CFR 84, Subpart E, §84.41:

(1) *Critical:* A product hazard that judgment and experience indicate is likely to result in a condition immediately hazardous to life or health (IHLH) for individuals using or depending on the compliant product. If an IHLH condition occurs, the user will sustain, or will be *likely* to sustain, an injury of a severity that could result in loss of life, or result in significant bodily injury or loss of bodily function, either immediately or at some point in the future.

(2) *Major A:* A product hazard, other than *Critical* that is likely to result in failure to the degree that the compliant product does not provide any protection or reduces protection, *and is not detectable to the user.* The phrase *reduced protection* means the failure of specific protective design(s) or feature(s) that results in degradation of protection in advance of reasonable life expectancy to the point that continued use of the product is *likely* to cause physical harm to the user, or where continued degradation could lead to IHLH conditions.

(3) *Major B:* A product hazard, other than *Critical* or *Major A,* that is likely to result in reduced protection and is detectable to the user. The phrase *reduced protection* means the failure of specific protective design(s) or feature(s) that results in degradation of protection in advance of reasonable life expectancy to the point that continued use of the product is *likely* to cause physical harm to the user, or where continued degradation could lead to IHLH conditions.

(4) *Minor:* A product hazard, other than *Critical, Major A,* or *Major B,* that is not likely to materially reduce the usability of the compliant product for its intended purpose or a product hazard that is a departure from the established applicable standard and has little bearing on the effective use or operation of the compliant product for its intended purpose.

Where the facts are conclusive, based on characteristics of the hazard classified as indicated previously, the certification organization should consider initiating the following corrective actions with the authorized and responsible parties:

(1) *Critical* product hazard characteristics: product recall
(2) *Major A* product hazard characteristics: product recall or safety alert, depending on the nature of the specific product hazard
(3) *Major B* product hazard characteristics: safety alert or no action, depending on the nature of the specific product hazard
(4) *Minor* product hazard characteristic: no action

Table A.4.3.4(a) Testing Structural Fire Fighting Garments

Test	Section Number	Test Material or Component												Conditioning		
		Garments	Composite	Outer Shell	Moisture Barrier	Thermal Barrier	Winter Liner	Labels	Other Materials	Thread	Seams	Hardware	Trim	Washing/ Drying[a]	Room Temp[b]	Convective Heat[c]
Flame resistance	8.2			X	X	X	X		X				X	X	X	
Heat/thermal resistance	8.6			X	X	X	X	X	X			X	X		X	
TPP	8.10		X												X	
Thread melting	8.11									X					X	
Tear resistance	8.12			X	X	X	X							X	X	
Seam strength	8.14										X			X		
Cleaning shrinkage resistance	8.24			X	X	X	X							X		
Water absorption resistance	8.25			X										X		
Water penetration resistance	8.26				X									X	X	X
Liquid penetration resistance	8.27				X						X			X	X	X
Viral penetration resistance	8.28				X						X			X	X	X
Corrosion resistance	8.29											X			X	
Total heat loss	8.33		X												X	
Label durability	8.41							X								
Trim retroreflectivity	8.45												X		X	X
Trim fluorescence	8.45												X		X	
Overall liquid penetration	8.47	X												X		
Breaking strength	8.49			X												
CCHR	8.50		X											X	X	
Light degradation resistance	8.61				X									X	X	X
DRD function	8.58	X														
DRD material strength	8.57								X		X					

[a]See 8.1.2.
[b]See 8.1.3.
[c]See 8.1.5.

A.4.6.13 Reports, proposals, and proposed TIAs should be addressed to the technical committee that is responsible for the applicable standard and be sent in care of Standards Administration, NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471.

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. Purchasers might also wish to include a requirement in the purchase specifications for inclusion of a blank label or blank space on a label for the end user to "write in" information; however, considerations should also be given to the size of this label and all labels in order to minimize the size and amount of labels utilized in the product.

A.5.1.3 See A.4.1.4.

N **A.5.1.7.3** For example, an additional thermal layer that is used in the significant portion of the footwear should be listed on the label. Similarly, any special form of external reinforcement that covers a significant portion of the footwear should be listed. Zippers, eyelets, toe caps, puncture-resistant plates, and ladder shanks are not required to be listed. Type of leather is not required to be listed. Trade names can be used in place of generic material names, if desired.

A.5.1.7.4 Examples of shell materials are thermoplastic, thermoplastic/leather, fiberglass composite, Kevlar® composite, and fiberglass composite/leather.

Δ Table A.4.3.4(b) Conditioning and Testing of Structural Fire Fighting Helmets

Test	Section Number	Specimen Numbers					
		Room Temperature[a]	Wet[b]	Low Temperature[c]	Radiant[d]	Convective Heat[e]	Washing/ Drying[f]
Helmet, faceshield, and goggle flame test	8.2 & 8.3	1					
Heat resistance	8.6	2					
Retention	8.34	1					
Suspension retention	8.35	1					
Shell retention	8.43	13					
Electrical resistance	8.30	4					
Faceshield, goggle luminous transmittance	8.44	6					
Faceshield, goggle impact resistance	8.17	3	4	9		13	
Top impact	8.15	3	4	9	7	11	
Label legibility	8.42	2	4	9	7		
Impact acceleration	8.16	5	6	10	8		
Penetration	8.19	3	4	9	14	12	
Faceshield, goggle lens abrasion resistance	8.22	8					
Hardware corrosion	8.29	3					
Trim retroreflectivity and fluorescence	8.45	X					
Thread heat resistance	8.11	X					
Ear cover, chin strap flame resistance	8.2	X					X
Ear cover, chin strap heat resistance	8.6	X					X
Ear cover TPP	8.10	X					

[a] See 8.1.3.
[b] See 8.1.7.
[c] See 8.1.4.
[d] See 8.1.6.
[e] See 8.1.5.
[f] See 8.1.2.

Δ Table A.4.3.4(c) Testing Structural Fire Fighting Gloves

Test	Section Number	Test Material or Component						Test Conditioning				
		Whole Glove	Glove Composite	Glove Gauntlet	Glove Wristlet	Thread	Hardware	Room Temp[a]	Washing/ Drying[b]	Convective Heat[c]	Wet[d]	Flex[e]
TPP	8.10		X	X	X			X	X			
Heat and thermal shrinkage resistance	8.6	X						X	X			X
Conductive heat resistance test 1	8.7		X					X	X		X	
Flame resistance test 3	8.4		X	X	X			X	X			
Thread melting	8.11					X		X				
Viral penetration resistance	8.28		X					X	X	X		
Liquid penetration resistance	8.27		X					X	X	X		
Cut resistance	8.21		X	X	X			X	X			
Puncture resistance test 1	8.20		X					X			X	
Glove hand function	8.37	X						X				
Burst strength	8.13				X			X				
Seam breaking strength	8.14			X	X				X			
Overall liquid integrity test 1	8.32	X							X	X		
Glove donning test	8.36								X			
Liner retention test	8.62	X							X			
Label durability and legibility test 1	8.41	X						X		X		
Grip	8.38	X							X		X	
Corrosion resistance	8.29						X	X				

[a] See 8.1.3.
[b] See 8.1.2.
[c] See 8.1.5.
[d] See 8.1.8.
[e] See 8.1.10.

Δ Table A.4.3.4(d) Testing Structural Fire Fighting Footwear

Test	Section Number	Test Material or Component: Whole Footwear	Footwear Composite	Footwear Sole	Footwear Toe Section	Footwear Moisture Barrier	Footwear Moisture Barrier Seam	Thread	Labels	Test Conditioning: Room Temp[a]	Convective Heat[b]	Wet[c]
Radiant heat resistance test 1	8.9	X								X		X
Conductive heat resistance test 1	8.7	X								X		
Conductive heat resistance test 2	8.8	X								X		
Flame resistance test 4	8.5	X								X		
Thread melting test	8.11							X		X		
Liquid penetration resistance	8.27					X	X			X	X	
Viral penetration resistance	8.28					X	X			X	X	
Puncture resistance test	8.20	X	X							X		
Cut resistance	8.21		X							X		
Slip resistance	8.40	X								X		
Abrasion resistance	8.23			X						X		
Electrical insulation test 2	8.31	X								X		
Ladder shank bend	8.39	X								X		
Eyelet and stud post attachment	8.48	X								X		
Corrosion resistance	8.29	X								X		
Label durability and legibility	8.41								X	X	X	
Overall liquid integrity test 2	8.70	X								X		
Heat and thermal shrinkage resistance test	8.6	X								X		
Puncture resistance device flex test	8.20	X								X		

[a] See 8.1.3.
[b] See 8.1.5.
[c] See 8.1.9.

Δ Table A.4.3.4(e) Testing Structural Fire Fighting Interfaces

Test	Section Number	Test Material or Component: Hood	Hood Material or Composite	Hood Seam	Hood Thread	Wristlet Material or Composite	Wristlet Seam	Wristlet Thread	Conditioning: Washing/ Drying[a]	Room Temperature[b]
Flame resistance	8.4		X			X			X	X
Heat/thermal resistance	8.6	X				X			X	X
TPP	8.10		X			X			X	X
Thread melting	8.11				X			X		X
Burst strength	8.13		X			X				X
Seam strength	8.14			X			X			X
Cleaning shrinkage	8.24	X				X			X	

[a] See 8.1.2.
[b] See 8.1.3.

Table A.4.3.4(f) Testing Proximity Fire Fighting Garments

		Test Material or Composite												Conditioning		
Test	Section Number	Garments	Com-posite	Outer Shell	Moisture Barrier	Thermal Barrier	Winter Liner	Labels	Other Materials	Thread	Seams	Hard-ware	Trim	Washing/ Drying[a]	Room Temp[b]	Convective Heat[c]
Flame resistance	8.2			X	X	X	X		X				X	X	X	
Heat/thermal resistance	8.6			X	X	X	X	X	X			X	X		X	
TPP	8.10		X												X	
Thread melting	8.11									X					X	
Tear resistance	8.12			X	X	X	X							X	X	
Seam strength	8.14										X			X		
Cleaning shrinkage resistance	8.24			X	X	X	X							X		
Water absorption resistance	8.25			X										X		
Water penetration resistance	8.26				X									X	X	X
Liquid penetration resistance	8.27				X						X			X	X	X
Viral penetration resistance	8.28				X						X			X	X	X
Corrosion resistance	8.29											X			X	
Total heat loss	8.33		X												X	
Label durability	8.41							X								
Overall liquid penetration	8.47	X													X	
Breaking strength	8.49			X												
CCHR	8.50		X											X	X	
Light degradation resistance	8.61													X	X	X
DRD function test	8.58															
DRD material strength test	8.57															
Radiant heat resistance test 2	8.60			X											X	
Wet flex	8.53			X											X	
Adhesion after wet flex	8.54			X											X	
Flex at low temperature	8.55			X											X	
Resistance to high temperature blocking	8.56			X											X	

[a] See 8.1.2.

[b] See 8.1.3.

[c] See 8.1.5.

Δ Table A.4.3.4(g) Conditioning and Testing of Proximity Fire Fighting Helmet

Test	Section Number	Specimen Numbers					
		Room Temperature[a]	Wet[b]	Low Temperature[c]	Radiant[d]	Convective Heat[e]	Washing/ Drying[f]
Helmet, faceshield flame test	8.3	1					
Heat resistance	8.6	2					
Retention	8.34	1					
Suspension retention	8.36	1					
Shell retention	8.43	13					
Electrical resistance	8.30	4					
Faceshield luminous transmittance	8.44	6					
Faceshield impact resistance	8.17	3	4	9		13	
Faceshield radiant reflective test	8.51	15					
Top impact	8.15	3	4	9	7	11	
Label legibility	8.42	2	4	9	7		
Impact acceleration	8.16	5	6	10	8		
Penetration	8.19	3	4	9	14	12	
Radiant heat transmittance test	8.52	15					
Hardware corrosion	8.29	3					
Trim retroreflectivity	8.45	X					
Thread heat resistance	8.11	X					
Shroud, cover, chin strap flame resistance	8.2	X					X
Shroud, cover, chin strap heat resistance	8.6	X					X
Shroud TPP	8.10	X					
Shroud, cover radiant reflective test	8.51	X					
Shroud, cover wet flex test	8.53	X					
Shroud, cover flex at low temperature	8.53	X					
Shroud, cover high temperature blocking	8.56	X					
Shroud, cover tear resistance	8.12	X					X
Shroud, moisture barrier water penetration	8.26	X				X	X
Shroud, moisture barrier liquid penetration	8.27	X				X	X
Shroud, moisture barrier viral penetration	8.28	X				X	X

[a] See 8.1.3.
[b] See 8.1.7.
[c] See 8.1.4.
[d] See 8.1.6.
[e] See 8.1.5.
[f] See 8.1.2.

Δ A.5.1.7.5 Leather should be identified by the type of hide — for example, cow leather or elk leather. Any significant additional layer should also be identified, such as an additional thermal liner or other layer that is used on the back of the hand in the glove body. Items including, but not limited to, elastic, thread, and liner attachment tapes do not have to be listed on the label.

A.5.3.4 The necessity exists to label the shroud with applicable helmet and cover information. In addition, it is necessary to label the cover (where separate from the shroud) with the applicable helmet and shroud information. Labeling in this manner will ensure all three pieces (helmet, shroud, and cover) are addressed on all individual component labels such that the proper components and models are present and used with one another. Where the shroud and cover are combined, only one label is necessary for both the cover and the shroud.

A.5.4.4 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.6.1 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.

Δ 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

Δ Table A.4.3.4(h) Testing Proximity Gloves

Test	Section Number	Test Material or Component: Whole Glove	Glove Composite	Glove Outer Shell Material	Glove Gauntlet	Glove Wristlet	Thread	Hardware	Test Conditioning: Room Temp[a]	Washing/ Drying[b]	Convective Heat[c]	Wet[d]	Flex[e]
TPP	8.10		X		X	X			X	X			
Heat and thermal shrinkage resistance	8.6	X							X	X			X
Conductive heat resistance test 1	8.7		X						X	X		X	
Flame resistance test 3	8.4		X		X	X			X	X			
Thread melting	8.11						X		X				
Viral penetration resistance	8.28		X						X	X	X		
Liquid penetration resistance	8.27		X										
Cut resistance	8.21		X		X	X			X	X			
Puncture resistance test 1	8.20		X						X			X	
Glove hand function	8.37	X							X				
Burst strength	8.13					X			X				
Seam breaking strength	8.14				X	X				X			
Overall liquid integrity test 1	8.33	X								X	X		
Glove donning test	8.37	X								X			
Liner retention test	8.62	X								X			
Label durability and legibility test 1	8.41	X							X		X		
Radiant heat resistance test 2	8.60			X					X				
Wet flex	8.53			X					X				
Adhesion after wet flex	8.54			X					X				
Flex at low temperature	8.53			X					X				
Resistance to high temperature blocking	8.56			X					X				
Grip test	8.38	X								X		X	
Corrosion resistance	8.29							X	X				

[a] See 8.1.3.
[b] See 8.1.2.
[c] See 8.1.5.
[d] See 8.1.8.
[e] See 8.1.10.

padding could lead to fatigue or result in injury. Where garments have an inspection opening installed to facilitate advanced liner inspections as specified in NFPA 1851 the functionality of the opening should be inspected to determine that the opening will permit the examination of the entire liner interior. The inspection opening should be designed to prevent the entering of foreign matter.

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.6.1.8 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.6.1.9.2 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.

Δ A.6.1.11 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.6.1.12 Methods for attaching harnesses and belts to garments include, but are not limited to, sewing of any harness or belt components to garment materials, the use of loop through which harnesses or belts are inserted, or the use of fastener tape for attaching these items.

Δ A.6.2.2 The high-visibility materials required on fire fighter PPE effectively enhance visual conspicuity during the variety of fireground operations. The continuous use of high-visibility

Δ Table A.4.3.4(i) Testing Proximity Fire Fighting Footwear

Test	Section Number	Test Material or Component: Whole Footwear	Footwear Composite	Footwear Sole	Footwear Toe Section	Footwear Moisture Barrier	Footwear Moisture Barrier Seam	Thread	Labels	Test Conditioning: Room Temp[a]	Convective Heat[b]	Wet[c]
Radiant heat resistance test 2	8.60	X								X		X
Conductive heat resistance test 3	8.59	X								X		
Conductive heat resistance test 2	8.8	X								X		
Flame resistance test 4	8.5	X								X		
Thread melting test	8.11							X		X		
Liquid penetration resistance	8.27					X	X			X	X	
Viral penetration resistance	8.28					X	X			X	X	
Puncture resistance test	8.20	X	X							X		
Cut resistance	8.21		X							X		
Slip resistance	8.40	X								X		
Abrasion resistance	8.23			X						X		
Electrical insulation test 2	8.31	X								X		
Impact and compression	8.18				X					X		
Ladder shank bend	8.39	X								X		
Eyelet and stud post attachment	8.48	X								X		
Corrosion resistance	8.29	X								X		
Label durability and legibility	8.41								X	X	X	
Overall liquid integrity test 2	8.70	X								X		
Heat and thermal shrinkage resistance test	8.6	X								X		
Puncture resistance device flex test	8.19	X								X		

[a] See 8.1.3.
[b] See 8.1.5.
[c] See 8.1.9.

Table A.4.3.4(j) Testing Proximity Fire Fighting Interfaces

Test	Section Number	Test Material or Composite: Wristlet Material or Composite	Wristlet Seams	Wristlet Thread	Conditioning: Washing/Drying[a]	Room Temperature[b]
Flame resistance	8.2	X			X	X
Thermal shrinkage resistance	8.6	X			X	X
Heat resistance	8.6	X			X	X
TPP	8.10	X				X
Thread melting	8.11			X		X
Burst strength	8.13	X			X	X
Seam strength	8.14		X		X	X
Cleaning shrinkage	8.24	X			X	

[a] See 8.1.2.
[b] See 8.1.3.

garments is one component of a strategy to mitigate risks from struck-by hazards, which are known to cause serious fire fighter injuries and fatalities on an annual basis. Please note that additional high-visibility requirements for fire fighters on or near roadways are regulated by the U.S. Federal Highway Administration's *Manual on Uniform Traffic Control Devices (MUTCD)*, 2009 edition, §6D.03, pp. 564-565. It is the responsibility of the authority having jurisdiction to specify appropriate high-visibility apparel from the available garment options, and, based on a risk assessment, to establish policies for high-visibility apparel use in accordance with prevailing regulations (the *MUTCD*) and in compliance with applicable standards (e.g., NFPA 1971, ANSI/ISEA 107, *American National Standard for High Visibility Safety Apparel and Accessories*, and ANSI/ISEA 207, *High Visibility Public Safety Vests*). 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.

Δ Table A.4.3.4(k) Optional CBRN Protective Ensemble Test Matrix

	MIST	Overall Liquid Penetration	Chemical Permeation Resistance	Burst Strength	Puncture Propagation Tear (PPT) Resistance	Cold Temperature Performance	Cut Resistance	Puncture Resistance	Abrasion Resistance
Test Material or Component*	**8.66**	**8.48**	**8.67**	**8.13**	**8.68**	**8.69**	**8.22**	**8.20**	**8.70**
Overall ensemble	X	X							
CBRN barrier layer			X						
External CBRN barrier layer (garment)				X	X	X			
External CBRN barrier layer (glove)							X	X	
External CBRN barrier layer (footwear)							X	X	X

*Each ensemble element must meet the requirements for both ensemble and the respective ensemble as a prerequisite for applying the CBRN protection option.

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.6.2.3 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.6.2.4 It is recommended that the trim on trousers be positioned at least 75 mm (3 in.) above the leg hem.

N A.6.4.8 Examples of items that might be installed or attached include, but are not limited to, the following:

(1) Front holders for helmet identification shields
(2) Supplemental faceshields
(3) Other eye/face protection where goggles are provided with the helmet as the required faceshield/goggle component identified in 6.5.2

A.6.5.2 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, and coverings for the component(s) that are inherently resistant to the fire fighting environment. Fire departments should consider the health risks associated with contaminated goggles coming in direct contact with the wearer's face. Goggles do not have to be attached to the helmet.

N A.6.7.3.5 The procedures for the measurement of wrist crease are shown in the Figure A.6.7.3.5(a) through Figure A.6.7.3.5(d).

N A.6.7.3.5(4) The measurements given in 6.7.3.5(4)(a) through 6.7.3.5(4)(d) are palm lengths and were determined using historical anthropometric data that related digit length to glove length for various sized gloves.

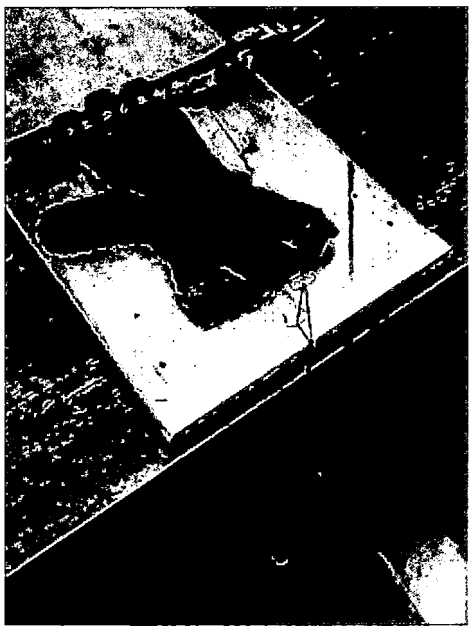


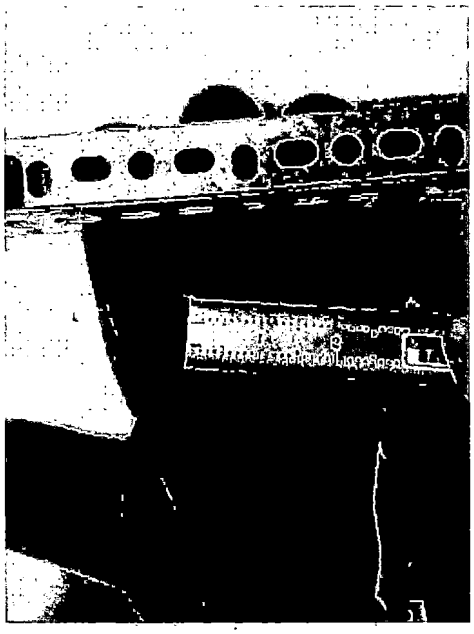
FIGURE A.6.7.3.5(a) Glove on Measurement Board with Attached Weight.

N A.6.7.5 Manufacturers can provide upon request a size chart for each model or style of glove based on hand breadth and index finger length as measured on a Brannock-style measuring device.

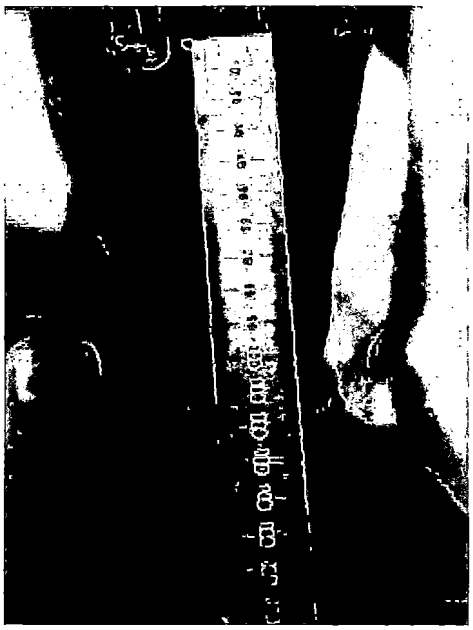
N A.6.7.6 The proposed sizing system requires D2 index finger lengths for each size. The data in Table A.6.7.6 from "Hand Anthropometry of U.S. Army Personnel" (Greiner 1991) is provided as guidance for the other fingers.

After selecting a size from 6.7.6, the ratios in Table A.6.7.6 can be used for guidance for the other finger lengths. Refer to the original study (Greiner 1991) for a complete discussion on the variance for each of these measurements.

Δ A.6.7.7 The values contained in Figure 6.7.6.1 are bare-hand dimensions, not glove pattern dimensions. Guidelines for



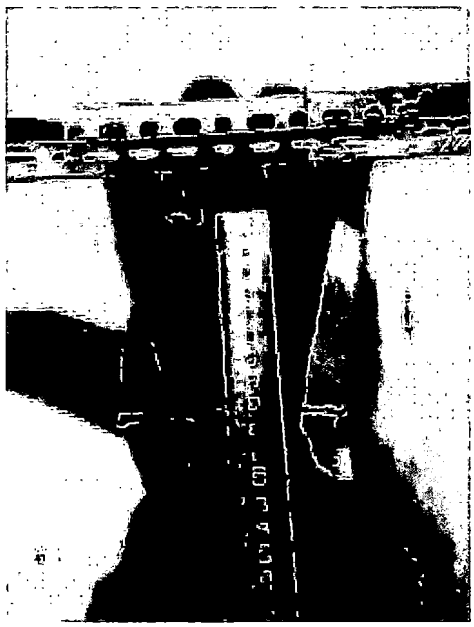
Δ FIGURE A.6.7.3.5(b) Determining the Location for the Bottom of Digit Three.



Δ FIGURE A.6.7.3.5(c) Marking the End Point of the Added Dimension.

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.

A.6.13.6.3 Invalidation of the NIOSH certification might occur as the result of modifications to the respirator by the attachment of additional parts or interface components, or



Δ FIGURE A.6.7.3.5(d) Line Drawn Marking the Wrist Crease.

through modification of the respirator configuration in order for the respirator to be donned with the ensemble. This requirement is not intended to affect common industry practices for the integration of respirators with protective ensembles such as through the use of a soft, flexible gasket material on the hood of a protective ensemble that provides a circumferential seal around the respirator facepiece.

A.6.16.2 See A.6.1.9.2.

Δ **A.7.1.1** Thermal protective performance (TPP) is a measure of the thermal insulation provided by the garment composite: outer shell, moisture barrier, and thermal barrier. The test uses an exposure heat flux representative of the thermal energy present in a flashover.

A 6 in. square specimen of the composite is placed in a holder that suspends the specimen horizontally over the heat source. The heat source consists of two Meker burners and a radiant panel that are adjusted to provide a 50/50 balance of convective and radiant energy at a heat flux of 2 calories/cm^2/sec.

The outer shell of the sample composite is positioned to face the heat source. A weighted sensor containing a copper calorimeter is placed on top of the specimen, on the facecloth of the thermal barrier. A water-cooled shutter between the specimen and heat source is withdrawn to begin the exposure. The copper calorimeter, which is connected to a computer, measures the heat transfer through the specimen. The time required for enough thermal energy to transfer through the sample composite to cause a second degree burn is measured. This time is then multiplied by the exposure heat flux (2 calories) to provide a TPP rating (e.g., 20 seconds × 2 calories = a TPP rating of 40). Higher TPP ratings indicate better performance.

TPP test results have some inherent variability. In recognition of this variability, each TPP test consists of three speci-

Table A.6.7.6 Finger Sizing System

		Means		Means	
Finger		Females (mm)	Females: Ratio Compared to D2	Males (mm)	Males: Ratio Compared to D2
D1	Thumb	63.50	0.91	69.70	0.93
D2	Index	69.60	1.00	75.30	1.00
D3	Middle	77.20	1.11	83.80	1.11
D4	Ring	72.20	1.04	79.20	1.05
D5	Little	58.30	0.84	64.70	0.86

Source: Greiner, T. M., "Hand Anthropometry of U.S. Army Personnel," U.S. Army Natick Soldier Research Development and Engineering Center, 1991.

mens. The TPP rating is based on the average TPP results of the three specimens. If an individual test result for one specimen varies from the average of the three specimens by more than 8 percent ±, the results from that test set are discarded.

It should be noted that this is a harsh exposure and does not represent conditions in which fire fighters are intended to work. It measures the ability of the composite to provide a few seconds to escape from such an exposure. It should also be understood that although the heat flux used in this test is severe, this is a laboratory test and fire fighters can encounter conditions even more severe.

A.7.1.15 Fire fighters can encounter many common liquids during the normal performance of their duties, such as doing fire fighting operations. The performance requirements of 7.1.15 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.7.2.2 Total heat loss (THL) is a performance requirement for evaporative heat transfer. It measures how well the garment composite (outer shell, moisture barrier, and thermal barrier) allows heat and moisture vapor to transfer away from the wearer, thus helping to reduce heat stress.

The test consists of two parts. Part 1, "dry heat," is the insulation factor. Part 2, "wet heat," is the heat lost as moisture vapor passes through the composite. The test takes both of these parts into consideration, thus the term "total heat loss."

The test plate (sweating hot plate) represents sweating skin and the way in which sweating skin evaporates heat. The plate is heated to 35°C (95°F) (approximately skin temperature), and the test chamber temp is controlled at 25°C (77°F) . The composite is placed on the plate as it is worn, with the face cloth of the thermal barrier on the plate and the outer shell on the top or outermost layer. Moisture is delivered to the plate to simulate sweating. The test measures the amount of electricity (W/m^2) required to maintain the plate at a constant temperature. If more heat is escaping through the composite, more electricity is required to maintain the plate at a constant temperature. Higher THL ratings indicate better performance.

THL test results have some inherent variability. In recognition of this variability, each THL test consists of three specimens. The THL rating is based on the average THL results of the three specimens. If an individual test result for one specimen varies from the average of the three specimens by more than 10 percent plus or minus, the results from that test set are discarded.

It should be noted that small differences in THL might be difficult for fire fighters to distinguish in the field. It might take 20 to 25 W/m^2 or more, depending on the individual and the conditions, to be felt by the wearer.

The study the committee used to justify the implementation of the THL testing and for basing the current requirement is J.O. Stull and R. M. Duffy, "Field Evaluation of Protective Clothing Effects on Fire Fighter Physiology: Predictive Capability of the Total Heat Loss Test," *Performance of Protective Clothing: Issues and Priorities for the 21st Century*: Seventh Volume, ASTM STP 1386, C. N. Nelson and N. W. Henry, Eds., American Society for Testing and Materials, West Conshohocken, PA, 2000, pp. 481–503.

A.7.4.4(8) This requirement applies to any component that is attached to the helmet by the helmet manufacturer before shipment.

A.7.7.9 Fire fighters can encounter biohazards during the 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.

Δ **A.7.7.11** 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 7.7.11 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 Asso-

ciation 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 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 are as follows:

(1) Resistance to cut: 7.7.13
(2) Resistance to puncture: 7.7.14
(3) Resistance to heat penetration: 7.7.5, conductive heat resistance; and 7.7.1, thermal protective performance
(4) Resistance to wet heat penetration: 7.7.5, conductive heat resistance; 7.7.1, thermal protective performance; and 7.7.11, liquid penetration resistance (as recommended by the NIOSH study)
(5) Resistance to cold: 7.7.11, 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: 7.7.15
(8) Resistance to liquids: 7.7.11 (as recommended by the NIOSH study)
(9) Comfort: 7.7.15, dexterity; and 6.7.6, sizing
(10) Resistance to flame: 7.7.6
(11) Durability: No performance requirements, but durability is addressed in Section 5.4 as part of manufacturer's instructions
(12) Drying: No performance requirements, but drying is addressed in Section 5.4 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 7.7.1 and 7.7.5 (TPP and conductive heat testing) with wet gloves. The last three types of exposures are addressed in 7.7.11 (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 7.7.15 and 7.9.2 (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 7.7.11 (liquid penetration resistance) and 7.7.15 (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 7.7.11 (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.7.7.15 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

Δ **A.7.7.18** 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 7.7.11 and Section 8.27, respectively, and the performance and testing requirements for glove composite materials for biopenetration are found in 7.7.9 and Section 8.28, respectively. The whole glove performance and testing requirements of 7.7.18 and Section 8.32 use water as a convenient and repeatable medium for evaluating whole glove integrity, since the provisions of Sections 8.27 and 8.28 only allow for testing of glove composites and not the entire glove. A precedent exists in NFPA 1992 where water is used to test the integrity of the entire protective suit.

A.7.7.19 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.7.10.10 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.

•*N* **A.7.14** It is recommended that hoods certified to this optional set of requirements also be evaluated for inward particle leakage as part of full ensembles as specified in Section 8.66, Inward Particle Leakage Test, and show the absence of particulate on the heads and necks of the test subjects. It is recommended that this testing be performed without a black witness garment on the test subjects' heads during the exposure to aid in the clearer visual observation of the hood's performance and how it interfaces with other parts of the ensemble. If the objective of the testing is solely to evaluate the performance of hoods offering particulate blocking capabilities, it is further recommended that the other portions of the ensemble be blocked off with tape — such as the coat and pants front closures, coat sleeve to glove interfaces, and pant to footwear interfaces — for isolating the performance of the hood.

N **A.7.14.3** It is widely accepted that THL of hood materials will be significantly higher in the absence of a particulate blocking layer. Therefore, testing THL only on the areas of the hood composite that contain the particulate blocking layer represents the worst case.

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.

N **A.8.1.9** A test apparatus that can provide this method of wetting consists of a chamber in which a specialized nozzle directs flow downward onto a horizontally positioned specimen that is placed on a balance. An apparatus meeting the requirement in this section consists of a Plexiglas chamber with piping that supports a full cone brass misting nozzle that is positioned at a distance of 560 mm (22 in.) above a specimen on top of a balance protected in a plastic bag that uses a Plexiglas 150 mm × 150 mm (6 in. × 6 in.) square as the balance pan in lieu of the original balance pan. Pressure to the nozzle is provided by a 560 W (¾ horsepower) clear water pump with a capacity of 2.46 m^3/hr (gal/hr), a maximum pressure of 296 kPa (43 psi), and a 25 mm (1 in.) NPT outlet. A gate valve is positioned to control flow of water from a 20 L (5 gal) bucket reservoir into the pipe with a 200 mesh water filter installed prior to the nozzle. The system is also equipped with an overflow value and venturi valve to eliminate dripping from the nozzle during starting and ending of the water flow. The entire assembly is mounted to a movable cart. Specific instructions for the operation of this system are as follows:

(1) Fill the 20 L (5 gal) bucket at least one-half full of tap water *[see Figure A.8.1.9(a)]*. The bucket cannot be removed from the cart, but this can be achieved by pouring water from inside the chamber through a funnel or pumping water in from the side into the top of the bucket.
(2) Always maintain several centimeters (a few inches) of water in the bucket. If the bucket is empty, the pump will lose its prime. To reprime the pump, remove the brass screw on the prime valve located on the top/back of the pump *[see Figure A.8.1.9(b)]*. Pour water into the pump until it is full, and replace the screw.
(3) Plug the pump (black cord) into the outlet box/switch that is located underneath the front left side of the unit, as shown in Figure A.8.1.9(c).
(4) Plug the outlet box/switch (red cord) into a standard 220 volt outlet. This cord is located on the right side of the cart pictured in Figure A.8.1.9(d).
(5) Open the main flow valve fully. For the open position, the handle should be "in line" with the pipe as shown in Figure A.8.1.9(e).
(6) Attach the bottom end of the overflow tube onto the bucket as shown in Figure A.8.1.9(f) to continuously drain the water from the test apparatus back into the system.
(7) Turn the blue handle to fully open the overflow valve, as shown in Figure 8.1.9(g).
(8) Remove the blue rubber cap from the nozzle *[see Figure A.8.1.9(h)]* that is used to prevent excess water from prematurely getting on the sample.
(9) Remove the plastic and metal sections on top of the balance shown in Figure A.8.1.9(i) as these items are not needed.
(10) Place the scale in a clear plastic bag and seal. as shown in Figure A.8.1.9(j).

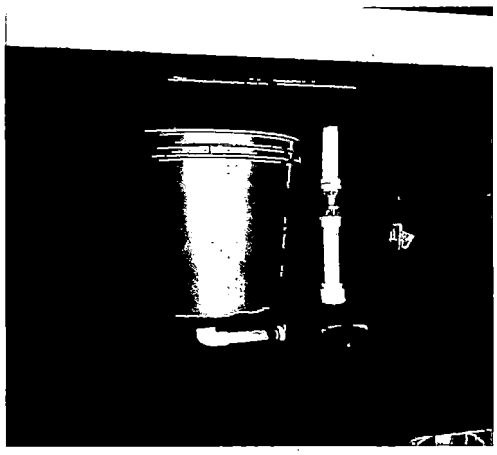
Note: The scale set on is a plexiglass elevated platform that is shown in Figure A.8.1.9(k) to allow drainage.

(11) Center the scale in the spray chamber and place a 150 mm × 150 mm (6 in. × 6 in.) Plexiglas square on top of the scale in the chamber *[see Figure A.8.1.9(l)]*.
(12) Place the sample on the Plexiglas balance pan. Turn on the scale, tare to 0.0 g, place the sample on the Plexiglas scale tray, and tare again to 0.0 g as shown in Figure A.8.1.9(m).
(13) Multiply the weight of the sample times the percent of the weight gain needs to be achieved. This will give the ending weight value to stop the timer.
(14) Close the chamber door for even air flow.
(15) Turn on the pump switch and timer until desired weight is met (calculated above).
(16) Turn off the pump switch and timer.

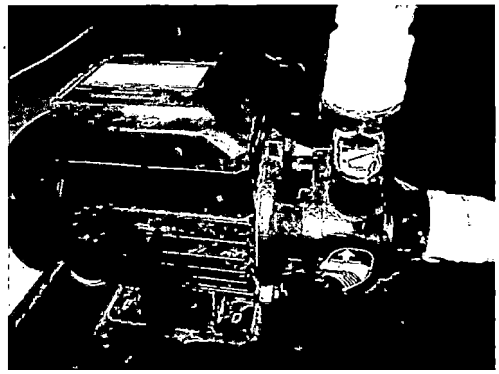
Note: Periodically the water filter should be cleaned. The water filter is located inside the black elbow on the top of the main flow pipe *[see Figure A.8.1.9(n)]*. Unscrew the top cap, remove the filter, rinse under water, and replace.

Photographs showing the front and back views of the complete test apparatus are provided in Figure A.8.1.9(o) and Figure A.8.1.9(p).

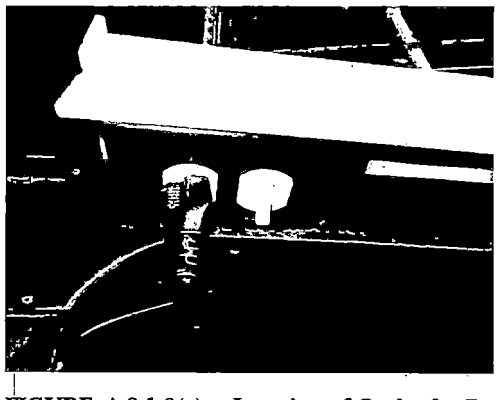
A.8.1.17 When a glove is 2 dimensional rather than 3 dimensional (the glove in Figure 8.1.17 is 3 dimensional), then the same methodology should be applied to the 2 dimensional glove. For example, if there are requirements for the sides of the fingers, then the area of the glove that would cover the sides of the fingers should be considered for these requirements even though the glove does not have forchettes.



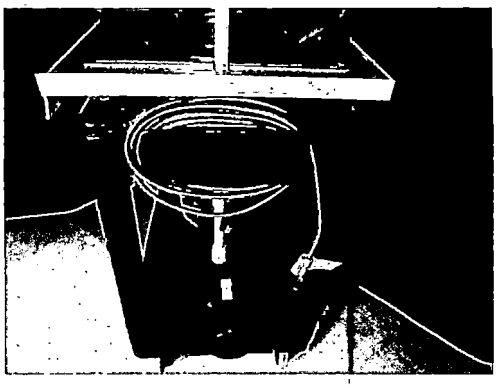
Δ FIGURE A.8.1.9(a) Fill Bucket for Test Apparatus.



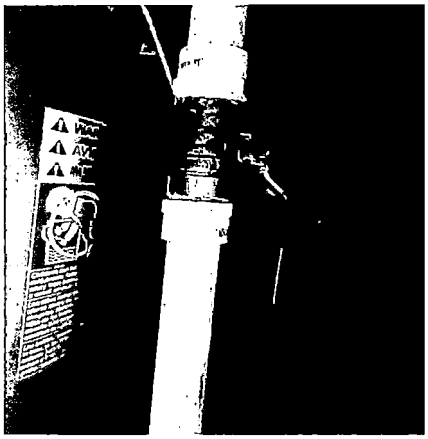
Δ FIGURE A.8.1.9(b) Test Apparatus Pump Showing Brass Screw on Prime Valve.



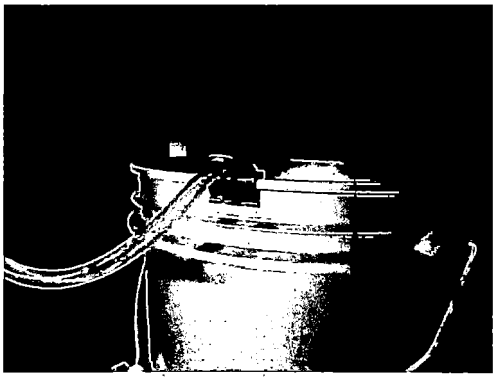
Δ FIGURE A.8.1.9(c) Location of Outlet for Pump Electrical Connection.



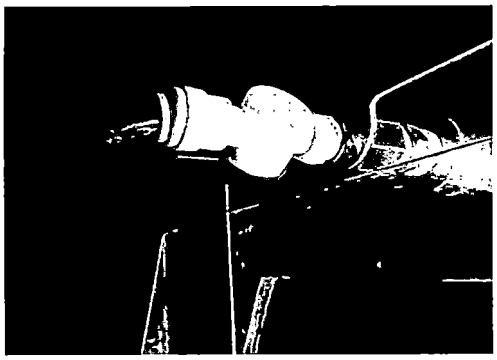
Δ FIGURE A.8.1.9(d) Location of Power Cord for Test Apparatus.



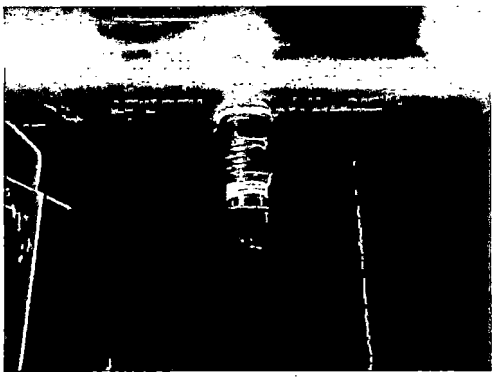
Δ FIGURE A.8.1.9(e) Location of Test Apparatus Main Flow Valve (in Open Position).



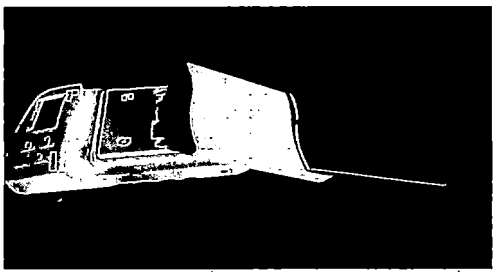
Δ FIGURE A.8.1.9(f) Overflow Tube Clamped onto Test Apparatus Bucket.



Δ FIGURE A.8.1.9(g) Test Apparatus Overflow Valve in Open Position.



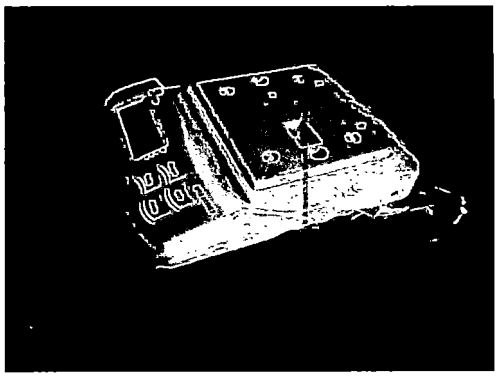
Δ FIGURE A.8.1.9(h) Rubber Cap on Test Apparatus Spray Nozzle.



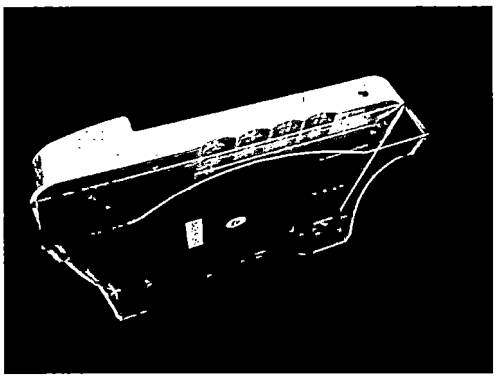
Δ FIGURE A.8.1.9(i) Tray and Pan Cover for Removal from Balance.

When wearing a correctly sized glove and laying the gloved hand completely flat on an even, flat surface, the portion of the glove that comes in contact with the even, flat surface should be considered the palm test areas of the glove. The layers immediately above the palm areas should be considered the areas next to the palm areas.

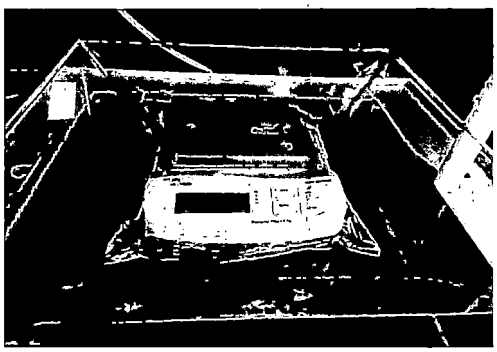
The finger sides should include the interior side areas of the small, ring, middle, and index fingers for a glove, that are hidden from sight, as observed both from the glove palm and glove back sides, when an individual wearing a correctly sized glove has his or her fingers completely closed.



Δ FIGURE A.8.1.9(j) Coverage of Scale by Plastic Bag.



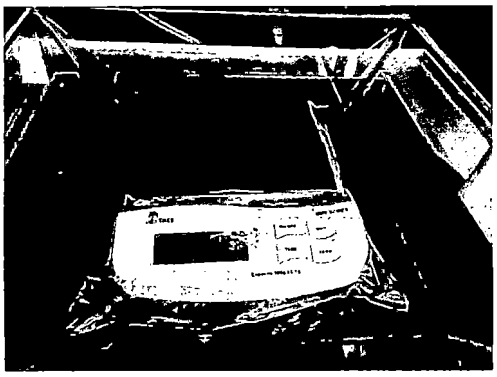
Δ FIGURE A.8.1.9(k) Plexiglas Standard Supporting Scale.



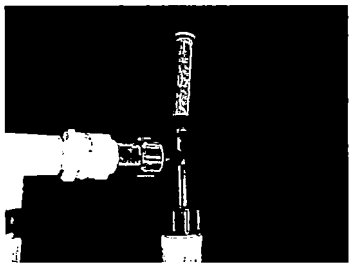
Δ FIGURE A.8.1.9(l) Scale Encapsulated in Plastic Bag and Centered in Spray Chamber.

The back area is intended to include all parts of the glove that are not defined as the palm area or the side areas. The layers immediately beneath the back areas should be considered the side areas next to the back areas.

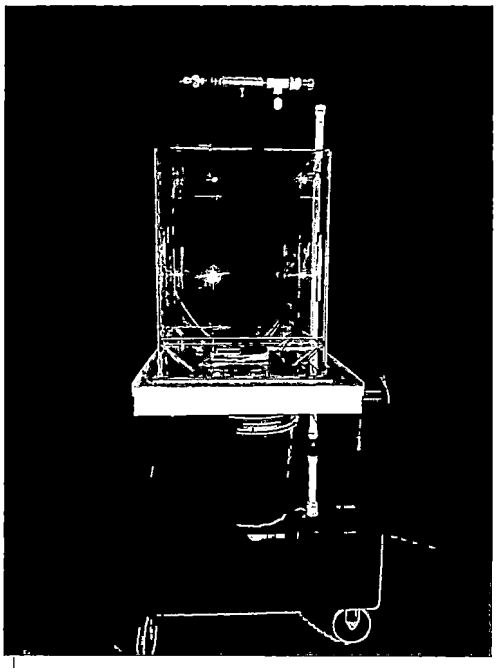
A.8.6.8.6 Where there is more than one moisture barrier layer, it is intended that only the layers between the hand and the nearest moisture barrier layer be tested. Also for this test the concern about separation is within a layer rather than between layers. Thermal protection is diminished with separation such as hole formation or consumed materials.



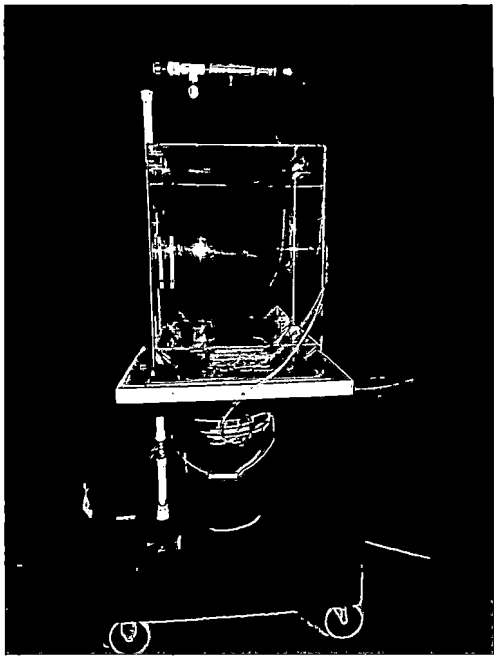
Δ FIGURE A.8.1.9(m) Sample on Scale Tared to 0.0 g.



Δ FIGURE A.8.1.9(n) Location of Test Apparatus Water Filter.



Δ FIGURE A.8.1.9(o) Front View of Wet Conditioning Test Apparatus.



Δ FIGURE A.8.1.9(p) Back View of Wet Conditioning Test Apparatus.

N **A.8.6.13.4(2)** A cotton muslin fabric has been found to be a suitable material for the construction of the lightweight bag to hold the beads.

N **A.8.6.16.13** This average should be based on a total of 12 values of percent shrinkage with 4 values per specimen.

N **A.8.6.16.14** This average should be based on a total of 9 values of percent shrinkage with 3 values per specimen.

A.8.10 The TPP test method described in Section 8.10 is intended for the measurement of structural fire-fighting protective ensemble elements and proximity fire-fighting protective ensemble elements including garment composites, hoods, shrouds, ear covers, and gloves.

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.

• *N* **A.8.10.5** These quartz lamps may be offered with a clear or frosted finish on the quartz tube. While similar, the two lamp types are known to produce different test results. To reduce variability this Standard specifies the use of only frosted type lamps. Some manufacturers may designate the frosted lamps as "transparent" or "translucent".

N **A.8.11.4** The specified procedure in ASTM D7138, *Standard Test Method to Determine Melting Temperature of Synthetic Fibers,* involves the use of differential scanning calorimetry to determine the precise melting temperature of the specimen. This procedure is in contrast to the previous method employed in NFPA 1971 (2013 edition and earlier) where a visual determination of whether thread melted at 260°C (500°F) was made.

Δ **A.8.15.4.9** *Equipment Guidelines.* The instrumentation should be allowed to warm up until it stabilizes. No simple means

exists to calibrate the impact system required by this standard. Nevertheless, calibration is necessary. The equipment should be checked for repeatability before and after each series of tests by impacting a standardized elastomeric shock pad. A minimum of three such impacts are recorded before and after testing. If the post-test average readings of the three impacts differs from the pre-test average by more than 5 percent, the entire test series is discarded.

The impact tester should have a guide rail at least 3 m (9.8 ft) in height and capable of producing impact velocities required by this standard. Test anvils, headforms, transducers, and so forth, mounted to the base should be attached so that no energy is absorbed through deflections and the base should be at least 25 mm (1.0 in.) thick steel. Guide mechanisms that slide on the rail should have recirculating ball bearings to minimize friction. The impactor guide mechanism should contain an automatic brake to prevent second impacts (bounding). A velocity detector is required to assure proper drop heights. The position of said detector should be adjustable so that the speed of impact is measured no more than 20 mm (0.79 in.) from the point of impact. A detector flat attached to the guide mechanism that passes through or by the detector should not be greater than 26 mm (1.02 in.) in height. The detector should be capable of resolving velocities of 0.01 millisecond increments. Magnetic detector systems can also be used if equivalency is established. An electronic timer is used to determine the speed at which the flag traverses the detector. The load cell should conform to the following characteristics:

(1) Size: 75 mm (3.0 in.) diameter min
(2) Measuring range: 0–5000 N (0–1124 lbf) min
(3) Resolution: 45 N (10.1 lbf) max
(4) Accuracy, linearity: ±2.5% full-scale max
(5) Rigidity: 4.5×10^9 N/m (2.6×10^7 lbf/in.) min
(6) Transverse sensitivity: 3.0% max

The load cell/headform mounting system should not have a resonant frequency less than 5 kHz, and the frequency response of the system should be in compliance with SAE Recommended Practice J211b, *Channel Class 1000.*

It is recommended that the load cell output be recorded with a storage oscilloscope, transient recorder, or similar device designed to store maximum readings. However, maximum for readings can be obtained using a peak-indicating meter designed to store only a maximum reading. The frequency response of peak-indicating meters should at least meet the requirements of SAE Recommended Practice J211b, *Channel Class 1000.* Resolution should be 45 N (10.1 lbf) max with rise time capability less than 0.01 milliseconds.

Calibration. Strain gauge-type load cells can generally be calibrated statically by applying a known dead weight to the top of the load cell and checking the output signal. This works well with an oscilloscope or voltmeter. However, transient vibrations tend to create a problem when using peak-indicating meters, and thus the load must be applied and/or removed with extreme care. Furthermore, static calibration does not take into account the dynamic response of the measuring system. Dynamic calibration is recommended but requires a calibrated reference accelerometer and a calibrating medium (shock pad). The reference accelerometer should have the following characteristics:

(1) Measuring range: 0–400 Gs min
(2) Resolution: 1.0 G max
(3) Accuracy, linearity: 1.0% full-scale max
(4) Transverse sensitivity 3.0% max
(5) Resonant frequency: 20 kHz min
(6) Frequency response: ±0.5 db @ 0.1 hz–2.0 kHz
(7) Repeatability/stability: 1.0% full-scale max

The calibrating medium should have the following characteristics:

(1) Material: Elastomer (high resilience and low hysteresis)
(2) Durometer: 50–60 Shore A
(3) Thickness: 25 mm (1.0 in.) min
(4) Size: 100 m (4.0 in.) diameter min

The accelerometer is mounted on top of the 3.6 kg (8.0 lb) impactor along its vertical axis (±2.5 degrees of true vertical) according to the manufacturer's instructions. A dual channel storage oscilloscope is recommended for making simultaneous records of both accelerometer and load cell outputs. Both accelerometer and oscilloscope should be in recent calibration.

Force Measuring System Calibration Procedure. Remove headform from load cell and mount the calibrating medium to the top of the load cell. All electronic systems should be turned on and allow to stabilize. The impactor, with accelerometer attached, should be dropped onto the calibrating medium from a height that yields a maximum acceleration reading of 100 Gs ± 10 Gs. Outputs of both accelerometer and load cell should be recorded. The two maximum values should read within 2.5 percent of each other according to $F = ma$ (Force = mass × acceleration). This degree of accuracy must be repeatable throughout at least five impacts.

Velocity Measuring System Calibration Procedure. If a simulated detector flat (ball) cannot be dropped in "free fall" from a known height through or by the detector, the velocity measuring system should be returned to the manufacturer at least every 12 months for recalibration. Otherwise, a ball of known diameter can be dropped from a known height to trigger the velocity detector. The ball must be large enough to properly trigger the detector and have enough mass to negate the effects of aerodynamic friction. The ball should be dropped from at least 1 m (3.3 ft). The actual velocity is then calculated from the following equation:

N

[A.8.15.4.9]

$$V = \sqrt{2gh}$$

where:
g = gravitational constant
h = drop height

This value is then compared to the measured velocity. Both values should agree within 1.0 percent.

System Repeatability Procedure. With the calibrating medium (shock pad) described above mounted to the top of the load cell, three consecutive drops of the impactor onto the medium should be made. The velocity of impact should be maintained at 4.0 m/sec ± 0.03 m/sec (13.1 ft/sec ± 0.1 ft/sec). The repeatability value should be the average of the three maximum transmitted force readings. However, the total range for the three values should not exceed 5.0 percent of the average value.

A.8.16.4.8 The instrumentation should be allowed to warm up until it stabilizes. No simple means exists to calibrate the

impact system required by this standard. Nevertheless, calibration is necessary.

The equipment should be checked for repeatability before and after each series of tests by impacting a standardized elastomeric shock pad as specified in A.8.15.4.9. A minimum of three such impacts should be recorded before and after testing. If the post-test average readings of the three impacts differs from the pre-test average by more than 5 percent, the entire test series is discarded.

The impact tester should have a guide rail at least 2.0 m (6.6 ft) in height to produce impact velocities required for this standard.

The flat anvil should be made to be inter-changeable on the base and be attached so that no energy is absorbed through deflections and the base should be at least 25 mm (1 in.) thick steel. Guide mechanisms that slide on the rail should have recirculating ball bearings to minimize friction. A velocity detector is required to assure proper drop heights. The position of said detector should be adjustable so that the speed of impact is measured no more than 20 mm (0.79 in.) from the point of impact. A detector flag attached to the guide mechanism that passes through or by the detector should not be greater than 25 mm (1 in.) in height. The detector should be capable of having a resolution no greater than 0.01 milliseconds. The photo beam, visible, infrared, and so forth, should have emitter/receiver slots no greater than 0.05 mm (0.002 in.) running normal to the path of travel of the flag. Magnetic detector systems can also be used if equivalency is established. An electronic timer is used to determine the speed at which the flag traverses the detector. A mounting ball should be attached to the guide mechanism, in such a way as to prevent rotation. Test headforms are mounted on said ball with a clamping ring such that the headforms can be swiveled about the ball. An accelerometer should be mounted inside the ball, having its axis (or the vertical axes, in the case of a triaxial accelerometer) within 2.5 degrees of vertical alignment.

The accelerometer should conform to the following characteristics:

(1) Shape: Cubic, with flat sides
(2) Size: 25 mm (1.0 in.) max dimensions
(3) Measuring range: 0–500 Gs min
(4) Resolution: 1.0 G max
(5) Accuracy, linearity: 1.0% full-scale max
(6) Transverse sensitivity: 5.0% max
(7) Resonant frequency: 20 kHz min
(8) Frequency response: ±5 db @ 0.1 Hz-2 kHz
(9) Repeatability/stability: 1.0% full-scale max

The frequency response of the system should be in compliance with SAE Recommended Practice J211b, *Channel Class 1000.* Each channel resolution should be 1.0 G max with rise time capability less than 0.01 mili-seconds.

Calibration. While there are several acceptable methods of accelerometer calibration, one method can be performed using the fixture specified in A.8.15.4.9 for dynamic calibration. In this case, however, the calibrated reference accelerometer and the test accelerometer should be fixed in "piggyback" fashion, one on top of the other. The cubic shaped test accelerometer lends itself well to this procedure. The axis should be in vertical alignment with the axis of the reference accelerometer and the vertical axis of the impactor. Practice has demonstrated that thin, "double stick" tape can be used to fixture the accelerometers one on top of the other. This assumes that the flat surface of the accelerometers in contact with the tape is at least 50 mm^2 (2.0 $in.^2$) and that the cables are properly tied down and held in place.

Acceleration Measuring Procedure for Test Accelerometer. Remove the test accelerometer from the mounting ball. Mount this unit on the impactor, then mount the calibrated reference accelerometer on top of the test accelerometer. Mount the calibrating medium as specified in A.8.15.4.9. All electronic systems should be turned on and allowed to stabilize. The impactor with accelerometers attached should be dropped onto the calibrating medium from a height that yields a maximum acceleration, as indicated by the reference accelerometer of 200 G ± 20 G. The vertical axis outputs of both accelerometers should be recorded. The two maximum values should read within 2 percent of each other. This degree of accuracy should be repeatable through at least five impacts.

(Alternate) Acceleration Measuring System Dynamic Calibration Procedure. Mount the calibrating medium on top of the load cell and install the load cell in place of the test anvil. All electronic systems should be turned on and allowed to stabilize. Position the headform inverted with the basic plane horizontal. The headform with accelerometer installed should be dropped onto the calibrating medium from a height which yields a maximum acceleration reading of 300 ± 20 Gs. Outputs of both accelerometer and load cell should be recorded. The two maximum values should read within 2.5 percent of each other according to $F = ma$ (Force = mass × acceleration). This degree of accuracy shall be repeatable through at least five impacts.

Velocity Measuring System Calibration Procedure. For checking the calibration of velocity detectors, see A.8.15.4.9.

System Repeatability Procedure. Mount the calibrating medium (shock pad) described in A.8.15.4.9 onto the test base in place of the test anvil(s). Position the headform inverted, with the basic plane horizontal. With the accelerometer connected to the recording/computing instrumentation, three consecutive drops of the headform onto the medium should be made. The velocity of the impact should be maintained at 3.0 m/sec ± 0.03 m/sec (9.8 ft/sec ± 0.1 ft/sec). For each drop a maximum G value should be recorded. The repeatability value should be the average of the three measurements. However, the total range for all three values should not exceed 5.0 percent of the average value.

A.8.16.5.9 The test anvil should not be moved from its alignment as specified in 8.16.4.4, except in those circumstances where contact of the brim will first occur for the helmet brim. Every effort should be made to maintain the alignment specified in 8.16.4.4, since significant deviations of this alignment will result in erroneous accelerations measurements.

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.

N **A.8.24.9.9** This average should be based on a total of 12 values of percent shrinkage with 4 values per specimen.

N **A.8.24.9.10** This average should be based on a total of 9 values of percent shrinkage with 3 values per specimen.

N **A.8.27.4.2** The list of common fireground chemicals is intended to provide a number of substances to which fire fighters might be exposed during ordinary fireground and other emergency operations. It is not intended to be an all-inclusive list of hazardous liquids to which fire fighters might be exposed while wearing protective clothing.

In 2015, the list was reviewed by a task group of the NFPA Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment. The investigation involved a review of information indicating differences in the effect of hydraulic fluid on moisture barrier materials; an examination of the types of hydraulic fluids used throughout industry, including those in fire service tools; and a detailed survey with more than 1500 responses that addressed fire service member exposure to different liquids on the fireground, including hydraulic fluid. These findings, including the survey results, are captured in supplemental material that was made available to NFPA. As a result of this investigation, it was concluded that different types of fire-resistant hydraulic fluid are still in use throughout a variety of industries, and that some of these hydraulic fluids contain low molecular weight phosphate esters. It was further concluded that most gasoline contains ethanol, and that antifreeze fluid, which predominantly contains ethylene glycol, is frequently encountered and should be added to the list of the original five fireground liquid chemicals.

The list of chemicals is used in the evaluation of the liquid penetration resistance of moisture barriers provided in structural and proximity fire-fighting protective ensemble elements with the objective that moisture barrier materials and seams should not allow the penetration of these liquids through the element onto the fire fighter's skin. This penetration might occur as the result of the liquid causing degradation of the moisture barrier material or seam. In some cases, such as in glove and footwear elements, it might not be possible to inspect the moisture barrier.

A.8.32.4.1 The water markable glove should be thin, snug fitting, and show liquid contact easily, and the fabric should not have any surface treatment.

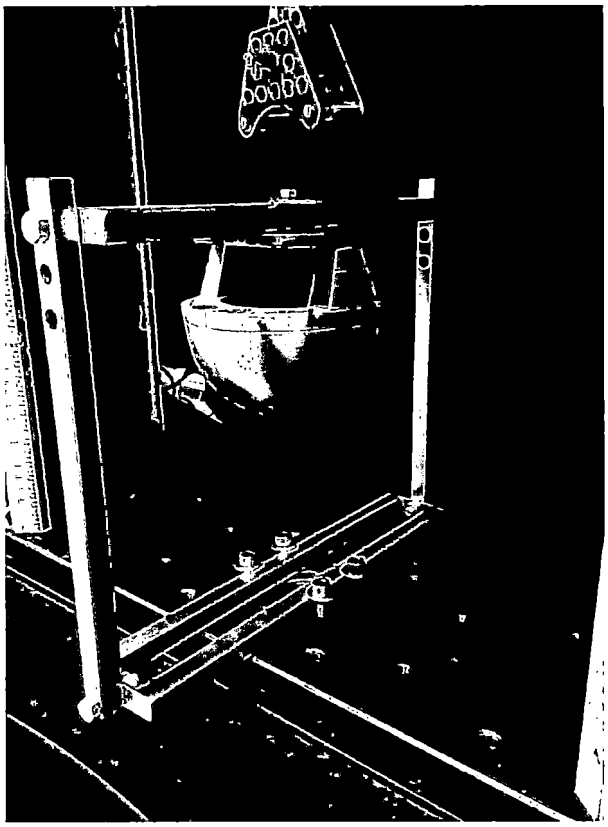
A.8.33 Copies of an IAFF report can be obtained from the International Association of Fire Fighters Department of Health and Safety, 1750 New York Avenue, NW, Suite 300, Washington, DC 20006-5395.

Copies of an NFPRF report can be obtained from the National Fire Protection Research Foundation, 1 Batterymarch Park, Quincy, MA 02169–7471.

A.8.33.5 These modifications should be used instead of Note 6 in ASTM F1868, Part C.

N **A.8.34.4.2** Figure A.8.34.4.2 represents an example of an appropriate retention test fixture. Other appropriate test fixtures might be used.

A.8.34.5.4 The retention system test is measuring vertical movement. When applying the load, the helmet could shift from its original horizontal plane position. If this occurs, the helmet should be secured in such a manner that the horizontal plane position is maintained, but the vertical movement is not influenced. For example, this could be accomplished with a securing mechanism for the brim that moves vertically with the helmet.



Δ **FIGURE A.8.34.4.2 Retention Test Fixture.**

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N **A.8.43.4.1** Figure A.8.43.4.1(a), Figure A.8.43.4.1(b), and Figure A.8.43.4.1(c) represent one complete test, not multiple examples of one test. Other appropriate test fixtures might be used.

A.8.44.5 The Gardner pivotal sphere haze meter is described in ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.*

A.8.48.5(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.8.48.7 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.

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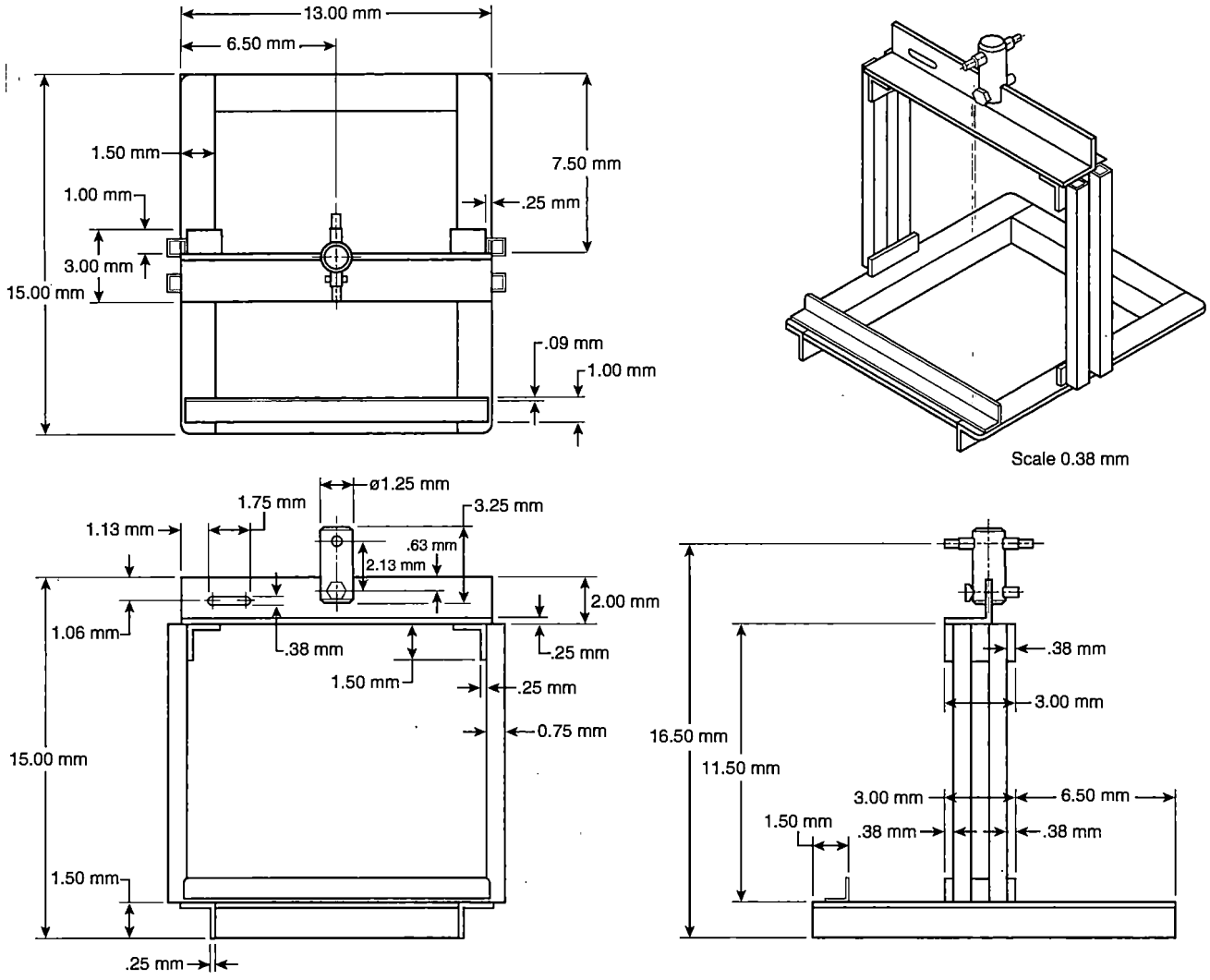
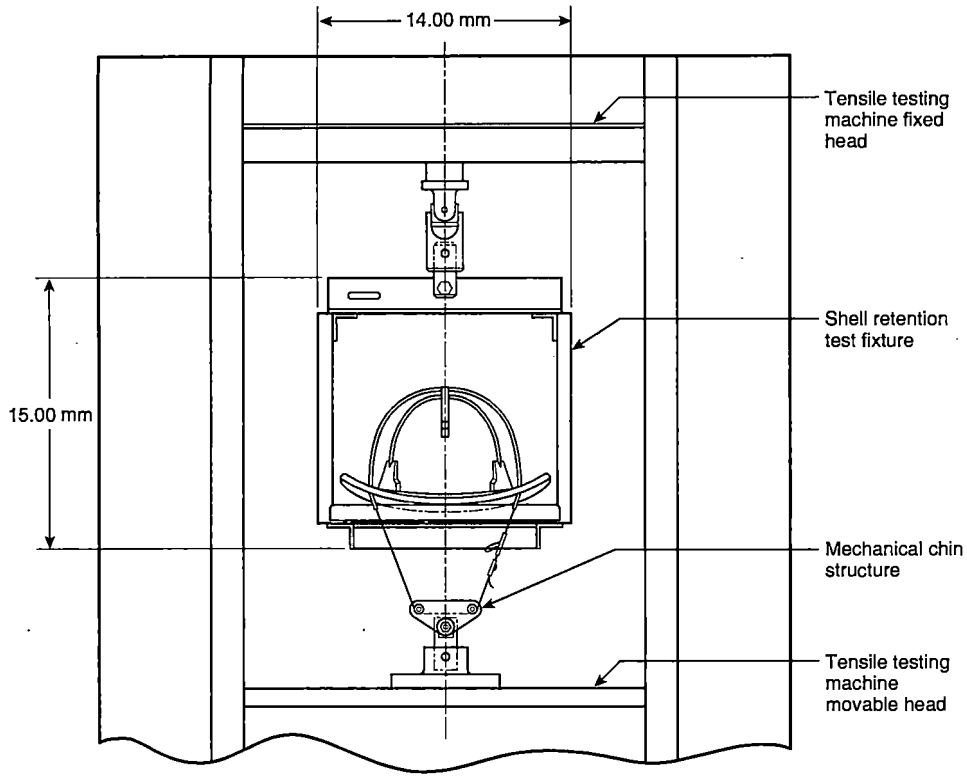
N **A.8.66.4.8** The super-high-intensity lamp, model SB-100P with flood bulb from Spectroline®, or equivalent, has been found suitable for use to meet the black light specifications.



For U.S. units, 1 mm = 0.0394 in.

Δ **FIGURE A.8.43.4.1(a) Shell Retention Test Fixture.**



For U.S. units, 1 mm = 0.0394 in.

Δ **FIGURE A.8.43.4.1(b) Shell Retention Test Setup 1.**

N **A.8.66.5.3** Areas of the indicator garment are masked to provide an additional means of evaluating leakage. The removal of the masked areas following testing allows for uncontaminated areas for comparison purposes. Using inappropriate materials for masking can affect the indicator garment by tearing, leaving residue, skewing black light visual analysis, and so forth.

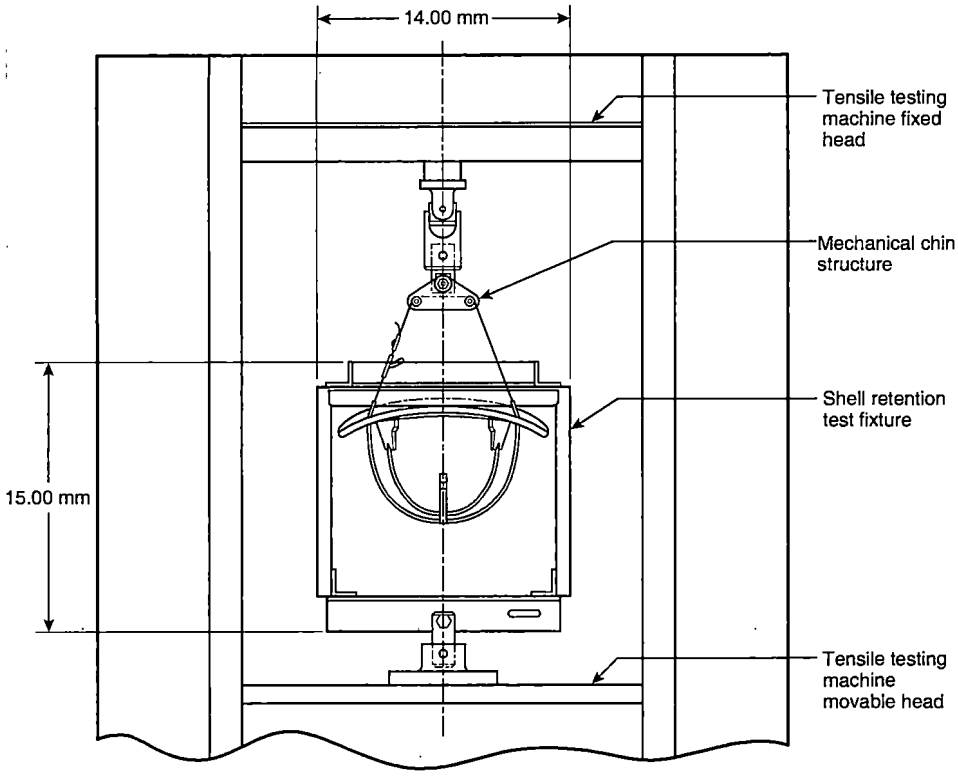
N **A.8.66.5.12** The super-high-intensity lamp model SB-100P with flood bulb from Spectroline®, or equivalent, has been found suitable for use to meet the black light specifications.

N **A.8.71.2.3** A reference sample is tested to confirm the equipment is functioning in the appropriate range prior to the commencement of a series of testing or when the test equipment is modified or repaired.

N **A.8.71.5.2** The slurry of suspended latex spheres with a particle size range of 0.1 μ to 1.0 μ in water can be made by diluting the uniform latex spheres at a ratio of 1000 to 1 in 1 liter of 0.05 μ deionized filtered water. The nominal particle sizes employed must fall within the midpoint or lower of the particle size channel range. For example, if the particle size range is 0.1 μ to 0.15 μ, the nominal particle size should not be greater than 0.125 μ.

The following references cite that fire ground particles are within the specified range:

Fabian, T., et al., *Firefighter Exposure to Smoke Particulates*, DHS AFG Grant #EMW-2007-FP-02093, Project Number: 08CA31673, 2010.



For U.S. units, 1 mm = 0.0394 in.

Δ **FIGURE A.8.43.4.1(c) Shell Retention Test Setup 2.**

Kleeman, M., et al., "Size and Composition Distribution of Fine Particulate Matter Emitted from Wood Burning, Meat Charbroiling, and Cigarettes," *Environ. Sci. Technol* Vol. 33, pp. 3516–3523, 1999.

Koseki, H., "Large Scale Pool Fires, Results of Recent Experiments," *Fire Safety Science,* Proceedings of the Sixth International Symposium, pp. 115–132.

Nowlen, S., "A Review of Research at Sandia National Laboratories Associated with the Problem of Smoke Corrosivity," *Fire Safety Journal,* Vol. 15, Issue 5, 1989, pp. 403–413.

Rau, J., "Composition and Size Distribution of Residential Wood Smoke Particles," *Aerosol Science and Technology,* Vol. 10, pp. 181–192, 1989.

N Annex B Description of Performance Requirements and Test Methods

This annex is not a part of the recommendations of this NFPA document but is included for informational purposes only.

N **B.1 Overview.** Annex B is intended to serve as a guide for both experienced and rookie fire fighters who want to better understand the performance requirements (tests) of the structural fire-fighting gear they wear and to develop a basic understanding of the minimum test requirements for the structural fire fighting gear described in Chapter 7 of the 2018 edition of NFPA 1971.

This annex will also help the reader gain a clearer understanding of the limits of the protective ensemble. However, Annex B only addresses performance requirements and test methods for protective elements (garments, helmets, gloves, footwear, and hoods) used for structural firefighting. Descriptions for specific performance requirements and test methods for proximity fire fighting elements will be addressed in a future edition.

Interpretations of tests, test methods, or test results will not be found here. Instead, Annex B provides background information and explains performance requirements and test methods in layman's terms. Fire department equipment officers, safety officers, purchasing agents, members of the selection committee, and end users/wearers will also find this information helpful.

The tests required by NFPA 1971 do not guarantee that the ensemble or ensemble element will not fail in the field. The tests evaluate representative samples of the protective ensemble elements, or materials used in their construction to determine whether the element will pass defined minimum performance requirements under controlled test conditions. These tests cannot be performed in the field — they must be performed by the qualified laboratory of an accredited certification organization.

Annex B also gives a brief description of the required NFPA tests performed by the certification organization (chosen by the manufacturer) on the five elements of the structural firefighting ensemble — protective garment (the coat and pants,

outer shell/moisture barrier/thermal liner), protective helmets, protective gloves, protective footwear, and protective hoods — with a section and corresponding table for each element.

The Test Method column in each table shows the number and name of the section in the standard that is described; the Test Method Description column provides an overview of the test, which indicates what is tested and, in general, how it is tested; and the Test Method Application column explains why the test method is specified and how the method is used to assess the performance of fire fighter protective clothing.

Some tests evaluate a representative piece or sample of the element while other tests evaluate the whole element as specified in the table. In general, tests are conducted on multiple specimens, not just one specimen. Tests are designed by experts familiar with fire-fighting field conditions. They are evaluated by fire fighters on the NFPA 1971 committee before they are put in the standard to ensure the performance requirements translate to an appropriate minimum level of protection.

Throughout the document, references are made to specimens being tested "as received" and "after conditioning." Specific descriptions and instructions for each type of conditioning can be found in Chapter 8, along with the test method details.

In general, however, the term *as received* means the specimens tested are new, out-of-the-box samples that have not been laundered or subjected to other environmental conditioning; "conditioning" generally refers both to laundering the samples and to exposing the samples to specific environmental conditions. Again, all the specific details for sample treatment can be found in Chapter 8.

To ensure environmental consistency prior to testing, the as-received samples are conditioned in an environmental chamber for 24 hours at 21°C ± 2.8°C (70°F ± 5°F) and 65 percent ± 5 percent humidity. The specific procedure used to condition samples to these parameters is found in ASTM D1776/D1776M, *Standard Practice for Conditioning and Testing Textiles.* As outlined in specific tests, elements might also require conditioning by one or more of the following procedures before testing can proceed:

(1) Washing and drying procedures (AATCC 135, *Dimensional Changes of Fabrics after Home Laundering*)
(2) Low temperature environmental conditioning
(3) Convective heat conditioning
(4) Radiant and convective heat conditioning
(5) Wet conditioning

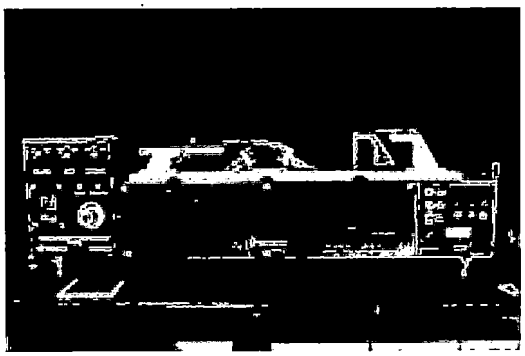
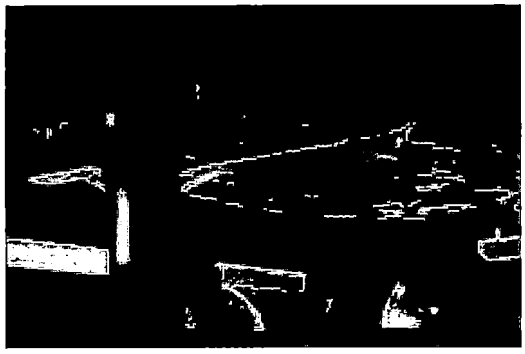
The Test Method Description column in the tables references specific test methods from other standards organizations such as ASTM or ISO. In these instances, some details found in the referenced test method, but not in NFPA 1971, are described for the respective test method. This information includes specific details that are key to understanding the test method in the context of how it might relate to what is experienced in the field and, therefore, is included in this annex.

Fire fighters face many hazards that manufacturers of personal protective equipment attempt to mitigate. The minimum performance requirements that protective ensemble elements have to meet are included in the 2018 edition of NFPA 1971. Certification organizations and their laboratories perform these tests and determine whether or not the samples provided pass the tests. Compliance for a particular product is indicated by the certification mark on the product label that is permanently attached to the coat and pants, helmet, gloves, footwear, or hood. The certification mark means representative samples have passed rigorous tests and are compliant with the 2018 edition of NFPA 1971. If the certification organization mark is not on the label, the equipment is neither NFPA-compliant nor third-party certified and should not be used.

N B.2 Garments. Table B.2 is intended to serve as an abbreviated guide to specified tests that apply to garments, including the outer shell, the moisture barrier, the thermal barrier, garment hardware, and materials used in the construction of the garment. These tests evaluate whether or not the garment meets the minimum performance requirements of the 2018 edition of NFPA 1971. They do not guarantee the safety of the fire fighter or ensure the fire fighter will not experience injury while wearing the garment.

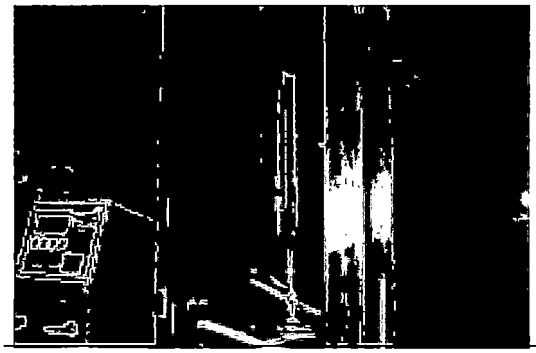
N B.3 Helmets. Table B.3 is intended to serve as an abbreviated guide to specified tests for helmets, including the whole helmet, the helmet ear cover, materials used in the construction of the whole helmet, the faceshield, and goggle components. The tests evaluate whether or not the helmet meets the minimum performance requirements of the 2018 edition of NFPA 1971. They do not guarantee the safety of the fire fighter or ensure the fire fighter will not experience injury while wearing the helmet.

N Table B.2 Garments

Test Method	Test Method Description	Test Method Application
7.1.1 Thermal Protective Performance (TPP) Test	This test is performed in accordance with ISO 17492, *Clothing for protection against heat and flame — Determination of heat transmission on exposure to both flame and radiant heat*, on three specimens/samples of the three-layer garment composite, which are tested both as received and after conditioning with five laundering cycles. Specimens comprise the outer shell, thermal liner, and moisture barrier and are layered and tested in the order in which they are worn. The outer shell exterior is exposed to both radiant and convective heat sources.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the three-layer system by evaluating how quickly heat is transferred from the outside of the garment to the inside.
 **TPP Test Apparatus.**		
 **TPP Test Being Run.**		
	The rate of temperature rise is recorded and compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the Thermal Protective Performance (TPP) rating.	Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn.

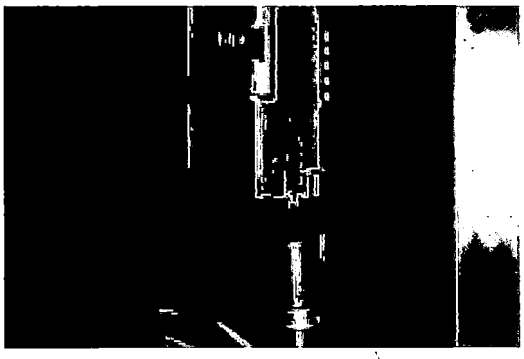
(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
	The TPP rating of the garment must be at least 35.	This is the primary test to measure the garment's ability to protect the fire fighter from severe heat and flame. The higher the number, the higher the protection from heat (under the specific test conditions), and, in general, the higher the heat stress on the fire fighter. Fire fighters should always consider the TPP rating as it relates to the Total Heat Loss (THL) rating.
7.1.2 Whole Garment and Ensemble Liquid Penetration Test (Shower Test)	This test is performed in accordance with ASTM F1359/F1359M, *Standard Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, on a full garment set (coat and pants) or coveralls. The whole garment is placed on a manikin dressed in a water-absorptive layer and exposed to 2.5 minutes of liquid spray from four different orientations for a total of 10 minutes. After removal of the garment, the water-absorptive layer is examined for evidence of moisture penetration.	The Shower Test is used to evaluate how well the seams and closures of the garment, under controlled test conditions, resist inward leakage of liquids from exterior sources. Note: The Shower Test is the *only* test performed on assembled garments — coats and pants.
7.1.3 Flame Resistance Test 1	This test is performed in accordance with ASTM D6413/D6413M, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, as received and after conditioning with five laundering cycles on garment components (hook and pile, elastic, and labels can be excluded from the test depending on their location in the garment).	The Flame Resistance Test 1 is used to evaluate the material, under controlled test conditions, for its ability to self-extinguish after the flame is removed. The char length of the material after exposure to flame is also measured.
	**Test Apparatus in Ready Position.**	

(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
	**Flame Test Being Performed.**	
	Each separable layer of multilayer composites is tested individually. The specimen is suspended over a flame for 12 seconds to determine how easily the material ignites. Ease of ignition and charring characteristics are observed and recorded. Materials cannot char more than 100 mm (4 in.), cannot show afterflame 2 seconds after removal of the test flame, and cannot melt.	This is the primary test to establish the flame-resistant properties of the materials used in garment construction.
7.1.4 Heat and Thermal Shrinkage Resistance Test (shrinkage)	This test is performed as received and after conditioning with five laundering cycles. Outer shells, moisture barriers, thermal barriers, collar linings, and winter liners (where provided) are tested individually. Fabric samples are marked and measured before exposure to 5 minutes of heat in a 260°C (500°F) oven. Post-exposure measurements are taken and averaged, and no more than 10 percent shrinkage is permitted.	The Heat and Thermal Shrinkage Resistance Test is used to evaluate the materials for shrinkage after exposure to high temperatures. Excessive shrinkage could compromise the fire fighter's mobility and impact the insulating qualities of the garment.
7.1.5 Heat and Thermal Shrinkage Resistance Test (melting, separation, ignition)	This test is performed as received and after conditioning with five laundering cycles on garment components, except for hook and loop and elastic, when placed where they will not contact the fire fighter's body. Samples are suspended in a 260°C (500°F) oven for 5 minutes. Garment components cannot melt, drip, separate, or ignite.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to determine whether or not components used to construct protective garments will melt, separate, or easily ignite. The test conditions are not intended to simulate actual fireground exposures but rather serve as a means to establish a minimum level of thermal stability for the materials used in the construction of protective clothing elements.

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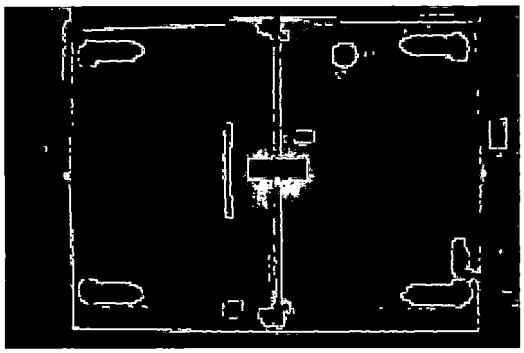
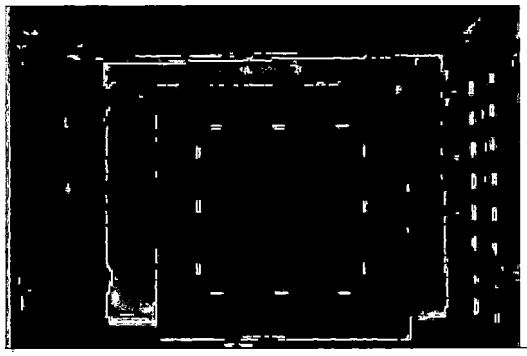
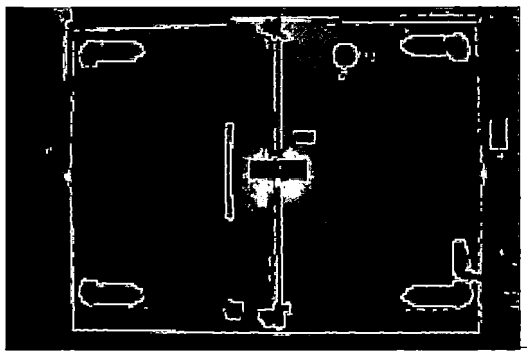
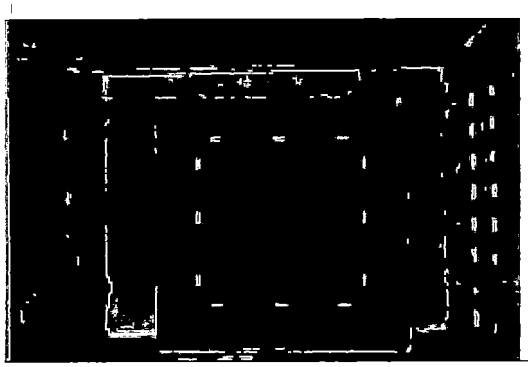
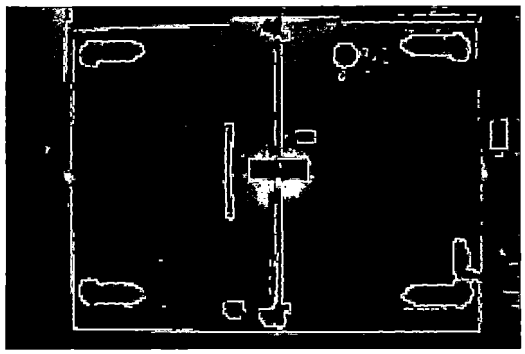
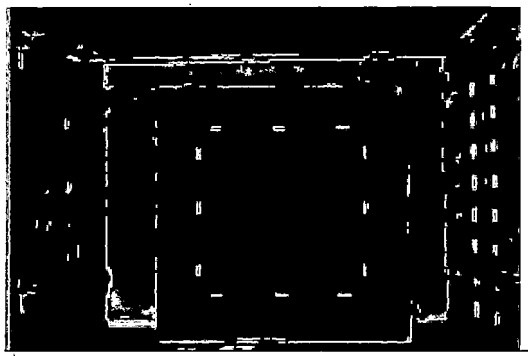
N Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
 **Oven Exterior.**		
 **Oven Interior.**		
7.1.6 Heat and Thermal Shrinkage Resistance Test (moisture barrier seams)	This test is performed as received and after conditioning with 5 laundering cycles on all moisture barrier seams. Samples are prepped and exposed to 5 minutes of heat in a 260°C (500°F) oven. Observations are limited to seam material ignition and dripping.	The Heat and Thermal Shrinkage Resistance Test is used to evaluate the ability of the moisture barrier seams to resist dripping or ignition.
 **Oven Exterior.**		

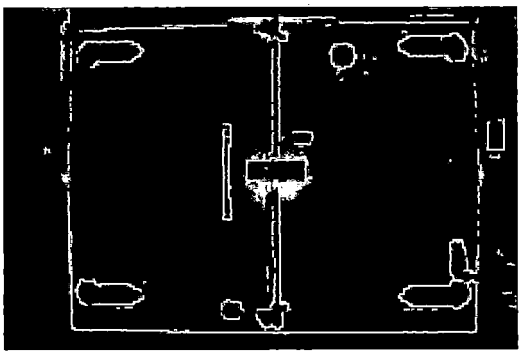
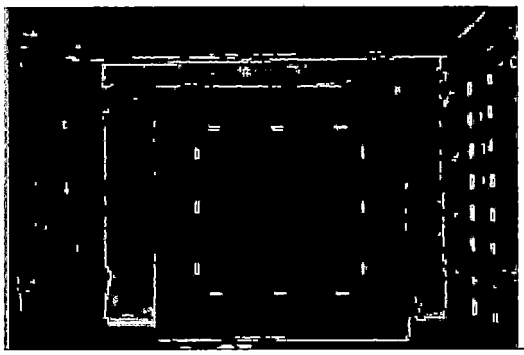
(continues)

N **Table B.2** *Continued*

Test Method	Test Method Description	Test Method Application
 **Oven Interior.**		
7.1.7 Heat and Thermal Shrinkage Resistance Test (outer shells and collar linings/char)	This test is performed as received and after conditioning outer shells and collar linings with five laundering cycles to identify charring when specimens are exposed to 5 minutes of heat in a 260°C (500°F) oven. Specimens cannot char.	The Heat and Thermal Shrinkage Resistance Test is used to evaluate whether or not the outer surfaces of the garment will char and/or break open, exposing interior layers. Charring and breaking open compromise the thermal and physical protection of the garments, which, in turn, increases the risk of fire fighter burns and injuries.
 **Oven Exterior.**		
 **Oven Interior.**		

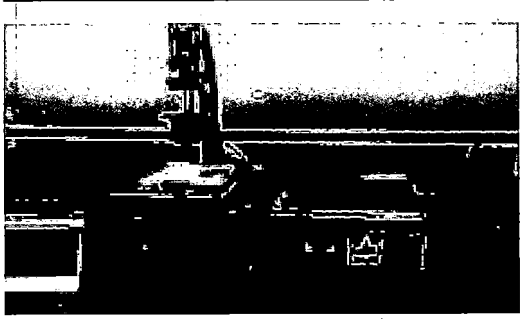
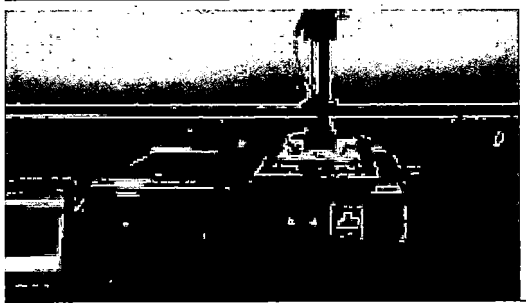
(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
7.1.8 Heat and Thermal Shrinkage Resistance Test (hardware)	This test is performed on hardware, excluding hook and pile, when they do not contact a fire fighter's body. Performance of the specimens is observed after exposure to 5 minutes of heat in a 260°C (500°F) oven.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the ability of the hardware to remain functional and resist ignition when exposed to heat. This test eliminates the use of hardware on garments that will not withstand exposure to a certain level of heat.
	**Oven Exterior.**	
	**Oven Interior.**	
7.1.9 Conductive and Compressive Heat Resistance (CCHR) Test	This test is performed on composites from the shoulder and knee areas with all layers placed in the same order as they are constructed. Sample sizes are representative of the knee and shoulder area and must be provided for each composite combination used by the garment manufacturer. Samples are tested in both the wet and dry condition under applied pressure.	The Conductive and Compressive Heat Resistance (CCHR) Test is used to evaluate the properties of the garment shoulder and knee areas, which are more likely to become compressed; thermal insulation is reduced under compression. The requirement sets a minimum number of seconds until the fire fighter would receive a second-degree burn when these areas are under compression.

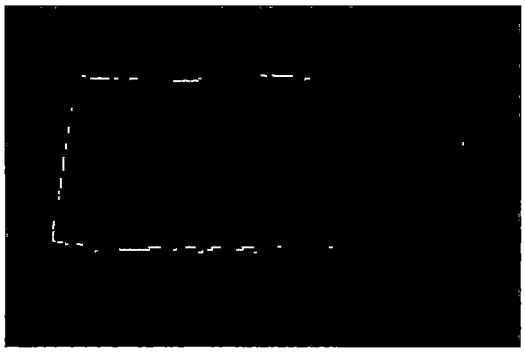
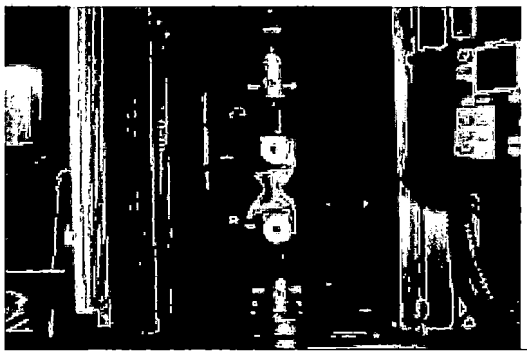
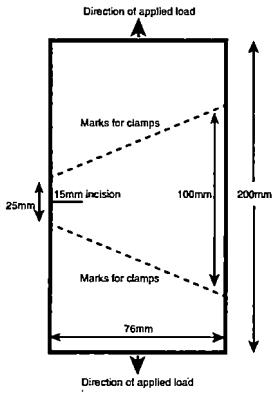
(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
	**Conductive and Compressive Heat Resistance (CCHR) Test Machine in the Ready State.**	
	**Conductive and Compressive Heat Resistance (CCHR) Test Machine in Operation.**	
7.1.10 Thread Melting Test	This test is performed in accordance with ASTM D7138, *Standard Test Method to Determine Melting Temperature of Synthetic Fibers*, on the three different specimens of sewing thread used in the construction of the garment as received. The temperature at which the thread melts or decomposes is recorded, and if it melts below 260°C (500°F), it fails.	The Thread Melting Test is used to evaluate the thread used in the construction of the garment to determine whether it has at least the same heat resistance as the fabric used in the garment's construction.
7.1.11 Tear Resistance Test (outer shells and collar linings)	This test is performed in accordance with ASTM D5587, *Standard Test Method for the Tearing of Fabrics by Trapezoid Procedure*, on outer shells and collar linings (tested individually) as received and after conditioning with five laundering cycles. The test measures the force (in pounds) needed to continue a pre-existing tear. Opposite ends of an intentionally notched, trapezoidal-shaped specimen are gripped in a machine and pulled apart until the specimen tears completely.	The Tear Resistance Test is used for this requirement to measure the ability of the outer shell fabric and collar linings to resist further tearing when a small tear occurs. Fabric tears further expose the fire fighter to the products of combustion. It also is a test of the strength and durability of the fabric. Fire fighting occurs in a harsh environment that includes many hazards that might tear a garment.

(continues)

N Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
	**Sample Marked and Pre-cut for Test.**	
	**Test Being Performed.**	
7.1.12 Tear Resistance Test (moisture barriers, thermal barriers)	This test is performed in accordance with ASTM D5587 on moisture barriers, thermal barriers, and winter liners as received and after conditioning with five laundering cycles. The test measures the force (in pounds) needed to continue a pre-existing tear. Opposite ends of an intentionally notched, trapezoidal-shaped specimen are gripped in a machine and pulled apart until the specimen tears completely.	The Tear Resistance Test is used for this requirement to measure the ability of the thermal barrier materials and the moisture barrier to resist further tearing when a small tear occurs, which further exposes the fire fighter to the products of combustion.
 Schematic of tear test template and test specimen	**Diagram of Trapezoidal Tear Test.**	

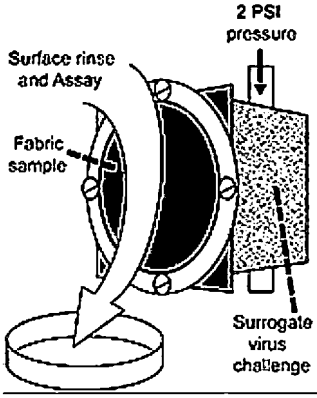
(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
7.1.13 Seam-Breaking Strength Test	This test is performed in accordance with ASTM D1683/D1683M, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, on all garment seam assemblies. Samples are tested after conditioning. Opposite ends of a 50 mm × 200 mm (2 in. × 8 in.) specimen with the seam bisecting the length are gripped in a machine and pulled apart until the specimen breaks.	The Seam-Breaking Strength Test is used to evaluate the strength of garment seams under stress. The test demonstrates the durability of the seam as an indicator of physical performance when subjected to repeated wearer movement, such as bending and stretching.
	**Seam Breaking Strength Test.**	
7.1.14 Water Penetration Resistance Test (moisture barriers)	This test is performed on specimens of garment moisture barriers as received and after conditioning. A circular portion of the moisture barrier is clamped down in a hydrostatic tester and exposed to high water pressure from underneath. The specimen is then examined for water penetration.	The Water Penetration Resistance Test is used to evaluate the ability of moisture barrier materials to keep water from getting through the barrier. The test demonstrates the capacity of the moisture barrier to keep the fire fighter dry from external pressurized water.
7.1.15 Liquid Penetration Resistance Test (moisture barrier and barrier seams)	This test is performed in accordance with ASTM F903, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, on moisture barrier fabric and seams for the garment, shroud, footwear, bootie, and glove. Specimens are conditioned for laundry and heat in specially made pockets comprised of two layers of outer shell and a layer of thermal. After conditioning specimens are placed in a test cell where the normal outer surface of the material is exposed to aqueous film-forming foam, battery acid, surrogate gasoline, fire-resistant hydraulic fluid, swimming pool chlorine, and automobile antifreeze fluid; each liquid is tested separately on an individual specimen. After 1 hour of exposure, each sample is evaluated. No liquid can penetrate any sample.	The Liquid Penetration Resistance Test is used to evaluate whether or not the garment's moisture barrier and seams resist penetration of liquids meant to be representative of those commonly encountered on the fireground.
7.1.16 Viral Penetration Resistance Test (moisture barrier and barrier seams)	This test is performed in accordance with ASTM F1671/F1671M, *Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X-174 Bacteriophage Penetration as a Test System*, on moisture barrier fabric and seams. Samples are conditioned for laundry and heat in specially made pockets comprised of two layers of outer shell and a layer of thermal barrier.	The Viral Penetration Resistance Test is used to evaluate the ability of the garment's moisture barrier fabric and seams to keep blood-borne pathogens from coming in contact with the fire fighter.

(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
	After conditioning, the specimens are then placed in a test cell where the film side is exposed to surrogate virus in a liquid solution and is evaluated for passage of virus after 1 hour. Any evidence of virus passage through the barrier fabric or seam as determined using a microbiological technique constitutes failure.	
	**Diagram of Viral Penetration Test for Moisture Barrier and Seams.**	
7.1.17 Cleaning Shrinkage Resistance Test (moisture barriers, winter liners, collar liners) *(see also 7.2.4)*	This test is performed on three conditioned specimens of garment moisture barriers, winter liners (when provided), and collar liners, each tested individually. This requirement allows no more than a 5 percent change in the width and length dimensions after five wash and dry cycles in accordance with AATCC 135, *Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics.*	The Cleaning Shrinkage Resistance Test is used to evaluate how much garment materials shrink after repeated laundering; shrinkage could decrease the fire fighter's mobility.
7.1.18 Water Absorption Resistance Test (resistance to water absorption)	This test applies to the garment outer shells and collar lining. The conditioned specimens, tested individually, are mounted on an apparatus specified in AATCC 42, *Test Method for Water Resistance: Impact Penetration Test,* and exposed to a constant flow of water to determine the level of water absorption.	The Water Absorption Resistance Test is used to determine how much water the outer shell absorbs. The requirement limits how much water can be absorbed — absorbed liquid adds weight, which increases fire fighter fatigue and decreases fire fighter mobility.
7.1.19 Corrosion Resistance Test	This test is performed in accordance with ASTM B117, *Test Method for Water Resistance: Impact Penetration Test,* to measure corrosion. Metal hardware is exposed to a saline solution spray for 20 hours following which base metal can show only slight surface corrosion and the hardware must remain functional.	The Corrosion Resistance Test is used to evaluate whether hardware will (1) corrode and (2) remain functional after extended exposure to salt spray. Hardware failure can result in loss of thermal and physical protection for the fire fighter.

(continues)

N Table B.2 ***Continued***

Test Method	Test Method Description	Test Method Application
7.1.20 Label Durability and Legibility Test 1	This test is performed on garment labels attached to sample fabric. Garment label specimens are exposed to 10 laundry cycles in accordance with AATCC 135 and then subjected to abrasion in accordance with ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Test Method).*	The Label Durability and Legibility Test is used to evaluate whether or not the label stays in place and is legible after exposure to multiple launderings, abrasion, and convective heat. The presence and legibility of labels is important for garment identification and tracking.
7.1.21 Drag Rescue Device (DRD) Materials Strength Test	This test is performed in accordance with ASTM D6775, *Standard Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material,* to measure the breaking strength of DRD materials, seams, splices, and joints. Specimens are conditioned then elongated to the point of breaking. The pounds of force needed to break each specimen is recorded and used to calculate the average breaking strength of the specimens.	The Drag Rescue Device (DRD) Materials Strength Test is used to evaluate the strength of the DRD materials, seams, splices, and joints to determine whether the specimens can withstand the force of dragging a downed fire fighter.
7.1.22 Drag Rescue Device (DRD) Function Test	This test is used to evaluate DRD functionality as it is installed in the coat or coverall. The garments and DRD, after conditioning at room temperature, are placed on a manikin with an SCBA. The DRD is deployed, and the manikin is dragged for a specified distance. The deployment time is recorded and reported, the ability to drag the manikin the required distance is recorded and reported, and any change in the position of the SCBA during deployment or dragging is recorded and reported. Ten seconds is the maximum amount of time permitted to deploy the DRD. For the DRD to pass the test, the SCBA can neither move higher on the torso than when initially donned nor become separated from the mannequin during the test.	The DRD Function Test is used to assess the ease of deploying and using the DRD to remove a downed fire fighter.
7.1.23 Light Degradation Resistance Test (moisture barrier)	This test is performed in accordance with ASTM G155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials,* on moisture barrier materials. Samples are conditioned for laundry and heat in specially made pockets comprised of two layers of outer shell and one layer of thermal barrier. After conditioning, the specimens are exposed to continuous light for 40 hours using a xenon apparatus, then conditioned in a dark, temperature-controlled room. The specimens are then tested by applying pressure with water for 1 minute in accordance with ASTM D751, *Standard Test Methods for Coated Fabrics.*	The Light Degradation Resistance Test is used to measure how much the moisture barrier degrades as a result of excessive light exposure, and the performance requirement sets a minimum exposure limit. Often, the moisture barrier is the first part of the ensemble to fail, especially if it has been exposed to prolonged sunlight or artificial light. This test is a measure of the durability of the moisture barrier.

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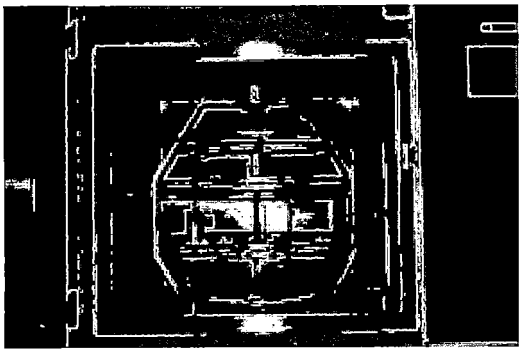
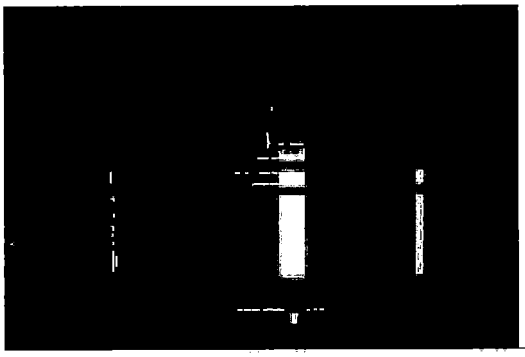
N Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
	**Exterior of Xenon Apparatus.**	
	**Interior of Xenon Apparatus in Use.**	
7.1.24 Zipper Strength Test	This test is used to evaluate zippers for crosswise breaking strength of the chain and of the separating unit. They are also tested for holding strength of stops, retainers, and separating units and for operating force and slider lock strength.	The Zipper Strength Test is used to assess the durability and functionality of zippers after repeated use.
7.1.25 Fastener Tape Strength Test (breaking)	This test is performed after three launderings in accordance with ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics*, and is based on the requirements of A-A-55126B, *Commercial Item Description, Fastener Tapes, Hook and Loop, Synthetic.* It is used to evaluate the breaking strength of hook and pile tape by separately pulling the hook and pile tapes in the jaws of a tensile testing machine until the tape breaks. The force used at the breaking point is recorded as the breaking strength.	The Fastener Tape Strength Test is used for this requirement to assess the overall strength of tapes used in hook and pile fasteners. The material must meet or exceed industry-established requirements based on the composition and width of the tape.

(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
7.1.26 Fastener Tape Strength Test (shear)	This test is performed after three launderings in accordance with ASTM D5169, *Standard Test Method for Shear Strength (Dynamic Method) of Hook and Loop Touch Fasteners*, and is based on the requirements of A-A–55126B. It is used to evaluate the shear strength of the hook and pile tape by measuring the force required to separate hook tape overlapping pile tape when pulled between two jaws of a tensile testing machine. Testing is performed after the tapes have been repeatedly attached and detached. The maximum measured force is reported as the shear strength.	The Fastener Tape Strength Test is used for this requirement to assess the durability and functionality of the hook and pile to not separate after repeated use.
7.1.27 Fastener Tape Strength Test (peel)	This test is performed after three launderings in accordance with ASTM D5170, *Standard Test Method for Peel Strength ("T" Method) of Hook and Loop Touch Fasteners*, and is based on the requirements of A-A-55126B. It is used to evaluate the peel strength of the hook and pile tape. In the test, hook tape is sealed over an equal length of pile tape and the end of the two tapes are separated half their length. The two open ends of tape are attached to the jaws of a tensile testing machine and pulled to measure the force required to completely separate the two tapes. This testing is performed after the tapes have been repeatedly sealed and resealed several times.	The Fastener Tape Strength Test is used for this requirement to assess the durability and functionality of the hook and pile to stay sealed after repeated use.
7.2.2 Total Heat Loss (THL) Test	This test is performed in accordance with ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate*, on samples of the garment composite (outer shell, moisture barrier, and thermal barrier) conditioned at room temperature arranged in the order and orientation as it is worn. Specimens are placed on a sweating hot plate to evaluate heat transfer under wet conditions and thermal resistance under dry conditions. These values are combined in an equation to provide a total heat loss value.	The Total Heat Loss (THL) Test is used to evaluate the amount of heat that can be transferred out of the garment composite via both sweat evaporation from the wearer's skin and conduction through the garment to the outside environment. The test does not account for other materials attached to the base garment composite such as trim, pockets, and other layers. Higher values indicate better performance and more heat loss. However, appropriate THL values for your department must be considered with TPP values. *(See A.7.2.2 for more detail.)*

(continues)

Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
7.2.3 Retroreflectivity and Fluorescence Test (garment trim)	The conditioned garment trim is tested for both retroreflectivity and fluorescence. The coefficient of retroreflection is tested in accordance with ASTM E809, *Standard Practice for Measuring Photometric Characteristics of Retroreflectors.* Once retroreflection is determined, the specimen is evaluated for fluorescence. The colorimetric properties are measured in accordance with ASTM E991, *Standard Practice for Color Measurement of Fluorescent Specimens.* Retroreflection/retroreflectivity is 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 the property being maintained over wide variations of the direction of the incident rays. Fluorescence is the process by which radiant flux of certain wavelengths is absorbed and reradiated nonthermally in other, usually longer, wavelengths.	The Retroreflectivity and Fluorescence Test is used to evaluate how well samples of retroreflective and fluorescent material retain their retroreflectivity and fluorescence. The standard has requirements for retroreflectivity and fluorescence to enhance nighttime/low light visibility (retroreflection) and daytime visibility (fluorescence). The visibility of a fire fighter is crucial during both interior and exterior operations. In addition, almost all emergency incidents begin in a roadway (apparatus placement), and many emergency incidents are roadway-related. For fire fighter safety, it is important that garments have effective retroreflectivity and fluorescence for conspicuity (visibility).
7.2.4 Cleaning Shrinkage Resistance Test (outer shell, moisture barrier, thermal barrier, winter liner, wristlet, bootie) *(see also 7.1.17)*	This test, performed in accordance with AATCC 135 measures the percent of change in the width and length dimensions after five wash and dry cycles. Tests are performed on three specimens of the conditioned garment outer shell, moisture barrier, thermal barrier, winter liner, wristlet, bootie material where present, and protective hoods. Each material and each separable layer of a composite material is tested separately.	The Cleaning Shrinkage Resistance Test is used to measure how much fabrics shrink after cleaning; they will not pass if they shrink more than 5 percent. Excessive shrinkage could compromise the fire fighter's mobility and impact the insulating qualities of the garment.
7.2.5 Breaking Strength Test (outer shell and collar lining)	This test is performed in accordance with ASTM D6775 on the garment outer shell and collar lining materials (individually) after conditioning. Five specimens from the sample, in the warp and fill direction, are elongated to the point of breaking.	The Breaking Strength Test is used to evaluate the garment's outer shell and collar lining strength for material robustness so it remains intact in rugged fireground environments. Material breakage can compromise the thermal and physical protection features of the garments, which increases the risk of fire fighter burns and injuries.

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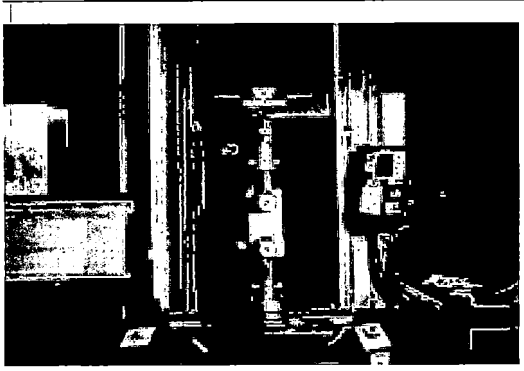
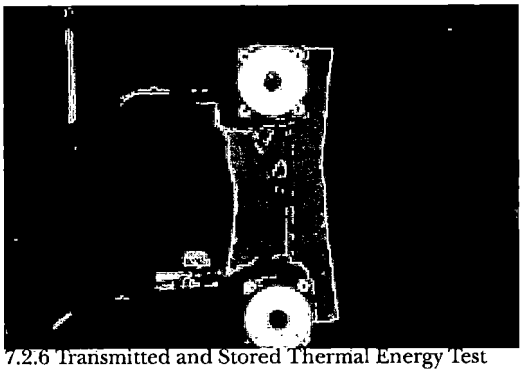
N Table B.2 *Continued*

Test Method	Test Method Description	Test Method Application
 **Apparatus Ready for Test.**  **Sample Fabric upon Completion of Test.** 7.2.6 Transmitted and Stored Thermal Energy Test (enhanced composites related to sleeves)	This test is performed in accordance with ASTM F2731, *Standard Test Method for Measuring the Transmitted and Stored Energy in Fire Fighter Protective Clothing Systems*, on conditioned garment sleeve composites containing enhancements; enhancements include, but are not limited to, trim, emblems, flags, reinforcements, and so forth. The test is run on a base composite with the enhancement attached, following wet conditioning of the samples.	The Transmitted and Stored Thermal Energy Test is used to evaluate the ability of the garment composite enhancements to store and then transfer heat through the composite and enhancement to the skin. The test is used to evaluate the potential for burn injury when the composite is compressed, during a lower heat, longer time exposure. The test is intended to ensure that there is a level of protection to the fire fighter to help prevent a burn injury when the garment does not indicate evidence of thermal exposure.

N Table B.3 Helmets

Test Method	Test Method Description	Test Method Application
7.4.1 Top Impact Resistance Test (Force)	This test is performed on helmet specimens, each of which is conditioned five ways prior to testing: at room temperature, at low temperature, in convective heat, in radiant and convective heat, and wet conditioning.	The Top Impact Resistance Test (Force) is used to evaluate the helmet's shock absorption characteristics from the impact of a falling object (such as ceiling material) as well as fire fighter protection from striking an object while walking, crawling, or falling on an object.
	After conditioning, the helmet is mounted on an aluminum head and adjusted to the size providing the least amount of clearance. A specific weight steel drop mass is dropped from a height that yields a specific impact velocity. The peak force and impact velocity are recorded for a pass or fail performance. The amount of force transmitted through the helmet specimens cannot exceed 3780 N (850 lbf).	This test is used to assess the effect of force on the top of the helmet when struck by falling or stationary objects. It also assesses the level of protection from a head and or neck injury from the force of impact with a moving or stationary object.
7.4.2 Impact Resistance Test (Acceleration)	This test is performed on helmet specimens, each of which is conditioned four ways prior to each impact during testing: at room temperature, at low temperature, in radiant and convective heat, and wet conditioning. The whole helmet will undergo accelerated impact testing on the top, front, left, right, and back, in that order.	The Impact Resistance Test (Acceleration) is used to evaluate the helmet's shock absorption characteristics from the impact of the fire fighter falling.
	The helmet is tested on a headform using a specific weight drop assembly (test headform, accelerometer, and moving portion of the headform guidance assembly). The drop assembly is dropped from a height that creates a known velocity. The maximum acceleration and duration of the acceleration values are recorded for each impact for each helmet specimen. If one or more helmet specimens fail in any condition or at any impact site, then the helmet fails in any condition or at any impact site.	This test assesses the level of protection from a head injury caused by falling and striking the head.
7.4.3 Physical Penetration Resistance Test	This test is performed on helmet specimens, each of which is conditioned five ways prior to each physical penetration test: at room temperature, at low temperature, in convective heat, in radiant and convective heat, and with wet conditioning.	The Physical Penetration Resistance Test is used to assess how well the helmet will resist penetration by falling sharp objects (such as a nail in a structural member or a shard of glass) or by stationary sharp objects that the fire fighter might strike while walking, crawling, or falling.
	The test uses an ISO headform, a penetration striker, and an electrical contact indicator. A penetration striker is dropped from a height that yields a consistent velocity for the test on the helmet. A minimum of two penetration tests applied at different test areas on each helmet are performed. If the test striker electrically or physically contacts the headform in one or more specific tests, the helmet fails.	

(continues)

N Table B.3 ***Continued***

Test Method	Test Method Description	Test Method Application
7.4.4 Heat and Thermal Shrinkage Resistance Test(helmet: heat resistance)	This test is performed on complete helmet specimens that are tested with all components in place, as received. The helmet is placed in a preheated convective oven for 5 minutes. The helmet is evaluated for ignition, melting, and dripping. There are several possible points of failure for this test: (1) Parts of the complete helmet assembly that were not in contact with the headform before the test are in contact with the headform after the test. (2) The back of the helmet becomes distorted and extends more than allowed below the original position of the helmet shell. (3) The front and sides of the helmet shell become distorted and extend more than allowed below the original position of the helmet shell. (4) The retention system, energy absorption system, or ear covers separate, melt, or drip. (5) The chin strap closure device is dysfunctional. (6) Any part of the helmet assembly ignites. (7) The product labels ignite or melt. (8) Any helmet assembly component extends more than allowed below the initial point of the helmet shell in the front, both before and after oven exposure. (9) The faceshield/goggle component drips.	The Heat and Thermal Shrinkage Test is used to evaluate whether the helmet shell and helmet components can resist heat; they don't melt, drip, separate, or ignite. Helmet components that melt, drip, or ignite could contribute to burn injuries.
7.4.5 Flame Resistance Test 2, Procedures A and C	This test is performed on helmet specimens that are tested as received. A flame is applied to the underside of the helmet (Procedure A) and the top of the helmet (Procedure C) using a Bunsen burner for 15 seconds. Once removed, the afterflame and afterglow are evaluated. The helmet cannot show any visible afterflame or glow 5 seconds after the test flame is removed in each test.	The Flame Resistance Test 2, Procedures A and C, is used to evaluate the helmet, under controlled test conditions, for its ability to self-extinguish after the flame is removed.
7.4.6 Thermal Protective Performance (TPP) Test(ear cover)	This test is performed in accordance with ISO 17492 on helmet ear cover composites after conditioning with five laundering cycles. Specimens consist of materials from the portion of the ear covers that cover the ear and neck.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the helmet ear cover by evaluating how quickly heat is transferred from the outside of the helmet to the inside where skin might be in contact with the material. Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn.

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Table B.3 *Continued*

Test Method	Test Method Description	Test Method Application
	A sample is exposed to both radiant and convective heat sources to simulate flashover.	This is the primary test to measure the ability of the helmet ear cover to protect the fire fighter from severe heat and flame. A TPP rating of 20 is acceptable because the interface area is overlapped by another part of the ensemble that also provides insulation.
	The rate of rise in temperature is compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the TPP rating. The TPP rating of the helmet ear cover has to be at least 20.	
7.4.7 Retention System Test	This test is performed on complete helmets tested as received using a mechanical chin structure. This test measures the retention of the chinstrap of a helmet after specific force is applied for a specific time, by a tensile test machine. The distance between the top of the helmet and the bottom of the rollers is measured. Each helmet is observed for breaks and slip or stretch. Failure occurs if any helmet specimen shows a break or shows slip or stretch measured at more than what is allowed in the requirement.	The Retention System Test is used to evaluate the helmet chinstrap's elongation and its resistance to breaking or stretching under applied force. If the helmet chinstrap breaks or stretches too much, the helmet is more likely to fall off the wearer, which increases the risk of injury to the fire fighter.
7.4.8 Suspension System Retention Test	This test is performed on helmets tested as received on a tensile testing machine. The strap is cut to ensure a sufficient length of strap is secured by the jaws of the machine. An increasing force is applied along the centerline of the suspension strap. The specimen is inspected for separation from the helmet shell. Failure occurs if the helmet suspension system separates from the helmet shell.	The Suspension System Retention Test is used to evaluate whether or not the helmet suspension system separates from the helmet shell under applied force. If the helmet suspension system separates from the helmet, the helmet is more likely to fall off the wearer, which will increase the risk of injury to the fire fighter.
7.4.9 Shell Retention Test	This test is performed on helmets tested as received using a tensile testing machine. The helmet is firmly attached to the machine, similar to the attachment in the suspension system test, and a specified maximum force is applied to the helmet for specified period. The helmet receives a pass or fail performance based on the separation of the helmet shell from the suspension system or helmet retention system. If a helmet shell separates from the helmet suspension system or the helmet retention system, the helmet fails.	The Shell Retention Test is used to evaluate the ability of the helmet shell to stay attached to the helmet suspension system or helmet retention system.
7.4.10 Flame Resistance Test 1 [all materials used in the construction of helmet chin straps (hook and pile, elastic, and labels might be excluded from the test depending on their location in the garment) and goggle strap materials.]	This test is performed in accordance with ASTM D6413/D6413M, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, on five samples of on all materials used in the construction of the helmet chin strap, with each separable layer tested individually after conditioning with five laundry cycles.	The Flame Resistance Test 1 is used to evaluate the helmet chinstraps' and the goggle straps' resistance to an open flame and the ability to self-extinguish once removed. The char length and afterflame are measured and averaged and evidence of melting or dripping is recorded and constitutes failure of the material.

(continues)

Table B.3 *Continued*

Test Method	Test Method Description	Test Method Application
	Helmet chin straps are conditioned samples tested in accordance with ASTM D6413/D6413M. Observers will record the afterglow, char length, and visible melting or dripping. Materials cannot char more than 100 mm (4 in.), on average; cannot show afterflame 2 seconds, on average, after removal of the test flame; and cannot melt or drip.	This is the primary test to establish the flame-resistant properties and the ability of the materials used in chin strap construction to self-extinguish once removed from flame.
7.4.11 Heat and Thermal Shrinkage Resistance Test (helmet chin strap: shrinkage, melting, separation and ignition)	This test is performed on helmet chin strap specimens after conditioning with five laundering cycles. The helmet chin strap is suspended in a preheated oven for a specified time. Following testing, the samples are observed for evidence of melting, dripping, separation, and ignition. The helmet chin strap specimens cannot shrink more than 10 percent lengthwise, on average, and they cannot melt, separate or ignite. If one or more specimens shows evidence of melting, separation, or ignition, the helmet chin strap fails.	The Heat and Thermal Shrinkage Resistance Test is used to evaluate the ability of the helmet's chin strap to remain functional and resist melting, separation, ignition, and shrinkage. Melting, separation, ignition, and excessive shrinkage of the helmet chin strap might cause injury to the wearer.
7.4.12 Thread Melting Test	This test is performed in accordance with ASTM D7138, *Standard Test Method to Determine Melting Temperature of Synthetic Fibers,* on the three different specimens of sewing thread used in the construction of the helmet as received. The temperature at which the thread melts or decomposes is recorded, and if it melts below 260°C (500°F), it fails.	The Thread Melting Test is used to evaluate the thread used in the construction of the helmet to determine if it has at least the same heat resistance as the fabric used in garment construction.
7.4.13 Corrosion Resistance Test	This test is performed in accordance with ASTM B117 to measure corrosion. Metal hardware is exposed to a saline solution spray for 20 hours, following which base metal can show only slight surface corrosion and the hardware must remain functional.	The Corrosion Resistance Test is used to evaluate whether hardware will (1) corrode and (2) remain functional after extended exposure to salt spray. Hardware failure can result in loss of thermal and physical protection for the fire fighter.
7.4.14 Label Durability and Legibility Test 2	This test is performed on helmets with labels attached, each of which is conditioned four ways prior to testing: at room temperature, at low temperature, in radiant and convective heat, and with wet conditioning. After all conditioning methods are completed, the labels are visually evaluated by a person with 20/20 vision or corrected to 20/20 at a distance of 305 mm (12 in.) in a well-illuminated area. Helmet labels are examined to see if they both remained in place and attached and to determine if they are still legible. One or more label specimens failing either the placement or the legibility test results in failure.	The Label Durability and Legibility Test 2 is used to evaluate whether or not the label is legible after room and low temperature exposure, radiant and convective heat exposure, and wet conditioning. The presence and legibility of labels is important for helmet identification and tracking.

(continues)

N **Table B.3** *Continued*

Test Method	Test Method Description	Test Method Application
7.4.15 Faceshield/Goggle Component Lens Impact Resistance Test, Tests 1 and 2	This test is performed on complete helmets with the faceshield component or goggle components, each of which is conditioned four ways prior to testing: at room temperature, at low temperature, in convective heat, and with wet conditioning. Test One is a high-mass-impact procedure that secures the specimen for testing on a facial feature headform. A missile is dropped through a loose-fitting guide tube from a specific distance in line with the eyes of the faceshield or goggle component. At least four specimens are tested, and a lens break constitutes failure. Test Two is a high-velocity-impact procedure that secures the specimen for testing on a facial feature headform. A steel ball weighing and measuring specific amounts is propelled toward the faceshield or goggle component at various locations at a specific speed. One or more helmet specimens failing this test means the helmet fails. Both tests are evaluated for evidence of ejected parts or fragments of the faceshield or goggle component touching the "eye" of the headform. More specifically, no faceshield/goggle components can contact an "eye" of the headform, and no parts or fragments can be ejected from the component that could contact the "eye" of the headform.	The Faceshield/Goggle Component Lens Impact Resistance Test is used to evaluate whether or not the faceshield and goggle components resist impact. In either test, if the "eye" of the headform is contacted by parts or fragments of the faceshield or goggle component then the helmet fails. This test evaluates the impact resistance of the faceshield/goggle component lens to impact from flying or falling objects.
7.4.16 Flame Resistance Test 2, Procedure B (faceshield/goggle components)	This test is performed on helmet specimens with the faceshield/goggle components attached as received on the faceshield and goggle components of the complete helmet. The bottom edge of the faceshield/goggle components is subjected to a flame for a specific time, using a Bunsen burner underneath, after which the duration of the afterflame is measured, reported, and recorded. The faceshield/goggle component cannot show any visible afterflame 5 seconds after removal of the test flame.	The Flame Resistance Test 2, Procedure B, is used to evaluate the faceshield and goggle component's resistance to an open flame and the ability to self-extinguish once removed.
7.5.2 Flame Resistance Test 1 (all fabrics used in the construction of faceshield/goggle components)	This test is performed in accordance with ASTM D6413/D6413M on all fabric strap materials used in the construction of the faceshield and goggle components. The faceshield and goggle components are tested after five conditioning laundry cycles. The faceshield or goggle strap materials are evaluated on a pass/fail performance based on any observed melting, dripping, afterflame, and length of charring. Materials cannot char more than 100 mm (4 in.), and cannot show afterflame 5 seconds after removal of the test flame.	The Flame Resistance Test is used to evaluate the faceshield or goggle strap material, under controlled test conditions, for its ability to self-extinguish after the flame is removed. The char length of the material after exposure to flame is also measured. This is the primary test to establish the flame-resistant properties of the materials used in faceshield/goggle component construction to self-extinguish once removed from flame.

(continues)

Table B.3 *Continued*

Test Method	Test Method Description	Test Method Application
7.5.3 Faceshield/Goggle Component Lens Scratch Resistance Test	This test is performed on specimens of faceshield/goggle component lenses in as-received condition.	The Faceshield/Goggle Component Lens Scratch Resistance Test is used to assess the durability and clarity of the faceshield and goggle lens material after exposure to abrasion.
	The specimen is placed in the test fixture and a specific diameter wool felt polishing pad is attached to the pad holder. The abrasive disc is rotated on top of each specimen for a specific number of cycles. The haze of the specimen is evaluated before and after abrasion using a haze meter in accordance with ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*. The delta haze is calculated by subtracting the initial haze measurement from the final haze measurement, the values for all tests are then averaged.	
	The average change in haze cannot increase more than 25 percent after abrasion.	
7.5.4 Luminous (Visible) Transmittance Test(faceshield/goggle component lenses)	This test is performed on complete faceshield/goggle component lenses in as-received condition to determine how much light is transmitted through the lens. The standard source for measuring radiant energy of luminous transmittance is used to determine the average amount of light transmittance. A pass/fail rating is administered.	The Luminous (Visible) Transmittance Test is used to measure how much light passes through the faceshield/goggle component lens.
	Clear lenses must transmit a minimum of 85 percent of the incident visible radiation and colored lenses must transmit a minimum of 43 percent of the incident visible radiation.	All lenses block some visible light and fire fighters have to wear protective faceshields/goggles. This requirement limits how much light can be blocked to prevent the use of lens materials that reduce a fire fighter's ability to see by more than an industry-accepted amount.
7.5.5 Flame Resistance Test 2, Procedure D(faceshield/goggle component attachment hardware, where provided)	This test is performed on helmets with faceshield/goggle component attachment hardware in place in as-received condition.	The Flame Resistance Test 2, Procedure D, is used to evaluate the resistance of the faceshield/goggle component's mounting hardware to an open flame and its ability to self-extinguish after the flame is removed.
	The complete helmet with faceshield/goggle component is mounted on a headform, and the faceshield/goggle component is exposed for a specific time, to an open flame using a Bunsen burner. The specimens are evaluated for the duration of an afterflame and afterglow.	
	The longest measured afterflame time is used to determine pass or fail. Any afterglow exceeding 5 seconds constitutes failure.	
7.5.6 Electrical Insulation Test 1, Procedure A and Procedure B	These tests are performed on complete helmets in as received condition.	The Electrical Insulation Test 1, Procedure A and Procedure B, is used to evaluate the ability of the helmet to protect the fire fighter against electricity conducted through accidental contact with live wires.

(continues)

Table B.3 *Continued*

Test Method	Test Method Description	Test Method Application
	Procedure A — the helmet is inverted and filled to a specific line with tap water. The specimen is then submerged in the same type of water to the test line. An electric voltage is applied to the water inside the specimen at a specific voltage for a specific time. The water outside the helmet is measured for current leakage. Procedure B — The specimen and the retention system are submerged in tap water for a specific time, then they are removed from the water and allowed to drain for no more than 2 minutes. A lead carrying 60 Hz alternating voltage is attached to the metal hardware parts on the exterior of the helmet, at or above the brim edge. Voltage is applied to the external helmet shell lead and increased to a specific level for a specific time. The metal head form is used to measure the current leakage or evidence of breakdown. One or more helmet specimens cannot have leakage current exceeding 3 mA in either test Procedure A or Procedure B.	
7.5.7 Flame Resistance Test 1 (all materials used in helmet ear covers, except elastic and hook and pile where these items do not come in direct contact with the wearer's body or hood)	This test is performed in accordance with ASTM D6413 individually on all materials used in the construction of helmet ear covers (except elastic and hook and pile when they are placed so that they will not directly contact the wearer's body or hood) after conditioning. Each separable layer of multilayer composites are tested individually. The specimen is suspended over a flame for 12 seconds to determine how easily the material ignites. Ease of ignition and charring characteristics are observed and recorded. Materials cannot char more than 100 mm (4 in.), cannot show afterflame 2 seconds after removal of the test flame, and cannot melt or drip.	The Flame Resistance Test 1 is used to evaluate the helmet ear cover material, under controlled test conditions, for its ability to self-extinguish after the flame is removed. The char length of the material after exposure to flame is also measured. This is the primary test to establish the flame-resistant properties of the materials used in ear cover construction.
7.5.8 Heat and Thermal Shrinkage Resistance Test [all materials used in helmet ear covers (elastic and hook and pile might be excluded from the test depending on their location in the garment) for shrinkage, melting, separation and ignition]	This test is performed individually on specimens of all materials used in the construction of helmet ear covers (elastic and hook and pile might be excluded from the test depending on their location in the garment) inas received-condition. The specimen is suspended in the center of the oven facing the airflow. Post-exposure measurements are taken to ensure that heat shrinkage is less than 10 percent in each direction. Materials cannot shrink more than 10 percent in any direction, and they cannot melt, separate, or ignite.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the materials for shrinkage, melting, separation, and ignition after exposure to high temperatures. Melting, separation, ignition, or excessive shrinkage can cause injury to the wearer.

(continues)

N Table B.3 *Continued*

Test Method	Test Method Description	Test Method Application
7.5.9 Retroreflectivity and Fluorescence Test (helmet visibility markings)	The conditioned helmet trim is tested for both retroreflectivity and fluorescence. The coefficient of retroreflection is tested in accordance with ASTM E809. Once retroreflection is determined, the specimen is evaluated for fluorescence. The colorimetric properties are measured in accordance with ASTM E991.	The Retroreflectivity and Fluorescence Test is used to evaluate how well samples of retroreflective and fluorescent material retain their retroreflectivity and fluorescence. The standard has requirements for retroreflectivity and fluorescence to enhance nighttime/low light visibility (retroreflection) and daytime visibility (fluorescence).
	Retroreflection/retroreflectivity is 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 the property being maintained over wide variations of the direction of the incident rays. Fluorescence is the process by which radiant flux of certain wavelengths is absorbed and reradiated nonthermally, in other, usually longer, wavelengths.	The visibility of a fire fighter is crucial during both interior and exterior operations. In addition, almost all emergency incidents begin in a roadway (apparatus placement), and many emergency incidents are roadway-related. For fire fighter safety, it is important that garments have effective retroreflectivity and fluorescence for conspicuity (visibility).
7.5.10 Helmet Ear Cover Removal Test	An individual provided with the manufacturer instructions is timed on how long it takes to remove the ear covers from the helmet.	This requirement is intended to promote the removal of ear covers from helmets to enable their cleaning.

N B.4 Gloves. Table B.4 is intended to serve as an abbreviated guide to specified tests for gloves, including the whole glove, glove interface, glove body, glove lining materials, glove extension, and materials used in the construction of the whole glove. These tests evaluate whether or not the gloves meet the minimum performance requirements of the 2018 edition of NFPA 1971. They do not guarantee the safety of the fire fighter or ensure the fire fighter will not experience injury while wearing the gloves. Some tests are performed on "new, as distributed" gloves that have undergone conditioning. This might seem contradictory, but the conditioning is limited to environmental parameters, and "new, as distributed" condition ensures that the gloves have not been broken in in any way.

N B.5 Footwear. Table B.5 is intended to serve as an abbreviated guide to specified tests for footwear, including the whole footwear boot, the footwear upper, and materials used in the construction of the whole footwear element. The tests are intended to evaluate whether or not the footwear meets the minimum performance requirements of the 2018 edition of NFPA 1971. They do not guarantee the safety of the fire fighter or ensure the fire fighter will not experience injury while wearing the footwear.

N B.6 Hoods. Table B.6 is intended to serve as an abbreviated guide to specified tests for hoods, including the whole hood, with or without an SCBA facepiece and materials used in the construction of the hood. In addition, the Optional Particulate Hood Requirements are included. The tests evaluate whether or not the hood meets the minimum performance requirements of the 2018 edition of NFPA 1971. They do not guarantee the safety of the fire fighter or ensure the fire fighter will not experience injury while wearing the hood.

N B.7 Wristlets. B.7 is intended to serve as an abbreviated guide to specified tests for wristlets and materials used in the construction of protective wristlet interface components. The tests evaluate whether or not the wristlet meets the minimum performance requirements of the 2018 edition of NFPA 1971. They do not guarantee the safety of the fire fighter or ensure the fire fighter will not experience injury while wearing protective elements including wristlets.

N Table B.4 Gloves

Test Method	Test Method Description	Test Method Application
7.7.1 Thermal Protective Performance (TPP)	This test is performed in accordance with ISO 17492 on the glove body composite as received and after conditioning with five laundering cycles. The glove body composite is exposed to direct flame and radiant heat to simulate flashover.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the composite by evaluating how quickly heat is transferred from the outside of the glove body to the inside. Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn.
(glove body composite)	The rate of rise in temperature is recorded and compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the TPP rating. The average TPP rating has to be at least 35.	This is the primary test to measure the glove body's ability to protect the fire fighter from severe heat and flame. The higher the number, the higher the protection from heat (under the specific test conditions).
7.7.2 Thermal Protective Performance (TPP)	This test is performed in accordance with ISO 17492 on the glove interface component as received and after conditioning with five laundering cycles. Specimens are exposed to direct flame and radiant heat to simulate flashover.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the interface component by evaluating how quickly heat is transferred from the outside of the glove interface to the inside. Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn.
(glove interface component composite)	The rate of rise in temperature is compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the TPP rating. The TPP rating of the glove interface component composite has to be at least 20.	This is the primary test to measure the glove interface's ability to protect the fire fighter from severe heat and flame. A TPP rating of 20 is acceptable because the interface area is overlapped by another part of the ensemble that also provides insulation.
7.7.3 Heat and Thermal Shrinkage Resistance Test	This test is performed in accordance with ASTM F2894, *Standard Test Method for Evaluation of Materials, Protective Clothing and Equipment for Heat Resistance Using a Hot Air Circulating Oven*, after conditioning the whole. Whole glove samples are measured in length and width directions, laundered, exposed to heat, and then measured a second time. For the heat exposure, the glove fingers are filled with a finite amount of glass beads and the glove body is packed with a mesh bag containing a finite amount of glass beads, then the glove opening is clamped together. The glove is suspended by a clamp and placed in a preheated oven for a specified period. After the heat exposure and second measuring, the glove is donned and flexed.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the gloves for melting, separation, ignition, and shrinkage after exposure to high temperatures.
(gloves: shrink, melt, separate, or ignite)	The specimen cannot melt, separate, ignite, or shrink more than 8 percent in length or width. The specimen also has to be donnable and flexible.	Specimens cannot melt, separate, or ignite, and they cannot shrink more than 8 percent. Excessive shrinkage will limit the dexterity and thermal protection of the glove. The glass beads simulate the mass of the hand inside the glove.

(continues)

N **Table B.4** *Continued*

Test Method	Test Method Description	Test Method Application
7.7.4 Heat and Thermal Shrinkage Resistance Test (glove lining materials: melt, separate, or ignite)	This test is performed in accordance with ASTM F2894, after conditioning with of five laundering cycles; all layers of the glove lining material between the moisture barrier layer and the hand are tested individually. The glove lining is suspended by a clamp and placed in a preheated oven for a specified period. Following exposure, the glove lining material is evaluated for evidence of melting, dripping, separation, or ignition.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the glove lining materials for melting, separation, or ignition after exposure to high temperatures. This test attempts to prevent the use of materials that melt, separate, or ignite, against the wearer's hands, under specific test conditions.
7.7.5 Conductive Heat Resistance Test 1 (glove body composite)	This test is performed in accordance with ASTM F1060, *Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact*, on the glove body composite palm side under four separate conditions: unlaundered wet, unlaundered dry, laundered wet, and laundered dry. The test measures the heat transfer through the composite when it is placed on a hot plate at a specific temperature and relates the transferred heat energy to predicted times to sensation of pain and second-degree burn injury. The test is conducted under pressure. Both the time to pain and time to second-degree burn (based on the Stoll Curve) are recorded for each specimen. The average time to pain cannot be fewer than 6 seconds, and the average time to second-degree burn cannot be fewer than 10 seconds.	The Conductive Heat Resistance Test 1 is used to evaluate the glove body palm side materials for thermal insulation when the glove is compressed in both dry and wet environments. The test conditions are not intended to simulate all fireground exposures but rather to evaluate glove materials for resistance to conductive heat transfer under a specific condition. This test is used to determine the protection provided by the glove when a fire fighter makes direct contact with a heated object.
7.7.6 Flame Resistance Test 3 (glove body composite: char length, afterflame, melt, drip, consumed materials) 7.7.7 Flame Resistance Test 3 (glove interface component composite: char length, afterflame, melt, drip, consumed materials) 7.7.8 Flame Resistance Test 3(glove extension composite: afterflame, melt, drip, consumed materials)	This test is performed in accordance with ASTM D6413 on the glove body composite (7.7.6), glove interface (7.7.7), and glove extension composite (7.7.8). Specimens are tested after conditioning. The specimen is mounted and suspended over a burner flame for 12 seconds. Once removed from the flame, the specimens are examined for afterflame, melting, dripping, and the amount of material that is consumed as a result of the heat exposure. Charring characteristics are evaluated after the specimen has been conditioned. The glove body composite cannot have an average char length of more than 100 mm (4 in.); the average afterflame of the specimens cannot be more than 2 seconds; the specimens cannot melt or drip; the amount of consumed materials cannot exceed 5 percent.	The Flame Resistance Test 3 is the primary test used to establish the flame-resistant properties of the materials used in glove construction. This test is used to evaluate the material's ability to self-extinguish after the flame is removed, and how much the material chars or disintegrates following the exposure.
7.7.9 Thread Melting Test	This test is performed in accordance with ASTM D7138 on the three different specimens of sewing thread used in the construction of gloves as received.	The Thread Melting Test is used to evaluate the thread used in the construction of the gloves to determine if it has at least the same heat resistance as the fabric used in its construction.

(continues)

N. Table B.4 *Continued*

Test Method	Test Method Description	Test Method Application
	The temperature at which the thread melts or decomposes is recorded; if it melts below that specific temperature, it fails.	
7.7.10 Viral Penetration Resistance Test (glove body seams)	This test is performed in accordance with ASTM F1671 on the moisture barrier fabric and seams. Samples are conditioned in multilayer composite samples by subjecting them to repeated cycles of laundering, followed by convective heat conditioning. After conditioning, the moisture barrier layer is placed in a test cell where the film side is exposed to a surrogate virus in a liquid solution and is evaluated for passage of the virus after 1 hour. Any evidence for virus passing through the barrier fabric or seam, as determined using a microbiological technique, constitutes a failure. After conditioning, the moisture barrier layer is placed in a test cell where the film side is exposed to a surrogate virus in a liquid solution and is evaluated for passage of the virus after 1 hour.	The Viral Penetration Resistance Test is used to evaluate the ability of the glove body moisture barrier fabric and seams to keep blood-borne pathogens from coming in contact with the fire fighter's skin.
7.7.11 Liquid Penetration Resistance Test (glove body seams)	This test is performed in accordance with ASTM F903 on the glove body moisture barrier fabric and seams. Samples are conditioned in multilayer composite samples by subjecting them to repeated cycles of laundering, followed by convective heat conditioning. The moisture barrier specimens are then placed in a test cell where the film side is exposed to aqueous film-forming foam, battery acid, surrogate gasoline, fire-resistant hydraulic fluid, swimming pool chlorine, and automobile antifreeze fluid. Each liquid is tested separately on an individual specimen. After 1 hour of exposure, each sample is evaluated. No liquid can penetrate any sample.	The Liquid Penetration Resistance Test is used to evaluate whether or not the glove body moisture barrier fabric and seams resist penetration of liquids meant to be representative of those commonly encountered on the fireground. However, liquid chemicals can still permeate the clothing materials by passing through moisture barriers and seams on a molecular level.
7.7.12 Cut Resistance Test (glove body composite)	This test is performed in accordance with ASTM F1790, *Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, on at least three conditioned samples of the glove body composite under a specific load. Small specimens of the glove body composite are clamped to a metal rod while a blade passes across the specimen until it makes contact with the metal rod. The distance the blade passes across each specimen without cutting through the material is recorded, then averaged. The average distance the blade travels across the material without cutting through the material has to be more than a specific length.	The Cut Resistance Test is used for this requirement to evaluate the ability of the glove body composite to resist being cut under specific test conditions. Longer blade travel distances represent greater cut resistance because it takes longer for the blade to cut through the material.

(continues)

Table B.4 *Continued*

Test Method	Test Method Description	Test Method Application
7.7.13 Cut Resistance Test [glove interface areas	This test is performed in accordance with ASTM F1790 on conditioned samples of the glove interface component under a specific load. The specimen is clamped to a metal rod while a blade passes across the specimen until it makes contact with the metal rod.	The Cut Resistance Test is used for this requirement to evaluate the ability of the glove interface areas to resist being cut, under specific test conditions. Longer blade travel distances represent greater cut resistance because it takes longer for the blade to cut through the material.
(wristlets and glove interface component)]	The distance the blade passes across each specimen without cutting through the material is recorded, then averaged. The average distance the blade travels across the material without cutting through the material has to be more than a specific length.	
7.7.14 Puncture Resistance Test	This test is performed in accordance with ASTM F1342, *Standard Test Method for Protective Clothing Material Resistance to Puncture*, on complete gloves or glove composite pouches that are both dry and wet. Specimens are clamped into a fixture while force is applied to puncture the specimen with a nail-like probe.	The Puncture Resistance Test is used to evaluate the ability of the gloves or glove composite pouches to resist puncture under specific test conditions.
(glove body composite)	The force required to puncture each sample is recorded then averaged, and the samples have to resist puncture under at least the specified force.	(Note: this test does not ensure that gloves will be puncture-proof, only puncture resistant.) Higher force averages indicate greater puncture resistance.
7.7.15 Glove Hand Function Test	This test is performed in accordance with ASTM F2010,/F2010M, *Standard Test Method for Evaluation of Glove Effects on Wearer Hand Dexterity Using a Modified Pegboard Test*, on at least three pairs of whole gloves, in two sizes, as received.	The Glove Hand Function Test is used to determine whether the glove meets a minimum requirement for dexterity. The lower percentages indicate that the gloves have fewer adverse effects on fire fighter dexterity.
	A test subject picks up metal pins and places them in a horizontal pegboard without gloves. The subject immediately repeats the test while wearing the correct size specimen gloves. The time it takes to complete the task is recorded for both tests, and an average is calculated and used to calculate a percentage that represents how much faster the test was completed bare-handed than with gloved hands.	To meet this requirement, bare-handed control cannot offer more than 220 percent better control than gloved hands. In other words, if it takes, on average, 60 seconds to complete the test barehanded, it cannot take more than 132 seconds, on average, to complete the same task with gloved hands.
	That percentage is reported as the bare-handed control for each glove size. The average result for bare-handed control cannot exceed 220 percent.	
7.7.16 Burst Strength Test	This test is performed in accordance with ASTM D6797, *Standard Test Method for Bursting Strength of Fabrics Constant-Rate-of-Extension (CRE) Ball Burst Test*, on the knit glove wristlet materials as received.	The Burst Strength Test is used to evaluate the strength of the glove wristlet material by measuring its resistance to bursting or rupturing when force is applied under specific test conditions.

(continues)

Table B.4 *Continued*

Test Method	Test Method Description	Test Method Application
(knit glove wristlet material)	A tensile testing machine is used to push a steel ball through the clamped wristlet material. The maximum force used to burst the material is recorded. The specimen cannot burst under less than the specified force.	It is used to determine whether, on average, the glove wristlet can sustain applied force of at least the specified force, under specific test conditions. Higher bursting force resistance numbers indicate stronger wristlet materials.
7.7.17 Seam-Breaking Strength Test	This test is performed in accordance with ASTM D1683, *Standard Test Method for Failure in Sewn Seams of Woven Fabrics*, on the conditioned glove body and glove interface component seams. Opposite ends of a specimen, with the seam bisecting the length, are gripped in a machine and pulled apart until the specimen breaks. If testing knit materials, the test is performed in accordance with ASTM D6797. The force required to break the seam is recorded and averaged for the test specimens and the average result cannot be less than the specified force.	The Seam-Breaking Strength Test is used to evaluate the strength of the glove's interface seams under stress. The durability of the seam is an indicator of physical performance when the glove is subjected to repeated donning, doffing, gripping, bending, and stretching. Higher breaking forces indicate stronger seams.
7.7.18 Overall Liquid Integrity Test 1	This test is performed on at least three pairs of whole gloves, in two sizes, after conditioning and convective heat conditioning. The test subject dons an inner glove then the glove to be tested and submerges the gloved hand in surfactant-treated water to the height line on the glove below the opening, for 5 minutes while flexing the hands into a fist every 10 seconds. The appearance, after testing, of any water mark on the inner glove of any of the three pairs of gloves is recorded and reported. The appearance, after testing, of any water mark on the inner glove of any glove is considered leakage and constitutes failing.	The Overall Liquid Integrity Test 1 is used to evaluate the glove's resistance to leakage when submerged in water, under specific test conditions. Surfactant treatments are used to lower water surface tension, making water penetration easier.
7.7.19 Glove Donning Test	This test is performed on at least three conditioned pairs of whole gloves in two sizes. While wearing a glove on one hand, the wearer must don a single glove on the opposite hand, without altering the glove lining, three consecutive times. The test is performed three times with a dry hand and dry gloves and three times with a wet hand and wet gloves. The time of each donning for each size is recorded and is averaged as a measure of the ease of donning.	The Glove Donning Test is used to evaluate the ease of donning the gloves with a wet and dry hand; whether or not the inner lining will become detached under the specific test conditions; and whether or not each digit of each glove of each size allows full insertion during the test.

(continues)

N Table B.4 ***Continued***

Test Method	Test Method Description	Test Method Application
	The standard requires a maximum average donning time for dry gloves and a separate maximum average donning time for wet gloves. While wearing a glove on one hand, the wearer must don a single glove on the opposite hand, without altering the glove lining, three consecutive times. The test is performed three times with a dry hand and dry gloves and three times with a wet hand and wet gloves. The key to this test is that pass or fail determinations are made based on the donning time (if one size fails, the glove fails), separation (any detachment of the inner liner and/or moisture barrier is a failure), and insertion (any glove digits that do not allow full insertion is a failure).	
7.7.20 Liner Retention Test	This test is performed on at least three conditioned pairs of whole gloves, in two sizes. A set of locking forceps is attached to the interior glove liner near the fingertip, which is then attached to a strain gauge and pulled, until the specified force registers on the machine. Each digit of each glove is inspected for inner liner detachment. The appearance of inner liner detachment in any digit of any glove of any size constitutes a failure. Gloves can be cut open to look for detachment.	The Liner Retention Test is used to evaluate the ability of the glove's inner liner and moisture barrier to stay attached under applied force after laundering.
7.7.21 Label Durability and Legibility Test 1	This test is performed on the whole glove, with labels attached, after laundering, abrasion, and convective heat exposure. The gloves are exposed to 10 laundry cycles as outlined in AATCC 135 subjected to abrasion in accordance with ASTM D4966 and, lastly, subjected to convective heat. Glove labels are examined for continued presence (have to remain attached to the glove) and for legibility.	The Label Durability and Legibility Test 1 is used to evaluate whether or not the label stays in place and is legible to the unaided eye after exposure to multiple launderings, abrasion, and convective heat. In addition to being legible, the labels must remain in place following the testing. The presence and legibility of labels is important for glove identification and tracking.
7.7.22 Grip Test	This test is performed on at least three pairs of new, as distributed gloves in two sizes. Six separate pull types are tested with three pulls each on a wet conditioned overhead vertical pole. The test subjects wet condition the gloves before each set of three pulls. The peak pull force value for each individual pull is recorded and reported. The minimum pull force value that occurs after the peak pull force value is recorded and reported.	The Grip Test is used to evaluate the glove's gripping ability, under applied force and specific test conditions. The test is designed to simulate use of a pike pole in ceiling pulls.

(continues)

N Table B.4 *Continued*

Test Method	Test Method Description	Test Method Application
	The individual percentage drop between the peak pull force value and the minimum pull force value is calculated and used to determine pass or fail performance (the drop cannot be more than 30 percent). In addition, failure during any pull constitutes glove failure of the overall test.	
7.7.23 Torque Test	This test is performed on at least three pairs of new, as distributed gloves in two sizes.	The Torque Test is used to evaluate how gloves affect a fire fighter's ability to perform gripping and twisting actions. The results compare the same gripping/twisting action performed both bare-handed and with the gloves. Percentages less than 100 percent mean that the gloves diminish gripping/twisting action while percentages over 100 percent mean that the gloves enhance gripping/twisting motion.
	The test subject dons the glove and attempts to twist a vertical rod mounted on a torque meter. The maximum force applied by the test subject in this twisting motion is measured. The test is performed both bare-handed and with gloves donned. The test results are recorded and averaged and the percent difference between the bare-handed results and the results for tests using gloves is used to determine glove performance. Gloves must allow at least 80 percent of the twisting force for the test subject compared to tests performed bare-handed.	
7.7.24 Glove Tool Test	This test is performed on at least three pairs of new, as distributed gloves in two sizes.	The Glove Tool Test is used to evaluate the effect of gloves on completing a task compared to completing the same task without gloves. Lower percentages indicate that the gloves have less adverse effects on fire fighter tool use.
	The test requires the wearer to pick up a bolt, nut, and washer set and assemble them on a test stand. While being timed, the wearer has to fill all holes across the top and all holes across the bottom of the test stand until all bolt, nut, and washer sets have been installed in the test board. The test is also performed without gloves to establish a baseline result to determine the effect of the gloves when the wearer has to handle small objects. The difference in times for the tests performed bare-handed (control) and with gloves is reported as a percentage. The difference cannot exceed 175 percent. This means that the use of the gloves cannot result in this task taking more than 1.75 times longer when performing the same task without gloves.	

(continues)

N Table B.4 *Continued*

Test Method	Test Method Description	Test Method Application
7.7.25 Transmitted and Stored Thermal Energy Test	This test is performed in accordance with ASTM F2731 on the glove body composite back side under wet conditions. The test measures the heat transfer through the composite when it is exposed to a radiant heat source at a specific heat flux and relates the transferred heat energy to a predicted time of second-degree burn injury. The time to second-degree burn are recorded for each specimen. The time to second-degree burn cannot be less than 130 seconds.	The Transmitted and Stored Thermal Energy Test is used to evaluate, on average, how long it takes to experience a second-degree burn on the back of the hand caused by radiant heat.
7.8.2 Corrosion Resistance Test (glove metal hardware and hardware that includes metal parts)	The test is performed in accordance with ASTM B117 to measure corrosion. Metal hardware is exposed to a saline solution spray for 20 hours, following which base metal can show only slight surface corrosion and the hardware must remain functional.	The Corrosion Resistance Test is used to evaluate whether hardware will (1) corrode and (2) remain functional after extended exposure to a salt spray. Hardware failure can result in loss of thermal and physical protection for the fire fighter.

Table B.5 Footwear

Test Method	Test Method Description	Test Method Application
7.10.1 Conductive Heat Resistance Test 2	This test is performed on the conditioned complete footwear element with removable soles in place. Thermocouples are taped to the insole surface inside the footwear, and the footwear is filled with a specified weight of steel balls. The weighted footwear is placed on a hot plate set at a specific temperature of for a specific time. The thermocouples inside the boot measure the temperature of the footwear insole.	The Conductive Heat Resistance Test 2 is used to evaluate the footwear's resistance to heat transferred through the sole by conduction.
	The average temperature at each test location of the specimen at the end of the specified period is recorded. The temperature of the insole cannot exceed the allowed temperature.	The steel balls weigh the footwear down to place pressure on the sole against the hot surface, similar to what happens on the fireground. The test conditions are not intended to simulate actual fireground exposures but rather serve as a means for measuring the footwear's response to heat. The performance requirement relates to the temperature that causes pain sensation.
7.10.2 Flame Resistance Test 4	This test is performed on the whole footwear element in a draft-free area as received. A tray of fuel is used to create the flame exposure. The fuel in the tray is ignited and is allowed to burn to produce a stable flame. The footwear specimen is clamped on a fixture then positioned above the burning tray where a shutter controls the exposure of the footwear specimen to flames for a specified period.	The Flame Resistance Test 4 is used to evaluate whether the footwear melts, drips, or exhibits burn-through and determines whether it has an afterflame lasting more than 5 seconds.
	Once the flame exposure is stopped, the footwear specimen is examined for afterflame (not more than 5 seconds allowed), melting, dripping, and burn-through. The specimen cannot melt, drip, or exhibit any burn-through.	This is the primary test to establish the flame-resistant properties of the materials used in footwear construction.
7.10.3 Thread Melting Test	This test is performed in accordance with ASTM D7138 on the three different specimens of sewing thread used in the construction of footwear as received.	The Thread Melting Test is used to evaluate the thread used in the construction of the footwear element to determine whether it has at least the same minimum heat resistance as the fabric used in the footwear's construction.
	The temperature at which the thread melts or decomposes is recorded and if it melts below the specific temperature, it fails.	
7.10.4 Liquid Penetration Resistance Test	This test is performed in accordance with ASTM F903 on the footwear moisture barrier and moisture barrier seams. Swatches representative of the footwear construction (not just the barrier layer) are exposed to convective heat conditioning; then the barrier layer is separated and becomes the testing specimen. The normal outer surface of the material is exposed to aqueous film-forming foam, battery acid, surrogate gasoline, fire-resistant hydraulic fluid, swimming pool chlorine additive, and automobile antifreeze fluid. Each liquid is tested separately on an individual specimen.	The Liquid Penetration Resistance Test is used to evaluate whether or not the footwear's moisture barrier material and seams resist penetration of liquids meant to be representative of those commonly encountered on the fireground.

(continues)

N Table B.5 *Continued*

Test Method	Test Method Description	Test Method Application
	During the exposure, pressure is applied behind the liquid for a period of time. At the end of exposure, each sample is evaluated. No liquid can penetrate any sample.	
7.10.5 Viral Penetration Resistance Test	This test is performed in accordance with ASTM F1671 on the footwear moisture barrier and moisture barrier seams. Swatches representative of the footwear construction (not just the barrier layer) are exposed to convective heat conditioning, then the barrier layer is separated and becomes the testing specimen. The normal outer surface of the material is exposed to a surrogate virus in a liquid solution and is evaluated for passage of virus after a specific time. During the specified time exposure, pressure is applied behind the liquid. At the end of exposure, the specimen is rinsed with a clean solution and examined. Any evidence of viral passage through the barrier fabric or seam as determined using a microbiological technique constitutes a failure.	The Viral Penetration Resistance Test is used to evaluate the ability of the footwear's moisture barrier materials and seams to keep blood-borne pathogens from coming in contact with the fire fighter.
7.10.6 Puncture Resistance Test	This test is performed in accordance with ASTM F1342/F1342M Test Method A, on footwear uppers as received. Footwear uppers are clamped into a fixture while force is applied to a nail-like probe in an effort to puncture the specimen. The force required to puncture each specimen is recorded and averaged, and the resulting average cannot be lower than the specified force.	The Puncture Resistance Test is used to evaluate the ability of the footwear uppers to resist puncture under specific test conditions. Higher average force measurements indicate greater puncture resistance.
7.10.7 Cut Resistance Test	This test is performed in accordance with ASTM F1790 on footwear uppers as received under a specific load. The specimen (a composite of footwear upper used in the actual footwear construction, including the tongue but excluding the gusset, with layers arranged in proper order) is clamped to a metal rod while a blade passes across the specimen until it makes contact with the metal rod. After testing, the average distance of blade travel is recorded and cannot be more than the specified length.	The Cut Resistance Test is used to evaluate the ability of the footwear upper composite to resist cutting under specific test conditions. Longer blade travel distances represent greater cut resistance because it takes longer for the blade to cut through the material.

(continues)

Table B.5 *Continued*

Test Method	Test Method Description	Test Method Application
7.10.8 Slip Resistance Test	This test is performed in accordance with ASTM F2913, *Standard Test Method for Measuring the Coefficient of Friction for Evaluation of Slip Performance of Footwear and Test Surfaces/Flooring Using a Whole Shoe Tester,* on the whole footwear element. A footwear specimen is placed in a machine that slides the footwear along a wet tile surface. This test measures the friction (traction) between the soles of the footwear and the tile surface. The coefficient of friction is recorded for each specimen and averaged. The result should be 0.40 or greater.	The Slip Resistance Test is used to evaluate the ability of the footwear to resist slipping under specified test conditions. The surface condition is chosen to simulate a typical slippery surface encountered by fire fighters.
7.10.9 Abrasion Resistance Test	This test is performed in accordance with ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device,* Method A, on material pieces removed from the footwear soles and heel as received. These material specimens are repetitively rubbed against a specific type of sandpaper under a specified pressure, then the amount of material removed by abrasion is measured. Abrasion resistance of the footwear sole and heel materials is adjusted by relative loss of material.	The Abrasion Resistance Test is used to evaluate the footwear's ability to resist abrasion under specified test conditions. The test is intended to measure how easily sole and heel material wear away.
7.10.10 Electrical Insulation Test 2	This test is performed in accordance with Section 9 of ASTM F2412, *Standard Test Methods for Foot Protection,* on whole footwear elements as received. The sample footwear are tested to a specific voltage. Voltage is applied to the footwear specimen through the metal mesh platform. The footwear element is evaluated for current leakage or evidence of breakdown. The footwear should not have a leakage in excess of the specified amount.	The Electrical Insulation Test 2 is used to evaluate the footwear's resistance to electricity under specified test conditions. The test simulates conditions when a fire fighter steps on a live wire.
7.10.11 Ladder Shank Bend Resistance Test	This test is performed on footwear ladder shanks or whole sole equivalents as received. The specimen is placed on mounting blocks, as it would be oriented toward the ladder, and subjected to force on its center with the test probe operated at a specific force. The average deflection is recorded and should not deflect more than a specific distance.	The Ladder Shank Bend Resistance Test is used to evaluate the footwear soles or ladder shanks for resistance to bending when supported only in the middle of the footwear. The test simulates what occurs when a fire fighter uses a ladder.
7.10.12 Eyelet and Stud Post Attachment Test	This test is performed on footwear eyelets and stud posts as received. Specimens are removed from the footwear element and attached to the upper position of the tensile testing machine using the proper puller fixture. The test is started and force is applied.	The Eyelet and Stud Post Attachment Test is used to evaluate the footwear stud posts and eyelets for attachment strength when force is applied. This test is used to determine whether stud posts and eyelets will stay attached under normal use conditions.

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Table B.5 *Continued*

Test Method	Test Method Description	Test Method Application
	At a minimum, the average of all specimen tests can be no less than the specified force. The footwear eyelets and stud posts have to be able to withstand, on average, at least the specified force.	
7.10.13 Corrosion Resistance Test	This test is performed in accordance with ASTM B117 to measure corrosion on all footwear hardware as received. Metal hardware is exposed to a saline solution for a specified period. Following the test, the hardware is evaluated for the appearance of corrosion or oxidation and to see if it remains functional. Evidence of corrosion on the base metal signifies failure.	The Corrosion Resistance Test is used to evaluate whether hardware will (1) corrode and (2) remain functional after extended exposure to salt spray.
(metal hardware and hardware that includes metal parts)		Hardware failure can result in loss of thermal and physical protection for the fire fighter.
7.10.14 Label Durability and Legibility Test 1	This test is performed in accordance with ASTM D4966 on the complete footwear element, with labels attached. Legibility is assessed with labels attached to the footwear after convective heat/ thermal exposure and assessed on individual labels after abrasion. Footwear specimens are subjected to abrasion and are exposed to convective heat to test for heat durability. Footwear labels are examined for continued presence (have to remain attached to the footwear) and for legibility.	The Label Durability and Legibility Test 1 is used to evaluate whether or not the label stays in place and is legible to the unaided eye after abrasion and thermal exposure. The presence and legibility of labels is important for footwear identification and tracking.
7.10.15 Heat and Thermal Shrinkage Resistance Test	This test is performed in accordance with ASTM F2894 on at least three men's size 9D complete footwear elements as received. The footwear component is filled with glass beads and exposed to thermal insult for a specified period of time. Post-exposure, the specimen is examined inside and outside before conditioning in an environmental chamber and again after conditioning for melting, separation, or ignition. Next, the footwear specimen is tested in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*, and flexed on a machine 100,000 times to simulate walking movement. Lastly, the footwear specimen is immersed in surfactant-treated water to a certain height for 2 hours then evaluated for leakage. The appearance of any liquid inside the footwear after exposure is reported as a failure. Also, all components must remain functional.	The Heat and Thermal Shrinkage Resistance Test is used to evaluate the footwear for heat degradation effects after exposure to high temperatures. Footwear is not permitted to melt, separate, or ignite under these conditions. Footwear is also tested for liquid penetration resistance after thermal exposure and flexing to show that footwear will continue to maintain its integrity following simulated use and heat exposure.

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Table B.5 *Continued*

Test Method	Test Method Description	Test Method Application
7.11.2 Radiant Heat Resistance Test 1	This test is performed on each area of the footwear upper, as well as the tongue but excluding the gusset, including booties, where provided, as received. The specimen is placed in front of a radiometer and exposed to heat for a specified period at a specific temperature. The temperature at 30 seconds of exposure for each area is recorded and reported, then averaged; the average cannot exceed the specified temperature.	The Radiant Heat Resistance Test 1 is used to evaluate the footwear for resistance to heat transfer from exposure to radiant energy. The test conditions are not intended to simulate actual fireground exposures, but rather serve as a means for measuring the footwear's response to radiant heat.
7.11.3 Conductive Heat Resistance Test 1	This test is performed in accordance with ASTM F1060 on the footwear upper composites as received. Composite specimens are placed on a hot plate that is heated to a specific temperature, while a specific pressure is applied. A weighted sensor on top of the specimen measures the rate of heat transfer. The heat transfer data are used to predict the time to pain and the time to second-degree burn. The average time to pain cannot be fewer than 6 seconds, and the average time to second-degree burn cannot be fewer than 10 seconds.	The Conductive Heat Resistance Test 1 is used to evaluate the upper portion of the footwear for thermal insulation. The test conditions are not intended to simulate actual fireground exposures, but rather serve as a means for measuring the footwear upper's resistance to heat transfer when contacted is made with a hot surface.

N Table B.6 Hoods

Test Method	Test Method Description	Test Method Application
7.13.1 Hood Opening Size Retention Test	This test is performed on the protective hood as received. The whole hood is placed on a tensile tester and elongated and returned to its original position 50 times to simulate donning and doffing. Once completed, the hood is removed from the tensile tester and allowed to rest for 1 minute. The hood is then placed on the hood face opening measuring device to determine compliance. The hood opening has to slide freely over the top half of the hood measuring device while in the relaxed state and cannot show any gaps when placed on the lower half of the hood measuring device.	The Hood Opening Size Retention Test is used to evaluate the ability of the hood to retain its shape after being pulled over the head many times and to make sure it doesn't fit too tightly around the neck when not deployed.
7.13.1.1 Hood Opening Size Retention Test (when the hood is designed for a specific SCBA facepiece)	This test is performed on the protective hood as received. The whole hood is placed on a tensile tester and elongated and returned to its original position 50 times to simulate donning and doffing. If the hood is designed to be manually adjusted when donned, the person performing the test has to manually adjust the hood each time it is placed on the facepiece. Once completed, the hood is removed from the tensile tester and allowed to rest for 1 minute. The hood is then donned on the headform and placed over the facepiece. The hood is evaluated in the original eight (or more) locations to determine if the hood opening retains its shape. The hood used in this test has to overlap the outer edge of the specific SCBA facepiece-to-face seal perimeter by at least 13 mm (½ in.).	This test evaluates the ability of the hood's SCBA face piece opening to retain its shape after being pulled over the head and the specified SCBA face piece many times.
7.13.2 Thermal Protective Performance (TPP) Test	This test is performed in accordance with ISO 17492 on the portions of the hood that cover the neck and facial area as received and after conditioning with five laundering cycles. Specimens used for testing must be at least a specific size. The hood is exposed to both radiant and convective heat sources. The rate of rise in temperature is recorded and compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the TPP rating. The TPP rating of the hood has to be at least 20.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the hood by evaluating how quickly heat is transferred from the outside of the hood to the inside. Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn. This is the primary test to measure the hood's ability to protect the fire fighter from severe heat and flame. A TPP rating of 20 is acceptable because the hood area is overlapped by another part of the ensemble that also provides insulation.

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Table B.6 *Continued*

Test Method	Test Method Description	Test Method Application
7.13.3 Flame Resistance Test 1	This test is performed in accordance with ASTM D6413 on five individual samples of hood material(s) and five individual samples of labels attached to hood material(s). Specimens are tested as received and after conditioning with five laundry cycles. Hood labels are cut from the conditioned samples and tested in a vertical flame chamber in accordance with ASTM D6413. Specimens are evaluated for average char length [cannot exceed 100 mm (4 in.]; for average afterflame (cannot be more than 2 seconds); and for evidence of melting or dripping (material cannot melt or drip).	The Flame Resistance Test 1 is used to evaluate the hood materials, under controlled test conditions, for the ability to self-extinguish after the flame is removed and to resist charring, melting, and dripping.
7.13.4 Heat and Thermal Shrinkage Resistance Test (shrinkage)	This test is performed on complete hoods as received and after conditioning with five laundry cycles. The hood is placed on a nonconductive headform in the center of the test oven and exposed to 260°C (500°F) for 5 minutes. After this exposure hoods are evaluated on a hood measuring device. Hoods are required to slide freely over the top half of the hood measuring device while in the relaxed state, and cannot show any gaps when placed on the lower half of the hood measuring device. Measurements from the top of the hood down the sides and down the back are used to determine shrinkage. Hoods cannot shrink more than 10 percent.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the hood materials for shrinkage after exposure to high temperatures. Excessive shrinkage could impact the insulating qualities of the hood.
7.13.5 Heat and Thermal Shrinkage Resistance Test (melting, separation, ignition)	This test is performed after conditioning hoods and labels with five laundry cycles. The specimen is placed on a nonconductive headform in the center of the oven and exposed to 260°C (500°F) for 5 minutes. Hoods cannot show evidence of melting, separation, or ignition after this test.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the hood materials for melting, separation, and ignition after exposure to high temperatures.
7.13.6 Cleaning Shrinkage Resistance Test	This test is performed on complete hoods as received. Hoods are machine washed five times using a specific laundry procedure. After washing, hoods are evaluated on a hood measuring device. Hoods are required to slide freely over the top half of the hood measuring device while in the relaxed state, and cannot show any gaps when placed on the lower half of the hood measuring device. Measurements from the top of the hood down the sides and down the back are used to determine shrinkage. Hoods cannot shrink more than 5 percent.	The Cleaning Shrinkage Resistance Test is used to evaluate hood materials for shrinkage after cleaning. Excessive shrinkage increases the possibility of burns.

(continues)

Table B.6 *Continued*

Test Method	Test Method Description	Test Method Application
7.13.7 Thread Melting Test	This test is performed in accordance with ASTM D7138 on the three different specimens of sewing thread used in the construction of the hood as received. The temperature at which the thread melts or decomposes is recorded, and if it melts below 260°C (500°F), it fails.	The Thread Melting Test is used to evaluate the thread used in the construction of the hoods to determine if it has at least the same heat resistance as the fabric used in garment construction.
7.13.8 Burst Strength Test	This test is performed in accordance with ASTM D6797 on the hood materials as received. Hood Material: A tensile testing machine is used to push a steel ball through the clamped hood material. The maximum force used to burst the material is recorded. The specimen cannot burst under less than the specified force.	The Burst Strength Test is used to evaluate the strength of the hood material by measuring its resistance to bursting or rupturing when force is applied under specific test conditions. This test is used to determine whether, on average, the hood material can sustain applied force, under specific test conditions. Higher bursting force resistance numbers indicate stronger hood materials.
7.13.9 Seam-Breaking Strength Test	This test is performed in accordance with ASTM D6797 on at least five specimens of conditioned hood seams. The seam breaking strength (the amount of pounds force required to break the seam) is recorded and reported for each specimen, and those values are averaged for the assessment. The force required to break the seam is recorded and averaged for the test specimens, and the average result cannot be less than the specified force.	The Seam-Breaking Strength Test is used to evaluate the strength of the hood seams under stress. The durability of the seam is an indicator of physical performance when subjected to repeated donning and doffing. Higher breaking forces indicate stronger seams.
7.13.10 Label Durability and Legibility Test 1	These tests are performed on hood labels on complete hoods with labels attached (laundering), individual labels (abrasion), and labels sewn onto a separate square of hood material (convective heat exposure). The laundering test is performed in accordance with AATCC 135 and the abrasion test is performed in accordance with ASTM D4966. Hood labels are examined for continued presence (have to remain attached to the hood) and for legibility.	The Label Durability and Legibility Test 1 is used to evaluate whether or not the label stays in place and is legible to the unaided eye after exposure to multiple launderings, abrasion, and convective heat. In addition to being legible, the labels must remain in place following testing. The presence and legibility of labels is important for hood identification and tracking.
7.14.2 Particulate Blocking Test (Optional Requirement)	This test is performed in accordance with ASTM F2299/F2299M, *Standard Test Method for Determining the Initial Efficiency of Materials Used in Medical Face Masks to Penetration by Particulates Using Latex Spheres,* on three specimens of conditioned particulate blocking materials. Modifications were made to the test method to allow for testing materials that are not air permeable. Materials are required to meet 90 percent efficiency.	The Particulate Blocking Test is intended to replicate smoke exposure to hoods. The hoods are evaluated for particulates penetrating the hood.

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Table B.6 *Continued*

Test Method	Test Method Description	Test Method Application
7.14.3 Total Heat Loss (THL) Test	This test is performed in accordance with ASTM F1868, *Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate,* on samples of the hood composite conditioned at room temperature arranged in the order and orientation it is worn. Specimens are placed on a sweating hot plate to evaluate heat transfer under wet conditions and thermal resistance under dry conditions. These values are combined in an equation to provide a total heat loss value.	The Total Heat Loss (THL) Test is used to evaluate the amount of heat that can be transferred out of the hood composite via both sweat evaporation from the wearer's skin and conduction through the garment to the outside environment.
(Optional Requirement)		Higher values indicate better performance and more heat loss. However, appropriate THL values for your department must be considered with TPP values. *(See A.7.2.2 for more details.)*

N Table B.7 Footwear

Test Method	Test Method Description	Test Method Application
7.16.1 Thermal Protective Performance (TPP) Test	This test is performed in accordance with ISO 17492 on the protective wristlet interface components as received and after conditioning. The protective wristlet interface components are exposed to both radiant and convective heat sources. The rate of rise in temperature is recorded and compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the TPP rating. The TPP rating of the protective wristlet interface components has to be at least 20.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the protective wristlet interface components by evaluating how quickly heat is transferred from the outside of the protective wristlet interface components to the inside. Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn. This is the primary test to measure the protective wristlet interface component's ability to protect the fire fighter from severe heat and flame. A TPP rating of 20 is acceptable because the protective wristlet interface component area is overlapped by another part of the ensemble that also provides insulation.
7.16.1.1 Thermal Protective Performance (TPP) Test (coat sleeve ends in a garment-glove interface)	This test is performed in accordance with ISO 17492 on the interface composite where the coat sleeve end terminates in a garment-glove interface, as received and after conditioning. The interface composite is exposed to both radiant and convective heat sources. The rate of rise in temperature is recorded and compared to the known skin response to heat; the recorded time is multiplied by the heat exposure energy to determine the TPP rating. The TPP rating of the protective wristlet interface components has to be at least 35.	The Thermal Protective Performance (TPP) test is used to measure the insulating performance of the garment-glove interface by evaluating how quickly heat is transferred from the outside of the interface composite to the inside. Under the given test conditions, which simulate severe flashover conditions, the TPP rating divided in half indicates the approximate number of seconds until a fire fighter would receive a second-degree burn. This is the primary test to measure the interface composite's ability to protect the fire fighter from severe heat and flame.
7.16.2 Flame Resistance Test 1	This test is performed in accordance with ASTM D6413/D6413M on five individual samples of protective wristlet interface component material(s). Specimens are tested after conditioning with five laundry cycles. Specimens are evaluated for average char length (cannot exceed a specified length); for average afterflame (cannot be more than 2 seconds); and for evidence of melting or dripping (material cannot melt or drip).	The Flame Resistance Test 1 is used to evaluate the protective wristlet interface component materials, under controlled test conditions, for the ability to self-extinguish after the flame is removed and to resist charring, melting, and dripping.

(continues)

Table B.7 *Continued*

Test Method	Test Method Description	Test Method Application
7.16.3 Heat and Thermal Shrinkage Resistance Test	This test is performed after conditioning with five laundry cycles on protective wristlet interface components materials.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the protective wristlet interface components materials for shrinkage after exposure to high temperatures.
(shrinkage)	Protective wristlet interface components cannot shrink more than 10 percent in any direction.	Excessive shrinkage could impact the insulating qualities of the protective wristlet interface components.
7.16.4 Heat and Thermal Shrinkage Resistance Test	This test is performed after conditioning protective wristlet interface components and labels with five laundry cycles.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the protective wristlet interface components materials for melting, separation, and ignition after exposure to high temperatures.
(melting, separation, ignition)	Protective wristlet interface components cannot show evidence of melting, separation, or ignition after this test.	
7.16.5 Cleaning Shrinkage Resistance Test	This test is performed after conditioning with five laundry cycles on protective wristlet interface component materials.	The Heat and Thermal Shrinkage Resistance Test is used for this requirement to evaluate the protective wristlet interface component materials for shrinkage after exposure to high temperatures.
	Protective wristlet interface component cannot shrink more than 5 percent in any direction.	Excessive shrinkage could impact the insulating qualities of the protective wristlet interface components.
7.16.6 Thread Melting Test	This test is performed in accordance with ASTM D7138 on the three different specimens of sewing thread used in the construction of the protective wristlet interface components as received.	The Thread Melting Test is used to evaluate the thread used in the construction of the protective wristlet interface components to determine if it has at least the same heat resistance as the fabric used in garment construction.
	The temperature at which the thread melts or decomposes is recorded, and if it melts below a specific temperature, it fails.	
7.16.7 Burst Strength Test (knit wristlet material)	This test is performed in accordance with ASTM D6797 on the knit protective wristlet interface components materials as received.	The Burst Strength Test is used to evaluate the strength of the protective wristlet interface components by measuring its resistance to bursting or rupturing when force is applied under specific test conditions.
	A tensile testing machine is used to push a steel ball through the clamped protective wristlet interface component materials. The maximum force used to burst the material is recorded. The specimen cannot burst under less than the specified force.	This test is used to determine whether, on average, the protective wristlet interface components can sustain applied force of at least the specified force, under specific test conditions. Higher bursting force resistance numbers indicate stronger protective wristlet interface components.
7.16.8 Seam-Breaking Strength Test	This test is performed on at least five specimens of conditioned knit protective wristlet interface components seams.	The Seam-Breaking Strength Test is used to evaluate the strength of the protective wristlet interface component seams under stress. The durability of the seam is an indicator of physical performance when subjected to repeated donning and doffing. Higher breaking forces indicate stronger seams.
(knit wristlet seams)	The seam breaking strength (the amount of pounds force required to break the seam) is recorded and reported for each specimen and those values are averaged for the assessment.	

(continues)

N Table B.7 *Continued*

Test Method	Test Method Description	Test Method Application
	The force required to break the seam is recorded and averaged for the test specimens, and the average result cannot be less than the specified force.	
7.16.9 Whole Garment and Ensemble Liquid Penetration Test (Shower Test)	This test is performed in accordance with ASTM F1359 on a full garment set (coat and pants) or coveralls. The whole garment is placed on a manikin dressed in a water-absorptive layer and exposed to 2.5 minutes of liquid spray from four different orientations for a total of 10 minutes. After removal of the garment, the water-absorptive layer is examined for evidence of moisture penetration.	The Shower Test is used to evaluate how well the seams and closures of the garment, under controlled test conditions, resist inward leakage of liquids from exterior sources. This is a test to determine whether or not the garment will help keep the fire fighter dry from hose streams, standing water, and precipitation.
(where the coat sleeve end terminates in a garment-glove interface)		Note: The Shower Test is the *only* test performed on assembled garments — coats and pants.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.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*, 2018 edition.

NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2014 edition.

NFPA 1973, *Gloves for Structural Fire Fighting*, 1993 edition (withdrawn).

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

NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies*, 2017 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*, 2017 edition.

C.1.2 Other Publications.

C.1.2.1 AATCC Publications. American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle, NC 27709.

AATCC 135, *Dimensional Changes of Fabrics After Home Laundering*, 2004.

AATCC 42, *Water Resistance: Impact Penetration Test*, 2013.

C.1.2.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM B117, *Test Method for Water Resistance: Impact Penetration Test*, 2016.

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

ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, 2013.

ASTM D1683/D1683M, *Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics*, 2011a.

ASTM D1776/D1776M, *Standard Practice for Conditioning and Testing Textiles*, 2016.

ASTM D4966, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Test Method)*, 2012e1.

ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*, 2013.

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

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

ASTM D5587, *Standard Test Method for the Tearing Strength of Fabrics by Trapezoid Procedure*, 2015.

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

ASTM D6775, *Standard Test Method for Breaking Strength and Elongation of Textile Webbing, Tape and Braided Material*, 2013.

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• Δ **C.1.2.11 Other Publications.**

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• **C.2 Informational References. (Reserved)**

C.3 References for Extracts in Informational Sections. (Reserved)

Index

Sequence of Events for the Standards Development Process

Once the current edition is published, a Standard is opened for Public Input.

Step 1 – Input Stage

- Input accepted from the public or other committees for consideration to develop the First Draft
- Technical Committee holds First Draft Meeting to revise Standard (23 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Technical Committee ballots on First Draft (12 weeks); Technical Committee(s) with Correlating Committee (11 weeks)
- Correlating Committee First Draft Meeting (9 weeks)
- Correlating Committee ballots on First Draft (5 weeks)
- First Draft Report posted on the document information page

Step 2 – Comment Stage

- Public Comments accepted on First Draft (10 weeks) following posting of First Draft Report
- If Standard does not receive Public Comments and the Technical Committee chooses not to hold a Second Draft meeting, the Standard becomes a Consent Standard and is sent directly to the Standards Council for issuance (see Step 4) or
- Technical Committee holds Second Draft Meeting (21 weeks); Technical Committee(s) with Correlating Committee (7 weeks)
- Technical Committee ballots on Second Draft (11 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Correlating Committee Second Draft Meeting (9 weeks)
- Correlating Committee ballots on Second Draft (8 weeks)
- Second Draft Report posted on the document information page

Step 3 – NFPA Technical Meeting

- Notice of Intent to Make a Motion (NITMAM) accepted (5 weeks) following the posting of Second Draft Report
- NITMAMs are reviewed and valid motions are certified by the Motions Committee for presentation at the NFPA Technical Meeting
- NFPA membership meets each June at the NFPA Technical Meeting to act on Standards with "Certified Amending Motions" (certified NITMAMs)
- Committee(s) vote on any successful amendments to the Technical Committee Reports made by the NFPA membership at the NFPA Technical Meeting

Step 4 – Council Appeals and Issuance of Standard

- Notification of intent to file an appeal to the Standards Council on Technical Meeting action must be filed within 20 days of the NFPA Technical Meeting
- Standards Council decides, based on all evidence, whether to issue the standard or to take other action

Notes:

1. Time periods are approximate; refer to published schedules for actual dates.
2. Annual revision cycle documents with certified amending motions take approximately 101 weeks to complete.
3. Fall revision cycle documents receiving certified amending motions take approximately 141 weeks to complete.

Committee Membership Classifications[1,2,3,4]

The following classifications apply to Committee members and represent their principal interest in the activity of the Committee.

1. M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
2. U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
3. IM *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
4. L *Labor:* A labor representative or employee concerned with safety in the workplace.
5. RT *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
6. E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
7. I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
8. C *Consumer:* A person who is or represents the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in (2).
9. SE *Special Expert:* A person not representing (1) through (8) and who has special expertise in the scope of the standard or portion thereof.

NOTE 1: "Standard" connotes code, standard, recommended practice, or guide.

NOTE 2: A representative includes an employee.

NOTE 3: While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of member or unique interests need representation in order to foster the best possible Committee deliberations on any project. In this connection, the Standards Council may make such appointments as it deems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.

NOTE 4: Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

Submitting Public Input / Public Comment Through the Online Submission System

Soon after the current edition is published, a Standard is open for Public Input.

Before accessing the Online Submission System, you must first sign in at www.nfpa.org. *Note: You will be asked to sign-in or create a free online account with NFPA before using this system:*

a. Click on Sign In at the upper right side of the page.
b. Under the Codes and Standards heading, click on the "List of NFPA Codes & Standards," and then select your document from the list or use one of the search features.

OR

a. Go directly to your specific document information page by typing the convenient shortcut link of www.nfpa.org/document# (Example: NFPA 921 would be www.nfpa.org/921). Sign in at the upper right side of the page.

To begin your Public Input, select the link "The next edition of this standard is now open for Public Input" located on the About tab, Current & Prior Editions tab, and the Next Edition tab. Alternatively, the Next Edition tab includes a link to Submit Public Input online.

At this point, the NFPA Standards Development Site will open showing details for the document you have selected. This "Document Home" page site includes an explanatory introduction, information on the current document phase and closing date, a left-hand navigation panel that includes useful links, a document Table of Contents, and icons at the top you can click for Help when using the site. The Help icons and navigation panel will be visible except when you are actually in the process of creating a Public Input.

Once the First Draft Report becomes available there is a Public Comment period during which anyone may submit a Public Comment on the First Draft. Any objections or further related changes to the content of the First Draft must be submitted at the Comment stage.

To submit a Public Comment you may access the online submission system utilizing the same steps as previously explained for the submission of Public Input.

For further information on submitting public input and public comments, go to: http://www.nfpa.org/publicinput.

Other Resources Available on the Document Information Pages

About tab: View general document and subject-related information.

Current & Prior Editions tab: Research current and previous edition information on a Standard.

Next Edition tab: Follow the committee's progress in the processing of a Standard in its next revision cycle.

Technical Committee tab: View current committee member rosters or apply to a committee.

Technical Questions tab: For members and Public Sector Officials/AHJs to submit questions about codes and standards to NFPA staff. Our Technical Questions Service provides a convenient way to receive timely and consistent technical assistance when you need to know more about NFPA codes and standards relevant to your work. Responses are provided by NFPA staff on an informal basis.

Products & Training tab: List of NFPA's publications and training available for purchase.

Information on the NFPA Standards Development Process

I. Applicable Regulations. The primary rules governing the processing of NFPA standards (codes, standards, recommended practices, and guides) are the NFPA *Regulations Governing the Development of NFPA Standards (Regs).* Other applicable rules include NFPA *Bylaws,* NFPA *Technical Meeting Convention Rules,* NFPA *Guide for the Conduct of Participants in the NFPA Standards Development Process,* and the NFPA *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council.* Most of these rules and regulations are contained in the *NFPA Standards Directory.* For copies of the *Directory,* contact Codes and Standards Administration at NFPA Headquarters; all these documents are also available on the NFPA website at "www.nfpa.org."

The following is general information on the NFPA process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

II. Technical Committee Report. The Technical Committee Report is defined as "the Report of the responsible Committee(s), in accordance with the Regulations, in preparation of a new or revised NFPA Standard." The Technical Committee Report is in two parts and consists of the First Draft Report and the Second Draft Report. (See *Regs* at Section 1.4.)

III. Step 1: First Draft Report. The First Draft Report is defined as "Part one of the Technical Committee Report, which documents the Input Stage." The First Draft Report consists of the First Draft, Public Input, Committee Input, Committee and Correlating Committee Statements, Correlating Notes, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.3.) Any objection to an action in the First Draft Report must be raised through the filing of an appropriate Comment for consideration in the Second Draft Report or the objection will be considered resolved. [See *Regs* at 4.3.1(b).]

IV. Step 2: Second Draft Report. The Second Draft Report is defined as "Part two of the Technical Committee Report, which documents the Comment Stage." The Second Draft Report consists of the Second Draft, Public Comments with corresponding Committee Actions and Committee Statements, Correlating Notes and their respective Committee Statements, Committee Comments, Correlating Revisions, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.4.) The First Draft Report and the Second Draft Report together constitute the Technical Committee Report. Any outstanding objection following the Second Draft Report must be raised through an appropriate Amending Motion at the NFPA Technical Meeting or the objection will be considered resolved. [See *Regs* at 4.4.1(b).]

V. Step 3a: Action at NFPA Technical Meeting. Following the publication of the Second Draft Report, there is a period during which those wishing to make proper Amending Motions on the Technical Committee Reports must signal their intention by submitting a Notice of Intent to Make a Motion (NITMAM). (See *Regs* at 4.5.2.) Standards that receive notice of proper Amending Motions (Certified Amending Motions) will be presented for action at the annual June NFPA Technical Meeting. At the meeting, the NFPA membership can consider and act on these Certified Amending Motions as well as Follow-up Amending Motions, that is, motions that become necessary as a result of a previous successful Amending Motion. (See 4.5.3.2 through 4.5.3.6 and Table 1, Columns 1-3 of *Regs* for a summary of the available Amending Motions and who may make them.) Any outstanding objection following action at an NFPA Technical Meeting (and any further Technical Committee consideration following successful Amending Motions, see *Regs* at 4.5.3.7 through 4.6.5.3) must be raised through an appeal to the Standards Council or it will be considered to be resolved.

VI. Step 3b: Documents Forwarded Directly to the Council. Where no NITMAM is received and certified in accordance with the Technical Meeting Convention Rules, the standard is forwarded directly to the Standards Council for action on issuance. Objections are deemed to be resolved for these documents. (See *Regs* at 4.5.2.5.)

VII. Step 4a: Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any document of the NFPA or on matters within the purview of the authority of the Council, as established by the Bylaws and as determined by the Board of Directors. Such appeals must be in written form and filed with the Secretary of the Standards Council (see *Regs* at Section 1.6). Time constraints for filing an appeal must be in accordance with 1.6.2 of the *Regs.* Objections are deemed to be resolved if not pursued at this level.

VIII. Step 4b: Document Issuance. The Standards Council is the issuer of all documents (see Article 8 of *Bylaws*). The Council acts on the issuance of a document presented for action at an NFPA Technical Meeting within 75 days from the date of the recommendation from the NFPA Technical Meeting, unless this period is extended by the Council (see *Regs* at 4.7.2). For documents forwarded directly to the Standards Council, the Council acts on the issuance of the document at its next scheduled meeting, or at such other meeting as the Council may determine (see *Regs* at 4.5.2.5 and 4.7.4).

IX. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the codes and standards development process and to protect the interests of the NFPA. The rules for petitioning the Board of Directors can be found in the *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council* and in Section 1.7 of the *Regs.*

X. For More Information. The program for the NFPA Technical Meeting (as well as the NFPA website as information becomes available) should be consulted for the date on which each report scheduled for consideration at the meeting will be presented. To view the First Draft Report and Second Draft Report as well as information on NFPA rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org/docinfo) or contact NFPA Codes & Standards Administration at (617) 984-7246.

Exhibit B

Fire Fighters Protective Clothing: Moisture Barrier Alert and Recall

As we previously informed our membership, the manufacturer of BREATHE-TEX® moisture barriers used in fire fighters' protective clothing has alerted protective clothing manufacturers using their product that this product is degrading in the field. The manufacturer, Aldan Engineered Coated Fabrics, states that the moisture barrier should be replaced if evidence of such breakdown has occurred.

The IAFF continues to believe that this situation may pose a significant safety hazard to fire fighters. Not only does the moisture barrier provide primary protection from water. it provides primary protection from many common liquids. Those liquids include some common chemicals and bloodborne pathogens encountered during the normal performance of fire fighting duties. These duties include structural fire fighting operations, aircraft rescue and fire operations, extrication of victims from vehicles and other entrapment situations, provision of first responder or emergency medical care and other fire fighting and rescue situations.

in offering their customers a recall of Breath-Tex at no cost to the customer. Two additional manufacturers, Starfield Safetywear and Bristol Uniforms North America have informed the IAFF that they have never used the BREATHE-TEX® product. We believe that a product recall and replacement is the right stand on this issue and all manufacturers of fire fighters' protective clothing should follow suit and initiate such a product recall.

Unfortunately, such is not the case.

On November 15, the manufacturers of Body-Guard (Lion Apparel), Cairns Protective Clothing (Globe), Fire-Dex, Fire-Gear (Securitex), Globe Firefighter Suits, Janesville (Lion Apparel), Quaker Safety, and Securitex Brands of fire fighters protective clothing issued the following Joint Statement regarding the wear life of moisture barriers. Their full statement follows:

- The moisture barrier is the most fragile protective component in your gear. While everyone would like to understand exactly what causes moisture barriers to wear out, and when it will happen, it is likely to happen before other elements of your protective clothing wear out. For this reason, every fire fighter and fire department should inspect their gear on a regular basis, as stated in our user guides. Particular attention should be paid to the moisture barrier, regardless of what brand it is.
- Aldan Industries, Inc., the producer of the majority of the moisture barriers being used today, has written to manufacturers of NFPA compliant turnouts to advise them that some of their "BREATHE-TEX® moisture barriers used in fire fighters' turnout garments are showing signs of degradation." The letter from Mr. Edwin T. Winter, chairman/CEO of Aldan, goes on to say that their "investigations suggest that the garments may have been subject to attack resulting from storage conditions, length of service, care and/or maintenance." Mr. Winter also indicates there are a number of factors that may cause this degradation to occur over time.
- BREATHE-TEX® has been in the fire service since 1994. Wear life issues were only recognized recently, five years after the product was introduced.
- We believe that the potential exists for polyurethane moisture barriers similar to BREATHE-TEX® to degrade over time in a similar manner. However, recent

- The long term wear characteristics of most fire fighting fabrics are not fully apparent until they have been in service for an extended period of time. For example, the full extent of the wear life difference between 6 ounce PBI® and 7.5 ounce PBI® was not known until the lighter weight product had been in service for several years.
- Just as no manufacturer claimed equivalent wear life for 6.0 ounce and 7.5 ounce PBI®, no manufacturer (including Aldan) has claimed that any polyurethane based moisture barrier will have equal durability to a Crosstech® PTFE barrier.
- There are differences and tradeoffs in performance, quality, durability and price throughout the entire range of outer shells, thermal barriers, moisture barriers, reflective trim, reinforcements, etc.
- Another manufacturer's 11/10/99 "recall" program for BREATHE-TEX® denies the similarities between that product and other Aldan offerings such as BREATHE-TEX PLUS®. It also fails to address the importance of inspecting and checking all moisture barriers on a regular basis.
- There is a simple field test you can perform to check any moisture barrier: Place your liner on a flat surface (or over a bucket) with the dry thermal barrier facing down and dry moisture barrier facing up. Pour about one-half cup of water on the moisture barrier and wait a few minutes. If the water passes through the moisture barrier and wets the thermal barrier, your liner should be removed from service and repaired or replaced. Perform this simple test in high abrasion areas (like the broadest part of the shoulders, at the knee, or the seat of the pants), or where you have detected other potential damage to the shell or thermal barrier. It is difficult to determine with any certainty whether your moisture barrier leaks by looking at either the film or the fabric it's laminated to. Do the test! Or have the test done by a reputable turnout cleaning and repair company.
- If you do this test on your gear, and there is leakage, or you detect leakage, contact your local dealer or original manufacturer about repair or replacement of the moisture barrier.

The IAFF strongly believes that this is the wrong course of action and places the fire fighter at risk. Just as Aldan has passed the responsibility for inspection

manufacturers' clothing. Although the manufactures are honoring their warranties on individual garment failures, these are often only within a one-year warranty period.

The IAFF has been a continual strong proponent of inspection, maintenance of and, when necessary, replacement of fire fighters protective clothing to assure the protection of the fire fighter that the garment was to provide. Accordingly, we agree with the Joint Statement regarding regular garment inspection. However, premature product failure demands a recall and replacement.

The Joint Statement also fails to recognize the critical uses of moisture barrier product other then as a liner. Moisture barrier product is used in all closure and interface areas (i.e., facings) to provide complete and circumferential protection to the fire fighter. For these reasons, the NFPA 1971, Standard on Structural Fire Fighting Protective Ensemble requires a full shower test to determine compliance of the liner and all such facings. **Spot-checking with a 1/2 cup of water demonstrates nothing, except when the product fails this simplistic test. In recognition of Aldan's statement, that the problem is not observable by routine visual inspection, and the failure to address closure and interface areas, "passing" the one-half cup of water test means very little. Accordingly, this product must be replaced.** Further, we are only aware of degradation of Aldan's BREATHE-TEX®. This polyurethane product is a non-crosslinked microporus polymer membrane that is laminated to a fabric, usually NOMEX E-89®.

Since this issue surfaced, the fire service has been bombarded with unfamiliar technical terms regarding moisture barriers. Following is a summary of moisture barrier product technology.

There are three types of moisture barrier product technology used today in fire fighters protective garments. These include using membranes that are microporous, monolithic, or bi-component.

A microporous membrane contains small passages (holes) allowing for minute air permeability and thus offers water vapor transfer (breathability) by air-diffusion. A non-crosslinked polyurethane polymer is used for the microporous moisture barrier product BREATHE-TEX®, as well as the PORELLE®, PROLINE®

silicone. These microporous membranes are laminated (glued) to a base fabric such as NOMEX E-89® or the BASOFIL® product VILENE®.

A monolithic membrane is a continuous polymer layer without any passages (holes), and, therefore, does not have any air permeability. Nonbreathable monolithic moisture barrier products include neoprene (NEOGUARD®) and polyvinyl chloride (PVC). Nonbreathable neoprene moisture barriers are still used in the fire service. However, the new edition of NFPA 1971 (2000 edition) has a breathability performance requirement that will eliminate their use. Nonbreathable PVC moisture barriers, while used in Europe, were not used in protective garments for the U.S. and Canadian fire service.

Breathable monolithic moisture barrier products use hydrophilic polymers (i.e., a water loving material that has a strong affinity for, and the ability to absorb water) that allow water vapor transfer (breathability) through molecular diffusion. Once water vapor contacts the hydrophilic polymer, it permeates through the polymer one molecule at a time. Cross-linked polyurethane polymers often are found in monolithic moisture barriers used by the fire service. Cross-linking is a polymer chemistry term that describes the stabilization of the polymer through additives. The chemical process connects the polymer's molecular chains through molecular bridges. Cross-linking of polymers can increase the product's thermal stability. Typically, increased cross-linking can also reduce breathability and increase stiffness of the final product. Monolithic moisture barrier products using polyurethane include BREATHE-TEX PLUS® and STEDAIR 2000®.

Other polymers are used for breathable monolithic moisture barrier products, including polyamides and co-polyesters. Monolithic moisture barrier products using co-polyesters are not typically used in the fire service for protective clothing moisture barriers; however, the co-polyester product SYMPATEX® is used as a moisture barrier in protective footwear. A monolithic moisture barrier product using polyamides is STEDAIR 82®.

These polymers are usually coated onto a base fabric such as Nomex E-89. There are two typical coating methods used for moisture barrier products. With cast-coating the polymer resin is applied over the base fabric and cured by

stationary knife, the gap between the knife and the fabric determines the coating thickness.

A bi-component moisture barrier product uses a combination of microporous and monolithic technologies, and allows no air permeability. There are two methods to combine this technology, intimate and layered.

An intimate bi-component moisture barrier product uses a monolithic polymer that is impregnated into a microporous membrane. Intimate bi-component membranes include GORE-TEX® and CROSSTECH®. These products use a microporous expanded polytetrafluoroethylene (ePTFE) membrane (TEFLON®) that is monolithically impregnated with cross-linked polyurethane. The membrane is laminated (glued) to a base fabric such as NOMEX E89® or NOMEX® ripstop (i.e. pajama check).

A layered bi-component moisture barrier product uses a monolithic polymer that is placed either on top of or below the microporous membrane. AQUATECHTM uses a base fabric that is laminated to a microporous membrane and than coated with a thin monolithic layer. COMFORT ZONE® uses a base fabric that is coated with a monolithic layer with a microporous layer on top. These layered bi-component membranes use a base fabric such as NOMEX® E-89 or the BASOFIL® product VILENE®.

Most fire service breathable moisture barrier products, as described above, use polyurethane technology due to this polymer's ability to be made hydrophilic. The challenging issue with hydrophilic polyurethanes is producing a moisture barrier product that is hydrophilic but that still maintains thermal and durable properties. Different degrees of polymer cross-linking are often used to create a balance in these properties, as are different construction technologies with microporous and monolithic layers.

Because the moisture barrier products described above use different polymer and construction techniques, research is continuing to determine whether the performance problems demonstrated with BREATHE-TEX® (especially cracking, flaking and leaking) are applicable to other moisture barrier products. Currently, there are no indications or field reports that other monolithic or bi-component moisture barrier products are experiencing the same degradation performance

and PROLINE®. Porvair International, Ltd. manufactures PURELLE®, which is sold in the United Kingdom (and in the United States as a moisture barrier membrane for fire fighter gloves). Porvair has licensed its microporous membrane technology to Aldan, which markets this product in the United States as BREATHE-TEX®, to Dominion Textile which markets this product in Canada as VAPRO® and to Lanair de Picardie, which markets this product in France as PROLINE®.

Some of these moisture barrier products are no longer being marketed to the fire service protective clothing manufacturers. BREATHE-TEX® has not been sold to the garment manufactures since the spring of 1999, but they may still be available to the fire service. In the case of BREATHE-TEX®, protective clothing manufacturers may have protective garments in stock that were constructed of this material. Also, there may be considerable numbers of protective garments that use BREATHE-TEX® in their distribution network. Fire departments must be made aware of this and must not accept any products that contain BREATHE-TEX®. The IAFF is also aware that some protective clothing manufacturers have used BREATHE-TEX® as facings (e.g., in front closures, cuffs, and liner interface areas). We believe this was done at a cost saving, where a more expensive moisture barrier liner (e.g., CROSSTECH®) was specified but the manufacturer used a cheaper product (in this case BREATHE-TEX®) as the facing. If the BREATHE-TEX® facing provides part of the circumferential protection, then it must be replaced. Also, fire departments should check their purchase specifications to make sure that such substitutions are not allowed.

We will continue to inform you of any new technical information on this issue and any new actions of the protective clothing manufacturers and the certifying organization.

November 12, 1999

Fire Fighters Protective Clothing: Moisture Barrier Alert and Recall

The IAFF has been informed that the manufacturer of BREATHE-TEX® moisture barriers used in fire fighters' protective clothing has alerted protective clothing manufacturers using their product that this product is degrading in the field. **The manufacturer, Aldan Engineered Coated Fabrics, states that the moisture barrier should be replaced if evidence of such breakdown has occurred.**

The IAFF believes that this may pose a significant safety hazard to fire fighters. Not only does the moisture barrier provide primary protection from water; it provides primary protection from many common liquids, including some common chemicals, and from bloodborne pathogens encountered during the normal performance of fire fighting duties. These duties include structural fire fighting operations, aircraft rescue and fire operations, extrication of victims from vehicles and other entrapment situations, provision of first responder or emergency medical care and other fire fighting and rescue situations.

Additionally, the moisture barrier provides protection from scald-type injuries, including those caused by wetting of an already heated garment, steam jet exposure, and saturated water vapor atmospheres. The moisture barrier also provides protection from cold injuries, including the prevention of water intrusion into the moisture barrier resulting in loss of function and comfort.

The following is the text of the letter sent to manufacturers from Aldan Engineered Coated Fabrics:

Fire Service Letter for Manufacturers
We are writing to inform you that some of our of BREATHE-TEX® moisture barriers used in fire fighters' turnout garments are showing signs of degradation. The degradation, not readily observable by routine visual inspection, is primarily in the form of film cracking. A degradated moisture

Our investigations suggest that the garments may have been subject to attack possibly resulting from storage conditions, length of service, care, and/or maintenance. We have striven to determine the cause of the degradation, but have not been able to replicate the condition. We are of course continuing to investigate the cause/s of this issue and will keep you fully informed of our progress.

For any of your customers currently using a BREATHE-TEX® moisture barrier, we recommend advising them of a potential problem and to have their gear checked. Where there is evidence that breakdown has occurred, we recommend the moisture barrier be replaced.

We regret any problems caused by this unforeseen condition.

Sincerely,

s/
Edwin T. Winter
Chairman, CEO

Wearing of fire fighter protective clothing that use BREATHE-TEX® as a functional element in protective clothing, including moisture barriers and garment interface elements (facings) may jeopardize the health and safety of fire fighters. Accordingly, the IAFF has also contacted the certification organization, Underwriters Laboratories, and requested an immediate investigation of malperformance and failure of this product in the field. The following is the text of letter sent to Underwriters Laboratories:

November 12, 1999
Thomas Castino
President
Underwriters Laboratories, Inc,
333 Pfingsten Road
Northbrook, IL. 60062

Dear Mr. Castino,
This letter serves as notification, as presented by the manufacturer, that there is evidence that BREATHE-TEX® moisture barriers, manufactured by Aldan

interface elements, and has been certified by UL to meet NFPA 1971 Standard on Protective Ensemble for Structural Fire Fighting, 1997 edition.

On November 3, 1999, Aldan Engineered Coated Fabrics informed their fire service manufacturing customers of the field degradation of their product and that the degraded moisture barriers be replaced.

In accordance with section 2-2.8 of the standard, we request that UL initiate a field investigation of these reports of malperformance and failure.

Section 2-2.8 states:

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

Upon completion of the investigation, and if supported by the investigation, we insist that UL require and enforce a recall on these defective products which bear the UL mark of certification in accordance with Sections 2-2.9 and 2-2.11 of NFPA 1971, which state:

2-2.9 The certification organization shall require the manufacturer to have a product recall system a s part of the manufacturer's quality assurance program.

2-2,11 The certification organization shall be in a position to use legal means to protect the integrity of its name and label.

We are fully aware that the certification procedures conducted by UL address the certification of new products. However, the above-cited sections clearly address field failure of certified components with recall mechanisms to effect their removal from service. The fire service and the American public have come to depend on UL certification as a symbol of product safety. We are certain that UL will fulfill its obligations in this matter. As employee representatives of product users whose lives are potentially jeopardized by this product we request a copy of the investigation report and notification of any actions by UL, which follow from the investigation.

Please do not hesitate to contact us if we may be of assistance in this matter.

All fire departments should have their protective clothing checked to determine the presence of BREATHE-TEX® moisture barriers and facings. If this cannot be determined by inventory tracking or by the product label, the clothing manufacturer must be contacted. Remember, this is a problem with the moisture barrier and facing components, and is not particular to any clothing manufacturer.

The manufacturers of protective clothing are now developing their response to address this issue. As of today (11/12/99), we are aware that one manufacturer, Total Fire Group (Morning Pride Clothing), has initiated a full recall of their garments from inventory and from the field that use BREATHE-TEX® moisture barriers. We will keep you informed of the actions of other protective clothing manufacturers. The following is a list of manufacturers of protective clothing in the United States and Canada:

Alb, Inc.
A. L. Bartolucci
President
366 Somerville Avenue
Somerville, MA 02143
617-666-8110
617-776-0165 (Fax)

Bristol Uniforms North America
Thomas Francis
Sales Manager
71 Rosedale Avenue, Unit A-2
Brampton, ONT, CAN L6X 1K4
800-565-5483
905-450-3436 (Fax)
Bristol@idirect.com (e-mail)

Cairns Protective Clothing (contact Globe Fire Fighters Suits)
Donald Welch
President
37 Loudon Road

[illegible] (Fax)
globesalesw@globefiresuits.com (e-mail)

Chieftain Safety Manufacturing
Scott McMichael
President
14040 NW 58th Court
Miami Lakes, FL 33014
305-556-2440
305-820-4290 (Fax)
nanm@protectmat.com (e-mail)

Fire-Dex, Inc.
William Burke
President
780 S. Progress Drive
Medina, OH 44256
330-723-0000
330-723-0035 (Fax)
firedex@earthlink.com (e-mail)

FireGear (contact Securitex)

Fyrepel
Gregory Willis
Sales Manager
202 Pride Lane, SW
Decatur, AL 35603
256-350-3107
256-350-3011 (Fax)
lake@net-master.net (e-mail)

Globe Fire Fighters Suits
Donald Welch
President
37 Loudon Road
Pittsfield, NH 03263

globecurtow@globefiresuits.com (e-mail)

Lion Apparel, Inc.
Steven Schwartz
President
P.O. Box 13576
Dayton, OH 45413
937-898-1949
513-898-9204 (Fax)
lionpsg@lionapparel.com (e-mail)

Morning Pride Manufacturing (contact Total Fire Group)

Mountain View Manufacturing
JoVonne Fitzgerald
Sales Manager
408 Russell Street
Walsenburg, CO 81089
719-738-2345
719-738-2319 (Fax)

Quaker Safety Products Corporation
Frank Nicholas
President
103 South Main Street
Quakertown, PA 18951
215-536-2991
215-538-2164 (Fax)
qspc@enter.net (e-mail)

Securitex, Inc.
Ross Cochran
President
715 4th Avenue
Grand Junction, CO 81501
514-282-0503

Starfield Safety
Phil Goodfield
President
1020 Lawrence Avenue, W.
Toronto, ONT, Can M6A 1C8
416-789-4354
416-789-5475 (Fax)
strfield@direct.com (e-mail)

Total Fire Group
William Grilliot
CEO
#1 Innovation Court
Dayton, OH 45413
937-264-2662
937-264-2677 (Fax)
bg@totalfiregroup.com (e-mail)

Veridian
Joe Adams
Vice President
1601 48th Street
West Des Moines, IA 50266
515-223-1399
515-223-6285 (Fax)
info@veridian.net (e-mail)

Exhibit C

MEMORANDUM OF AGREEMENT

The Town of Avon (hereinafter called "the Employer") and the Professional Firefighters of Avon, I.A.F.F. Local 3857 (hereinafter called "the Union") hereby agree, subject to ratification by their membership, as follows:

The Parties agree to extend the current collective bargaining agreement for the term beginning July 1, 2021 through June 30, 2024, which is in all respects, identical to the previous agreement of the Parties except as hereinafter amended.

1. **ARTICLE 2 – RECOGNITION OF BARGAINING UNIT**

Remove and Replace as Follows:

The Town of Avon in accordance with Massachusetts General Laws, Chapter 150E, hereby recognizes the Professional Firefighters of Avon, Local 3857, I.A.F.F, A.F.L.-C.I.O. as the exclusive representative and bargaining agent for all full-time firefighters of the Avon Fire Department up to and including the Deputy Chief of the Fire Department.

2. **ARTICLE 3 - MISCELLANEOUS**

Amend the opening section as follows:

Effective January 1, 1999, there shall be a bargaining unit Officer on each group.

3. OUT OF RANK

Remove first paragraph and replace as follows:

The Professional Firefighters shall endeavor to assure that all open shifts are filled in the following manner:

1. Paramedics shifts are filled within the ranks of Paramedics.
2. Shift Commanders are filled within the ranks of Shift Commanders.
3. Firefighter shifts are filled within the ranks of Firefighters.

4. SALARY REQUIREMEMENTS AND SALARY STRUCTURE

See Attached Exhibit A

5. CAPTAIN STATUS

All Captains shall hold or obtain a Fire Officer 1 Certification within one (1) year of appointment barring circumstances beyond the individual's control.

6. CERTIFICATION INCENTIVE

Amend as follows:

Each member will be eligible for an additional 1% of their base salary for each accredited Certification from the National Board on Fire Service Professional Qualifications, up to a maximum of 3% per year, and a total of not more than 7%, dividing the incentive amount into twenty-six equal pay periods. Firefighter 1, Firefighter 2 and Hazmat Operational Certifications shall not be eligible for additional compensation, as they are part of the Academy training. The certification incentive will be added as a percentage to the base effective on the start of the certification for the individual. No salary adjustments will be made until documentation of the certification is produced.

7. NEW SECTION: SPECIALIZED POSITIONS

EMS Coordinator: A full-time employee within the unit shall be appointed by the Fire Chief to serve as the Department's EMS Coordinator. The EMS Coordinator shall be paid an annual stipend of $2500.00 (to be paid in equal halves on the first full pay period following July 1 and January 1 of each Fiscal Year).

Fire Training Officer: A full-time employee within the unit may be appointed by the Chief to serve as Field Training Officer. If so appointed, the Field Training Officer shall be paid an annual stipend of $750.00 (to be paid in equal halves on the first full pay period following July 1 and January 1 of each Fiscal Year).

Public Fire Educator: A full-time employee within the unit may be appointed by the Chief to serve as Public Fire Educator If so appointed, the Public Fire Educator shall be paid an annual stipend of $750.00 (to be paid in equal halves on the first full pay period following July 1 and January 1 of each Fiscal Year).

Equipment and Vehicle Maintenance Coordinator: A full-time employee within the unit may be appointed by the Chief to serve as Equipment and Vehicle Maintenance Coordinator. If so appointed, the Equipment and Vehicle Maintenance Coordinator shall be paid an annual stipend of $750.00 (to be paid in equal halves on the first full pay period following July 1 and January 1 of each Fiscal Year).

To the extent possible, all work performed in said roles shall be accomplished within the individual's assigned (non-overtime) shift.

Said Stipends shall become effective July 1, 2022.

8. EDUCATIONAL INCENTIVE

Revise First Paragraph to list coursework as follows:

The program shall be limited to the attainment of either an Associates or Bachelor's degree from an accredited institution in the following courses of study: Fire Science, Fire Administration, EMS Administration, Emergency Services Management, Homeland Security, Nursing, Business Administration with a concentration in Public Administration, Health Care Administration, or Occupational Safety and Health.

9. **ARTICLE 4**

UNION BUSINESS:

Remove and Replace with:

All employees covered by this agreement who are officers of Local 3857 of the International Association of Firefighters, A.F.L.- C.I.O., who are appointed by said Local 3857 as delegates, or who are appointed by said Local 3857 as members of a collective bargaining negotiation team, shall be allowed time off for official union business, such as Professional Firefighters of Massachusetts and International Association of Firefighters, A.F.L. – C.I.O. meetings, conferences, seminars, and conventions without loss of pay and benefits and without requirements to make up this loss time. In no event shall the amount of paid time off herein for the unit exceed the sum of 1 day per year, per member.

The Collective Bargaining Unit of the union shall have unlimited time off for negotiations with the Board of Selectmen or its duly appointed representatives during the period of negotiations for a new agreement during the period of this agreement; and they shall not lose any pay or benefits or be required to make up any lost time resulting therefrom.

Such allowances shall be subject to the approval of the Fire Chief.

10. **ARTICLE 6 – PAID DETAILS AND COURT TIME**

Town detail rate increased to $45/hr. Other details to $60/hr. (Effective prospectively upon funding of the CBA by Town Meeting)

11. **ARTICLE 8 – UNIFORM ISSUE AND ALLOWANCE**

Remove and Replace with:

At the time of hire, the Town shall supply each new full-time employee with the following uniform items which are required to be worn in the performance of their duties:

- Department approved high visibility safety jacket
- 2 Rubin quarter-zips
- 4 Station Pants
- 4 Class B Shirts
- 4 Polo Shirts
- 1 pair of boots

In addition to providing the uniforms outlined above, the Town will provide all full-time employees a uniform allowance in the amount of $625.00 during the first year of employment.

After a full-time employee completes their first year of employment, the Town will provide that employee with a uniform allowance of $775.00 per year.

Upon completion of one year of employment and graduation from an approved graduate firefighting academy or equivalent, the Town will provide the employee with a Class A Dress Uniform.

Uniforms damaged in the line of duty in an accident or other unforeseen circumstance will be replaced exclusive of the clothing allowance.

Personal Protective Firefighting Gear

All protective clothing shall be to the NFPA 1971 or latest standard when issued. Each member will be issued a full set of turn-out gear at the time of hire to include:

- Firefighting Boots
- Bunker Pants
- Turn-out Coat
- Hood
- Gloves
- Helmet

All such items shall be replaced in accordance with NFPA 1971 standard or current standard, but in no event less than every ten (10) years.

The Town shall provide each full-time employee with a second set of tailored personal protective firefighting gear after the completion of their first year of employment and graduation from an approved graduate firefighting academy or equivalent.

Lockers

Each member of the unit shall be provided with a locker at the fire station. These lockers shall not be opened at any time, for any reason without the Professional Firefighter involved present.

12. ARTICLE 14 – PROMOTIONAL PROCEDURES

A Labor/Management Committee shall be formed for the purpose of updating AFD Rules and Regulations, Section 36 (dated 6/12/96)

13. ARTICLE 18- IOD

Add the following: Employees who receive compensation pursuant to this Article 18 for a complete calendar month shall not be entitled to vacation leave accrual pursuant to Article 5 for that month.

14. GENERAL UNDERSTANDINGS

- The Union explicitly acknowledges and understands that the Town may, solely at its discretion, appoint a Deputy Chief upon a vacancy. Nothing contained in this agreement or in the CBA compels or otherwise requires that the position of Deputy Chief be filled at any time. Should the Town choose not to fill the position of Deputy Chief, it will continue to staff each group with at least one Captain. Moreover, the Union shall not contest the appointment of an Assistant Fire Chief as usurping union work should the town so elect, except that an Assistant Fire Chief shall not be assigned to a group, shall not be assigned to staff the apparatus, and shall not perform any functions exclusively reserved to the bargaining unit pursuant to the CBA.

- Payment under this Agreement shall be made to all members of the Department who are actively employed as of the date of this Agreement. Employees who have retired or have otherwise separated from the Department shall not be entitled to any payment hereunder.

- Pay for salary changes made retroactive to July 1, 2021, shall be made by paying the difference between the retroactive straight time rate and the previously existing straight time rate for all hours worked.

- For purposes of placement on the new salary tables each current employee shall be placed as set forth on the attached Exhibit B.

- All other provisions of the existing Agreement will remain in full force and effect.

Pursuant to Chapter 150E, the terms of this Agreement are subject to ratification of the membership and funding in each year of the contract.

Dated: April 29, 2022.

Town of Avon, by:

Gregory Enos, Town Administrator

Prof. Firefighters of Avon, IAFF, Local 3857 by:

Stephen Hallissey

Daniel Wauhob

Julie Burns

Ex. A - SALARY PROGRESSION AND PAYSCALE

Effective July 1, 2022

Step 1	Step 2	Step 3	Step 4	Step yr 8	Step yr 12	Capt.	Deputy
$ 58,183.55	$ 59,347.22	$ 60,534.17	$ 61,744.85	$ 62,979.75	$ 64,239.34	$ 72,269.26	$ 83,109.65

Effective July 1, 2021 Retro on BASE ONLY - Including OT to be paid at STRAIGHT TIME

$ 57,042.70	$ 58,183.55	$ 59,347.23	$ 60,534.17	$ 61,744.85	$ 62,979.75	$ 70,852.22	$ 81,480.05

FY 24 Shall be paid at 1.5% COLA

Step Progression and placement on scale shall be as follows:

Step 1: Less than 1 year of Firefighting Experience

Step 2: Completion of 1 year of firefighting as well as Graduate of Firefighting Academy or equivalent

Step 3: Completion of 3 years of Firefighting experience and Graduate

Step 4: Completion of 5 years of Firefighting experience and a Graduate

Current employees shall be placed at the step commensurate with years of service as of July 1, 2021.

Incumbent Firefighters who would otherwise have been placed on Step 3 shall advance to Step 4 upon completion of their Paramedic program

EXHIBIT B

Bargaining unit employees will be placed at the following Steps effective July 1, 2021, or effective the employee's start date, whichever is later:

Employee	Step
Hallissey	Deputy
Wauhob	Captain
Sullivan	Captain
Curry	Captain
Barbour	Step 6
Burns	Step 4
Lucio	Step 4
Fidalgo	Step 4
Powers	Step 3
Kelley	Step 3
Stroud	Step 2
Zine	Step 2

Exhibit D

PFAS Project
Jan. 19, 2021, 3:01 AM
Firefighters Want Halt on Money From Makers of PFAS-Laden Gear
By Andrew Wallender

- Resolutions seek study of cancer-causing chemicals in garments
- Donations, sponsorships from apparel makers top $400,000

Bloomberg Law News 2023-06-07T14:48:52805617821-04:00
Firefighters Want Halt on Money From Makers of PFAS-Laden Gear

By Andrew Wallender 2021-01-19T05:01:30000-05:00
1. Resolutions seek study of cancer-causing chemicals in garments
2. Donations, sponsorships from apparel makers top $400,000

Members of the nation's largest firefighters' union want their organization to stop accepting funds from gear makers until they commit to ridding the garments of so-called "forever chemicals."

Manufacturers of protective garments worn by firefighters have given at least $420,000 to the International Association of Fire Fighters since 2016, according to a review of federal disclosures by Bloomberg Industry Group.

A resolution will be up for debate at the union's upcoming annual convention Jan. 25-28. It asks the IAFF "to no longer accept sponsorships from the chemical industry, textile manufacturers, or PPE [personal protective equipment] manufacturers." Convention delegates will be able to amend the resolution's language before voting to approve or reject it.

A second proposal asks the union to seek further testing on the presence of the chemicals in gear, and work with manufacturers to develop safer alternatives.

The moves are among the first member-driven attempts by the 323,000-person union to get suppliers to work on developing gear that doesn't contain chemicals known as PFAS, or for per- and polyfluoroalkyl substances.

"I don't think it's heavy lifting so to speak," said Jason Burns, former president of IAFF Local 1314 in Massachusetts. He backs the resolution addressing sponsorship and advised its drafting. "If we say don't take the money, we're not crippling our organization financially. That's something our organization can and–because of the health impacts–should deal with."

The transactions represent a small fraction of the overall IAFF's overall revenue stream. The union reported net assets of more than $23.5 million at the end of 2019.

One resolution calls out a history of "biased science," while the other says that "current bunker gear manufacturers continue to deny the potential for any health problems created by their use of PFAS."

The union said it is "a leader in forcing changes in the industry when data and science show a link between any chemicals, including PFAS in fire gear, and occupational cancer in firefighters," IAFF spokesperson Doug Stern said in a statement.

Linked to Health Problems

PFAS are a group of human-made chemicals that first hit the market as coatings for Teflon pans in the 1950s and are now found in products like microwave popcorn bags, pizza boxes, carpets, and cosmetics.

Thousands of chemical compounds are categorized as PFAS, including PFOS, which has been used in firefighting foams and PTFE, used in manufacturing firefighting turnout gear. The substances are known for their stability, and water and heat resistance.

But they are also linked to increased cholesterol levels, changes in liver enzymes, lower infant birth weights, and increases in the risk of kidney or testicular cancer, according to the Centers for Disease Control and Prevention.

The IAFF is currently engaged in three studies analyzing the effects of PFAS on firefighters. The results haven't yet been published.

"The extensive work of the IAFF in researching PFAS exposures and firefighter cancer is one important element of the much broader work that we do to combat the elevated rate at which firefighters contact cancer," Stern, the spokesperson, said.

Currently, firefighters have no choice but to wear PFAS-laden protective clothing as no alternatives are on the market. Concerned about possible health risks, they are demanding changes.

Makers Defend Gear

Gear makers insist that their products have been tested and are safe.

Turnout gear manufacturer Globe—owned by MSA Safety Inc.—said it doesn't add or use PFAS in any of its manufacturing processes. But the company also said it doesn't manufacture the raw materials or fabric that goes into its products, and that textile suppliers serving the entire fire industry use PFAS for water, oil, or chemical resistance.

"As industry leaders in firefighter protective equipment, we work to provide fire departments with innovative personal protective equipment that meets or exceeds NFPA standards, improves their members' performance, and helps guard against the health and safety risks that firefighters may face," MSA Safety spokesperson Samantha D'Uva said in a statement, referring to the National Fire Protection Association that sets safety standards for turnout gear.

W.L. Gore, a maker of moisture barriers for firefighting gear, said that it is aware of the IAFF resolutions and stands by the integrity of its products, which have passed rigorous safety requirements.

The company said it is "simply unable" to respond to all of the specifics offered to support a proposed PFAS ban, or to address all components of personal protective equipment because "PFAS is a broad class of materials, many with very different properties," according to spokesperson Amy Calhoun.

Following the Money

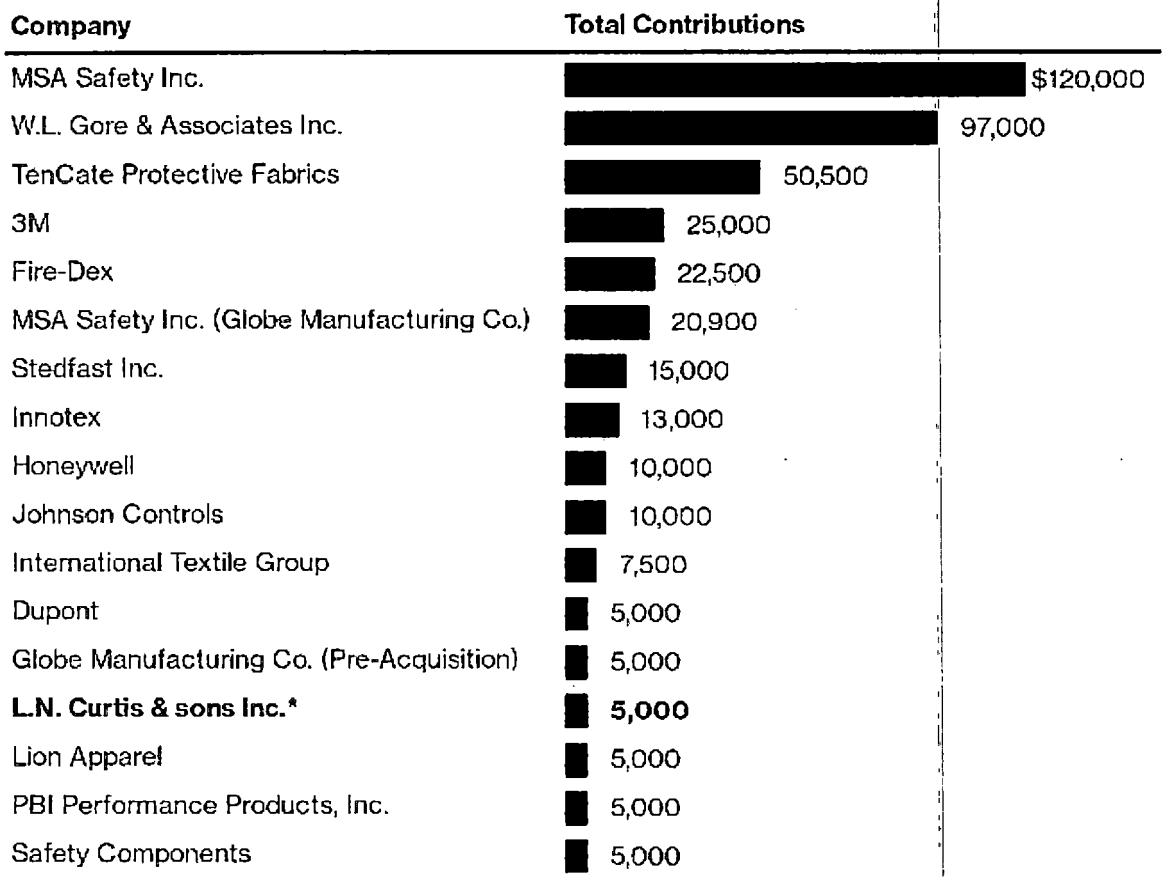
The IAFF reported at least $476,161 in transactions with companies and individuals tied to the manufacturing of turnout gear or firefighting foam between 2016 to 2019, according to the union's financial disclosures.

At least $421,400 was specifically designated by the union as sponsorship, exhibitor, or advertising revenue. Contributions that companies made to the union's charitable organization, the IAFF Foundation, were not included in this tally.

"The IAFF's dedication and drive to protecting firefighters and keeping them healthy and safe is influenced only by data and science," Stern, the IAFF spokesperson, said. "Sponsorships have never affected union policy or decision-making, and any assertion otherwise is reckless and baseless."

Gear Makers' Tight Relationship With Firefighters' Union

Makers, sellers of safety garments gave the IAFF union more than $400,000 from 2016-2019.



Souce: Bloomberg Industry Group Analysis of IAFF LM-2 Filings
*L.N. Curtis & sons Inc. only sells, and does not manufacture, firefighter gear

Bloomberg Law

MSA Safety Inc. paid out at least $120,000 to the IAFF between 2016 and 2019–the largest amount of any organization in the turnout gear industry during that time. An individual associated with Globe, turnout gear manufacturer MSA purchased in 2017, separately paid the union $15,900 for advertising in 2019. Globe also paid $5,000 for a symposium sponsorship in 2017.

The majority of MSA Safety's funding went directly to the IAFF Foundation, supporting charitable support and direct assistance to firefighters, according to D'Uva of MSA Safety.

"Like many manufacturers in the fire service, we also place digital and print advertisements in the IAFF's quarterly publication and sponsor various events throughout the year," D'Uva said in a statement. "The contributions for these initiatives represent a small portion of MSA's financial contributions to the IAFF."

W.L. Gore's engagement with the union has allowed it to better understand the needs of firefighters and "better apply our material science expertise," Calhoun said.

The total money pulled in from industry groups and manufacturers may be much higher than the nearly half-million dollars identified, as not all transactions are itemized with a clear description of how the money was spent.

'Really Came to the Table'

The relationship between the labor union and industry was on display in February 2018, when the IAFF hosted an inaugural Cancer Summit for its members.

IAFF General President Harold Schaitberger took the stage in Lake Buena Vista, Fla. After a moment of silence honoring firefighters who died in the line of duty from cancer, he asked those gathered to applaud the chemical makers and gear manufacturers who had sponsored the conference.

"I'd like to start by, first of all, thanking our sponsors: TenCate, W.L. Gore, Globe MSA, Dupont," Schaitberger said. "They really came to the table to provide everything we needed to put together this Cancer Summit and covered virtually all the costs associated with it, including this morning's breakfast, today's lunch, and so much more."

The sponsors received prime billing throughout the summit. The event's livestream superimposed company logos on top of research presentations, organizers played promotional videos between segments, and employees spoke before cancer researchers.

A screenshot from a recording of the IAFF's 2018 Cancer Summit displays the event's sponsors.
Screenshot: 'IAFF Cancer Summit: Morning Session' via YouTube

The sponsors Schaitberger named are now all defending against criticism and lawsuits that say their manufacturing processes have resulted in cancer outbreaks across the country.

For retired firefighter, former IAFF employee, and 44-year union member Eric Lamar, giving such prime billing to corporations sacrifices the union's integrity.

"How can anyone expect that we're going to appropriately view our personal protective equipment, and the needs and the requirements objectively, when all of these meetings are being funded by manufacturers?" he asked.

Call for Change

Firefighters who assisted in drafting the two resolutions said that they were driven to action by the alarming number of cancer cases they've seen.

Orlando Professional Firefighters Local 1365 President Ron Glass, who helped draft one of the resolutions, said he's lost two firefighters in his local union to cancer in the past year or so. One of those firefighters was 48 years old and had been battling cancer for nearly 20 years.

"Something's not adding up within the industry itself," Glass said. "I could see if it was just isolated to one or two cases. But when you have five young firefighters that all come down with the same type of cancer over a five-year period, then there's an issue out there. And I think we have an obligation as a union to study this."

Burns, the former local union president in Massachusetts, said he was drawn to this issue after his childhood best friend and fellow firefighter died of cancer at age 37. Shortly after, another firefighter he knew died of cancer at age 32.

"It kind of left me searching for answers," Burns said. "I knew what happened in the fire service—we often succumb to cancer. But we often succumb to cancer later on in life."

The resolutions are a welcome relief to Diane Cotter,wife of a firefighter diagnosed with cancer. She's spent years advocating against the dangers of PFAS in gear, and helped bring about a study by Notre Dame physicist Graham Peaslee that exposed high levels of PFAS in turnout gear.

Cotter said in a statement that she and her husband, Paul Cotter, are "delighted to see PFAS resolutions that acknowledge the need for independent, peer-reviewed science for turnout gear."

To contact the reporter on this story: Andrew Wallender in Washington at awallender@bloombergindustry.com

To contact the editors responsible for this story: John Dunbar at jdunbar@bloomberglaw.com; Anna Yukhananov at ayukhananov@bloombergindustry.com

Documents

- Convention Resolution 28
- Convention Resolution 31

Exhibit E

NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards

CODES & STANDARDS

Notice and disclaimer of liability concerning the use of NFPA standards

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

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

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, visit the "Codes & Standards" section on NFPA's website (www.nfpa.org).

Interpretations of NFPA Standards
A statement, written or oral, that is not processed in accordance with Section 6 of the *Regulations Governing the Development of NFPA Standards* shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Patents
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