NFPA®

1851

Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

2020

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NFPA® 1851

Standard on

Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

2020 Edition

This edition of NFPA 1851, *Standard on Selection, Care, and Maintenance of 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, released by the Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, and acted on by NFPA at its June Association Technical Meeting held June 17–20, 2019, in San Antonio, TX. It was issued by the Standards Council on August 5, 2019, with an effective date of August 25, 2019, and supersedes all previous editions.

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

This edition of NFPA 1851 was approved as an American National Standard on August 25, 2019.

Origin and Development of NFPA 1851

The first edition of NFPA 1851, published in 2001, was titled *Standard on the Selection, Care, and Maintenance of Structural Fire Fighting Protective Ensembles.* The standard was developed to be a companion document for NFPA 1971, then titled *Standard on Protective Ensembles for Structural Fire Fighting*, which has been in effect since 1975 and specifies product design, performance, testing, and certification.

NFPA 1851 is written for the organizations that evaluate the risks their emergency responders face and their particular needs for protective clothing, that develop purchase specifications, and that purchase structural fire-fighting protective ensembles and ensemble elements. It is also written for end users of structural fire-fighting protective ensembles and ensemble elements to be able to inspect, maintain, and care for the protective ensembles and ensemble elements they use during structural fire-fighting operations.

The overall protection and safety of fire-fighting personnel depend not only on adequate protective clothing but equally on the organization's policies, training, and administration of the correct use of the proper protective ensembles and ensemble elements in fire-fighting situations. To satisfy the portion of the organization's overall protective clothing and equipment program that addresses structural fire-fighting protective ensembles and ensemble elements, this document provides criteria for the selection, care, and maintenance of protective ensembles and ensemble elements.

In this standard, the requirements for several areas are written to begin with the person who actually uses the protective ensemble or ensemble element being constantly aware of its condition and need for cleaning, repair, or more in-depth inspection. Users can perform the simple actions to improve the condition of the protective ensemble or ensemble element. The more involved actions of advanced inspection, evaluation, cleaning, decontamination, and repair are handled by the organization's designated staff trained and authorized to perform such duties. In other areas, the requirements are written for the organization to perform the administrative functions of the structural fire-fighting protective ensemble program and to perform periodic actions to evaluate the program to ensure it is achieving its goals and that the quality of the protective ensembles and ensemble elements provides optimum safety to fire fighters.

The 2008 edition of NFPA 1851 was a complete revision of the first edition. Because NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, was incorporated into the 2007 edition of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, under

the Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment, this edition of NFPA 1851 was expanded to include both structural fire-fighting ensembles and proximity fire-fighting ensembles.

The 2008 edition followed the new standards format according to the *Manual of Style for NFPA Technical Committee Documents*.

New requirements in Chapter 11 for organizations and ISPs and for verification of the ISPs by independent, third-party certification organizations set the criteria for organizations and ISPs to perform the tasks of inspection, cleaning, and repairing of protective ensembles and ensemble elements. New requirements for testing methods for trained personnel in the organization as well as the ISPs set the criteria to determine functionality and protection afforded by ensembles and ensemble elements.

Chapter 10 was revised, requiring retirement of structural fire-fighting ensembles and ensemble elements and proximity fire-fighting ensembles and ensemble elements not later than 10 years from the date the ensembles or ensemble elements were manufactured. The radiant reflective outer shell of proximity fire-fighting ensembles and ensemble elements were required to be replaced a maximum of 5 years from the date the ensembles or ensemble elements were manufactured. More frequent replacement of fire-fighting ensembles and ensemble elements was required to better ensure that fire fighters had state-of-the-art protection from fire-fighting environments. The significant changes that technology underwent within two editions of this standard (approximately 10 years), in addition to the normal "wear and tear" of fire-fighting and additional emergency incident responses, training, and other factors, dictated that protective ensembles and ensemble elements be replaced. Fire departments that responded to a higher-than average number of emergency incidents or that had frequent or extensive "working fire" operations were encouraged to plan for replacement of ensembles or ensemble elements on a more frequent cycle.

The 2014 edition of NFPA 1851 was another complete revision and featured many editorial changes as well as new definitions for *manufacturer trained organization*, *verified organization*, and *verified independent service provider (ISP)*. A new table was added to Chapter 4 that specified the responsibilities for garment inspection, cleaning, and repair. Inspection for delamination and label integrity and legibility was added to Chapter 6. Changes were made to the cleaning and decontamination procedures in Chapter 7, and requirements in Chapter 8 for the repair of ensembles and ensemble elements were revised. There were also several changes to Chapter 11 that affected verification of organizations and ISPs, and two new tables were added that addressed advanced inspection and advanced cleaning evaluations.

The 2020 edition has seen major changes to the cleaning requirements in Chapter 4 and Chapter 7 and further changes to supporting definitions. In Chapter 4, the table of responsibilities for garment element inspection, cleaning, and repair has been redone to reflect six different groups that could potentially have one of those responsibilities with accompanying clarifications concerning how that responsibility is accomplished. In Chapter 7, each major heading has been rewritten in light of new technologies and information gleaned from research and testing. Two new decision trees have been added for handling, disposition, and cleaning of ensembles and ensemble elements to assist in determining the appropriate cleaning procedure(s). These changes have also led to a definition and associated annex material for the term *preliminary exposure reduction* to replace *on-scene preliminary cleaning*.

For the 2020 edition, the technical committee has strengthened the annex material associated with the Chapter 10 retirement requirements by expanding on existing language and explaining the work that was done that led to the development of retirement criteria in the standard. The technical committee has also added a paragraph concerning carcinogens and performance testing.

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

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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.

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NFPA 1851

Standard on

Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

2020 Edition

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

Chapter 1 Administration

1.1 Scope.

Δ **1.1.1** This standard shall specify the minimum selection, care, and maintenance requirements for structural fire fighting protective ensembles and the individual ensemble elements that include garments, helmets, gloves, footwear, and interface components that are compliant with NFPA 1971.

Δ **1.1.2** This standard shall also specify the minimum selection, care, and maintenance requirements for proximity fire fighting protective ensembles and the individual ensemble elements that include garments, helmets, gloves, footwear, and interface components that are compliant with NFPA 1971.

Δ **1.1.3** This standard shall also specify requirements for both structural fire fighting and proximity fire fighting protective ensembles, ensemble elements, clothing, and equipment certified as compliant with previous editions of NFPA 1971.

1.1.4 This standard shall also specify the minimum selection, care, and maintenance requirements for structural fire fighting protective ensembles with optional liquid and particulate contaminant protection and for proximity fire fighting protective ensembles with optional liquid and particulate contaminant protection.

1.1.5 This standard shall not specify requirements for other organizational programs such as appropriate use of structural fire fighting or proximity fire fighting protective ensembles for training, for operations, or for infection control, because these programs are under the jurisdiction of other NFPA standards.

Δ **1.1.6** This standard shall not apply to protective ensembles or protective clothing that are compliant with NFPA 1951, NFPA 1977, NFPA 1991, NFPA 1992, NFPA 1994, and NFPA 1999.

1.1.7 This standard shall not be construed as addressing all 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 to determine the applicability of regulatory limitations prior to use.

1.1.8 This standard shall not be construed as addressing all the safety concerns, if any, associated with the use of this standard by testing or repair 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 to determine the applicability of regulatory limitations prior to using this standard for any designing, manufacturing, and testing.

1.1.9 Nothing herein shall restrict any jurisdiction from exceeding these minimum requirements.

1.2 Purpose.

1.2.1 The purpose of this standard shall be to establish a program for structural fire fighting protective ensembles and ensemble elements and for proximity fire fighting protective ensembles and ensemble elements to reduce the safety risks and potential health risks associated with poorly maintained, contaminated, or damaged protective ensembles and ensemble elements.

1.2.2 The purpose of this standard shall also be to establish basic criteria for selection, inspection, cleaning, decontamination, repair, storage, and retirement of structural fire fighting protective ensembles or ensemble elements and proximity fire fighting protective ensembles or ensemble elements.

1.3 Application.

Δ **1.3.1** This standard shall apply to structural fire fighting and proximity fire fighting ensembles and ensemble elements certified as compliant with NFPA 1971.

Δ **1.3.2** This standard shall also apply to structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements certified as compliant with the previous editions of NFPA 1971.

1.3.2.1 This standard shall also apply to structural fire fighting protective ensembles with optional liquid and particulate contaminant protection and to proximity fire fighting protec-

tive ensembles with optional liquid and particulate contaminant protection.

1.3.3 This standard shall not apply to other organizational programs such as appropriate use of structural fire fighting or proximity fire fighting protective ensembles for training, operations, or infection control, because these programs are under the jurisdiction of other NFPA standards.

1.3.4 This standard shall not apply to respiratory protective equipment other than where such equipment interfaces with structural fire fighting protective ensembles or proximity fire fighting protective ensembles with the optional liquid and particulate contaminant protection.

1.3.5 The requirements of this standard shall not apply to accessories attached to any element of the structural fire fighting protective ensemble unless specifically addressed herein.

1.4 Units.

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

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

Chapter 2 Referenced Publications

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

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

NFPA 600, *Standard on Facility Fire Brigades,* 2015 edition.

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

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents,* 2013 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2018 edition.

NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting,* 2016 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents,* 2016 edition.

NFPA 1992, *Standard on Liquid Splash–Protective Ensembles and Clothing for Hazardous Materials Emergencies,* 2018 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incidents,* 2018 edition.

NFPA 1999, *Standard on Protective Clothing and Ensembles for Emergency Medical Operations,* 2018 edition.

2.3 Other Publications.

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

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

AATCC 198, *Horizontal Wicking of Textiles*, 2013.

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

ASTM D2261, *Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-of-Extension Tensile Testing Machine)*, 2013, reapproved 2017e1.

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

ASTM E2274, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants*, 2016.

ASTM E2406, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants for Use in High Efficiency Washing Operations*, 2016.

Δ **2.3.3 ISO Publications.** International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

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

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

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

2.3.4 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 1910.1030, "Bloodborne Pathogens."

Δ **2.3.5 Other Publications.**

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

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Δ **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.

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 Accessory/Accessories. An item, or items, that could be attached to a certified product but that are not necessary for the certified product to meet the requirements of the standard.

3.3.2 Advanced Cleaning. See 3.3.12.1, Advanced Cleaning.

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

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

3.3.5* Carcinogen/Carcinogenic. A cancer-causing substance that is identified in one of several published lists, including, but not limited to, those prepared by the U.S. National Toxicology Program, the International Agency for Research on Cancer (IARC), the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH).

3.3.6 Care. Cleaning and storage of protective clothing and equipment.

3.3.7 CBRN. An abbreviation for chemicals, biological agents, and radiological particulate hazards. *(See also 3.3.8, CBRN Terrorism Agents.)*

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3.3.8* CBRN Terrorism Agents. Chemicals, biological agents, and radiological particulates that could be released as the result of a terrorist attack. *(See also 3.3.3, Biological Terrorism Agents; 3.3.11, Chemical Terrorism Agents; 3.3.81, Radiological Particulate Terrorism Agents; and 3.3.109, Toxic Industrial Chemicals.)*

3.3.9 Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of a specific standard(s), authorizes the manufacturer to use a label on listed products that comply with the requirements of that standard(s), 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 that standard(s).

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

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

3.3.12* Cleaning. The act of removing soiling and contamination from ensembles and ensemble elements by mechanical, chemical, thermal, or combined processes.

3.3.12.1* *Advanced Cleaning.* The act of removing both soiling and contamination generally associated with products of combustion.

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3.3.12.2* *Specialized Cleaning.* The act of removing hazardous materials, soiling associated with body fluids, or other forms of contamination.

N **3.3.13* Cleaning Facility.** An entity, location, or site engaged in the cleaning of ensemble elements that includes an element manufacturer verified in cleaning, a verified cleaner, a verified organization, or a verified ISP.

3.3.14 Coat. See 3.3.94, Structural Fire Fighting Protective Coat, and 3.3.71, Proximity Fire Fighting Protective Coat.

Δ **3.3.15* Contamination.** The accumulation of products of combustion and other hazardous materials on or in an ensemble element that includes carcinogenic, toxic, corrosive, or allergy-causing chemicals, body fluids, infectious microorganisms, or CBRN terrorism agents.

3.3.16 Coverall. See 3.3.95, Structural Fire Fighting Protective Coverall, and 3.3.72, Proximity Fire Fighting Protective Coverall.

3.3.17 Craze. The appearance of fine cracks in the surface of a helmet shell or other smooth surface of an ensemble element.

3.3.18 Cross-Contamination. The transfer of contamination from one item to another or to the environment.

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

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

Δ **3.3.21* Decontamination.** The act of removing contamination from or neutralizing contamination in protective clothing and equipment. *(See also 3.3.12, Cleaning.)*

3.3.22* Disinfectant. A type of antimicrobial agent that destroys or irreversibly inactivates fungi and bacteria, but not necessarily their spores, on inanimate surfaces and objects.

3.3.23* Drag Rescue Device. A component integrated within the protective coat element to aid in the rescue of an incapacitated fire fighter.

3.3.24 DRD. See 3.3.23, Drag Rescue Device.

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

3.3.26 Elasticity. The ability of a material to return to its original form after being stretched.

3.3.27 Elements. See 3.3.32, Ensemble Elements.

3.3.28 Embrittlement. The hardening of a material that makes it susceptible to easy fracture.

3.3.29* Emergency Medical Operations. Delivery of emergency patient care, including patient transportation, provided prior to arrival at a hospital or other health care facility.

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

Δ **3.3.31 Ensemble.** See 3.3.96, Structural Fire Fighting Protective Ensemble, and 3.3.73, Proximity Fire Fighting Protective Ensemble.

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

3.3.33 Faceshield. The component of the helmet that provides limited protection to a portion of the wearer's face. Not primary eye protection.

3.3.34 Field Evaluation. The nonlaboratory assessment of an ensemble, ensemble element, or item.

3.3.35 Fit. The quality, state, and manner in which clothing and equipment, when worn, relate to the human body.

3.3.36* Flame Resistance (Protective Clothing and Equipment). 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. *(See also 3.3.51, Inherent Flame Resistance.)*

3.3.37 Footwear. See 3.3.98, Structural Fire Fighting Protective Footwear, and 3.3.75, Proximity Fire Fighting Protective Footwear.

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

3.3.39 Garment. See 3.3.99, Structural Fire Fighting Protective Garments, and 3.3.76, Proximity Fire Fighting Protective Garments.

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

3.3.41 Glove. See 3.3.100, Structural Fire Fighting Protective Glove, and 3.3.77, Proximity Fire Fighting Protective Glove.

3.3.42 Glove Wristlet. See 3.3.119, Wristlet.

3.3.43* Goggles. Ensemble element or component that provides limited protection to the wearer's eyes. Goggles might or might not provide primary protection.

N **3.3.44* Gross Decontamination.** A term used in the hazardous materials response industry to indicate the partial removal of exterior contamination from protective clothing, usually by rinsing with water, sometimes with detergent, to allow for the safe exit of the responder from the protective clothing in the contamination reduction zone of an emergency incident. *(See 3.3.66, Preliminary Exposure Reduction.)*

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

3.3.46* Hazardous Materials. Substances (solid, liquid, or gas) that when released are capable of creating harm to people, the environment, and property.

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

3.3.48 Helmet. See 3.3.101, Structural Fire Fighting Protective Helmet, and 3.3.78, Proximity Fire Fighting Protective Helmet.

3.3.49 Hood. See 3.3.103, Structural Fire Fighting Protective Particulate-Blocking Hood, and 3.3.102, Structural Fire Fighting Protective Hood.

3.3.50 Independent Service Provider (ISP). An independent third party utilized by an organization to perform advanced cleaning, advanced inspection, and repair services. In order to comply with NFPA 1851, an ISP must be verified. *[See also 3.3.115, Verified Independent Service Provider (ISP)].*

3.3.51 Inherent Flame Resistance. Flame resistance that is derived from the essential characteristics of the fiber or polymer.

3.3.52 Integrity. The ability of an ensemble or ensemble element to remain intact and provide continued minimum performance.

3.3.53 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.

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

3.3.55 Liner System. The moisture barrier and thermal barrier components as used in a garment.

3.3.56 Maintenance. The inspection, service, and repair of protective clothing and equipment, including the determination for removal from service.

3.3.57 Major A Seam. See 3.3.84.1, Major A Seam.

3.3.58 Major B Seam. See 3.3.84.2, Major B Seam.

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

3.3.60 Manufacturer-Trained Organization. See 3.3.64.1, Manufacturer-Trained Organization.

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

3.3.62 Minor Seam. See 3.3.84.3, Minor Seam.

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

3.3.64* Organization. The entity that provides the direct management and supervision for the emergency services personnel.

3.3.64.1 ***Manufacturer-Trained Organization.*** A non-verified organization trained by an element manufacturer of the same element type to conduct any one or a combination of advanced cleaning, advanced inspection, and basic repair on the organization's elements.

Δ **3.3.64.2** ***Verified Organization.*** An organization verified by a third-party certification organization to conduct advanced cleaning, advanced inspection and sanitization, basic repair, and advanced repair on any organization's elements.

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

N **3.3.66* Preliminary Exposure Reduction.** Techniques for reducing soiling and contamination levels on the exterior of the ensemble or ensemble element following incident operations.

N **3.3.67* Products of Combustion.** The end product when fuels, such as hydrocarbons and materials, remain after the process of combustion in a fire.

3.3.68 Protective Clothing. See 3.3.96, Structural Fire Fighting Protective Ensemble, and 3.3.73, Proximity Fire Fighting Protective Ensemble.

3.3.69 Protective Ensemble. See 3.3.96, Structural Fire Fighting Protective Ensemble, and 3.3.73, Proximity Fire Fighting Protective Ensemble.

3.3.70 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.

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

3.3.72 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.

3.3.73* 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.

3.3.74 Proximity Fire Fighting Protective Ensemble with Optional Liquid and Particulate Contamination 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.

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

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

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

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

3.3.79 Proximity Fire Fighting Protective Shroud. The component of the helmet that provides limited protection to the helmet/coat interface area.

3.3.80 Proximity Fire Fighting Protective Trouser. The element of the protective ensemble that provides protection to the lower torso and legs, excluding the ankles and feet.

3.3.81* 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.

3.3.82 Retirement. The process of permanently removing an ensemble element from emergency operations service in the organization.

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N **3.3.83* Sanitizer.** A type of antimicrobial agent that is used to reduce, but not necessarily eliminate, microorganisms from the inanimate environment to levels considered safe as determined by public health codes or regulations.

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

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

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

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

3.3.85 Selection. The process of determining what protective clothing and equipment (PCE) is necessary for protection of fire and emergency services response personnel from an anticipated specific hazard or other activity, the procurement of the appropriate PCE, and the choice of the proper PCE for a specific hazard or activity at an emergency incident.

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

3.3.87 Service Life. The period for which compliant product can be useful before retirement.

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

3.3.89 Shroud. See 3.3.79, Proximity Fire Fighting Protective Shroud.

Δ **3.3.90* Soiling.** The accumulation of sweat, dust, dirt, debris, and other nonhazardous materials on or in an ensemble or ensemble element that could degrade its performance or cause hygiene issues.

3.3.91 Specialized Cleaning. See 3.3.12.2, Specialized Cleaning.

3.3.92 Stress Area. Those areas of the garment that are subjected to more wear, including, but not limited to, crotches, knees, elbows, and shoulders.

3.3.93 Structural Fire Fighting. The activities of rescue, fire suppression, and property conservation in buildings, enclosed structures, vehicles, marine vessels, or like properties that are involved in a fire or emergency situation.

3.3.94 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.

3.3.95 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.

3.3.96* 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.

3.3.97 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.

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

3.3.99 Structural Fire Fighting Protective Garments. The coat, trouser, and coverall elements of the protective ensemble.

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

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

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N **3.3.102 Structural Fire Fighting Protective Hood.** The interface element of a protective ensemble that provides limited protection to the coat/helmet/SCBA facepiece interface area.

N **3.3.103* Structural Fire Fighting Protective Particulate-Blocking Hood.** A structural fire fighting protective hood that reduces particulate penetration.

3.3.104 Structural Fire Fighting Protective Trouser. The element of the protective ensemble that provides protection to the lower torso and legs, excluding the ankles and feet.

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

3.3.106 Tensile Strength. The force at which a fiber or fabric will break when pulled in one dimension.

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

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

3.3.109 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.

3.3.110 Trim. See 3.3.117, Visibility Markings.

3.3.111 Trouser. See 3.3.104, Structural Fire Fighting Protective Trouser, and 3.3.80, Proximity Fire Fighting Protective Trouser.

3.3.112* Universal Precautions. An approach to infection control in which human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

3.3.113 Utility Sink. A separate sink used for cleaning ensembles and ensemble elements.

N **3.3.114 Verified Cleaner.** An independent cleaning service verified by a third-party certification organization to conduct advanced cleaning and sanitization.

Δ **3.3.115 Verified Independent Service Provider (ISP).** An independent service provider verified by a third-party certification organization to conduct advanced inspection, advanced cleaning and sanitization, basic repair, and advanced repair service.

3.3.116 Verified Organization. See 3.3.64.2, Verified Organization.

3.3.117 Visibility Markings. Retroreflective and fluorescent conspicuity enhancements. Retroreflective enhancements improve nighttime conspicuity, and fluorescent enhancements improvement daytime conspicuity.

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

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

Chapter 4 Program

Δ **4.1 General.**

4.1.1* The organization shall develop and implement a program for the selection, care, and maintenance of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements used by the members of the organization in the performance of their assigned functions.

4.1.2 This program shall have the goal of providing structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are suita-

ble and appropriate for the intended use; maintaining such protective ensembles and ensemble elements in a safe, usable condition to provide the intended protection to the user; removing from use such protective ensembles and ensemble elements that could cause or contribute to user injury, illness, or death because of their condition; and reconditioning, repairing, or retiring such protective ensembles and ensemble elements.

4.1.3 Where this program for the selection, care, and maintenance of structural and proximity fire fighting protective ensembles and ensemble elements is part of an organization's overall program on protective clothing and protective equipment, the portion of the organization's overall program that affects structural and proximity fire fighting protective ensembles and ensemble elements shall be in accordance with Section 4.2.

4.2 Program Organization for Structural Fire Fighting Ensembles and Ensemble Elements and Proximity Fire Fighting Ensembles and Ensemble Elements.

4.2.1 The organization's program specified in Section 4.1 shall incorporate at least the requirements in Chapters 4 through 12 of this standard.

4.2.2* The organization shall develop written standard operating procedures (SOPs) that shall identify and define the various parts of the program and the various roles and responsibilities of the organization and of the members in the program parts specified in Table 4.2.2.

4.2.3* The organization shall not add or permit accessories to be added to any ensemble or ensemble element prior to the organization requesting approval in writing and receiving written approval from the ensemble or ensemble element manufacturer for each specific accessory.

4.2.3.1* The organization shall not add or permit accessories to be added to any ensemble or ensemble element where the organization's request for approval has been responded to in writing with a disapproval from the ensemble or ensemble element manufacturer.

4.2.3.2* In the event that the organization cannot make contact with the ensemble or ensemble element manufacturer for a specific accessory to be used on the ensemble or ensemble element, the organization shall be permitted to evaluate the accessory for attachment to an ensemble or ensemble element using recognized tests to determine that the accessory does not degrade the performance of the ensemble or ensemble element.

4.2.3.3* In the event the organization's written requests for permission have not received a reply from the ensemble or ensemble element manufacturer for a specific accessory to be used on the ensemble or ensemble element, the organization shall be permitted to evaluate the accessory for attachment to an ensemble or ensemble element using recognized tests to determine that the accessory does not degrade the performance of the ensemble or ensemble element.

4.2.4* The organization shall use one or any combination thereof of the following to perform advanced cleaning, sanitization or disinfection, advanced inspection, and repair services of ensembles and ensemble elements *(see Table 4.2.4)*:

(1) Manufacturer verified in cleaning
(2) Verified organization
(3) Verified independent service provider (ISP)
(4) Verified cleaner
(5) Manufacturer-trained organization for the organization's ensembles and ensemble elements only
(6) Ensemble or ensemble element manufacturer

Δ **4.2.4.1** Verified organizations, verified ISPs, manufacturers verified in cleaning, and verified cleaners shall meet the requirements of Chapter 11 and shall be verified by a third-party certification organization.

N **4.2.4.1.1** Manufacturers verified in cleaning shall meet the cleaning requirements of Chapter 11 and shall be verified by a third-party certification organization.

N **4.2.4.1.2** Verified cleaners shall meet the cleaning and quality management requirements of Chapter 11 and shall be verified by a third-party certification organization.

4.2.4.2* Where the organization is a verified organization, uses a verified ISP, or uses a verified cleaner, approval from the element manufacturer shall not be required.

Δ **4.2.4.3*** Verified organizations and verified ISPs shall receive written verification from the third-party certification organization to conduct garment element advanced cleaning, advanced inspection, and advanced repair services.

N **4.2.4.3.1*** Verified cleaners shall receive written verification from the third-party certification organization to conduct garment element advanced cleaning.

N **4.2.4.3.2** Manufacturers verified in cleaning shall receive written verification from the third-party certification organization to conduct garment element advanced cleaning.

• **4.2.4.4** All garment advanced repairs shall be conducted by the garment manufacturer, a verified organization, or a verified ISP.

Δ **4.2.4.5*** Manufacturer-trained organizations shall meet the training requirements in this section and shall be permitted to perform the activities identified in Table 4.2.4 for manufacturer-trained organizations.

N **4.2.4.5.1*** Training shall be provided by an element manufacturer of the same element type, a verified ISP, a verified organization, a verified cleaner, or any combination thereof.

Δ **Table 4.2.2 Required Program Parts for Structural and Proximity Fire Fighting Protective Ensembles and Elements**

Program Part	Chapter/Section of NFPA 1851
Records	Section 4.3
Protecting the public and personnel from exposure to contaminated PPE	Section 4.5
Selection	Chapter 5
Inspection	Chapter 6
Cleaning	Chapter 7
Repair	Chapter 8
Storage	Chapter 9
Retirement, disposition, and special incident procedures	Chapter 10

N Table 4.2.4 Responsibilities for Garment Element Inspection, Cleaning, and Repair

	Manufacturer Verified in Cleaning	Verified ISP or Verified Organization	Verified Cleaner	Manufacturer-Trained Organization	User	Ensemble or Ensemble Element Manufacturer
Routine inspections (Section 6.2)					X	
Preliminary exposure reduction (Section 7.2)					X	
Advanced inspection (Section 6.3)	X	X		X		X
Complete liner inspection (Section 6.4)	X	X		X		X
Advanced cleaning (Section 7.3)	X	X	X	X		
Sanitization or disinfection (Section 7.4)	X	X	X	X		
Specialized cleaning (Section 7.5)	X	X	X	X		
Basic repair (Sections 8.2 and 8.3)	X	X		X		X
Advanced repair (Sections 8.2 and 8.4)	X	X				X
Training for cleaning	X	X	X			X
Training for repairs	X	X				X
Training for inspection	X	X				X

N 4.2.4.5.2* Training shall be consistent with the requirements and information provided in this standard and shall incorporate at least the following:

(1) Program *(see Section 4.2)*
(2) Records *(see Section 4.3)*
(3) Protecting the public and personnel from exposure to contaminated PPE *(see Section 4.5)*
(4) Selection *(see Chapter 5)*
(5) Inspection *(see Chapter 6)*
(6) Cleaning *(see Chapter 7)*
(7) Repair *(see Chapter 8)*
(8) Storage *(see Chapter 9)*
(9) Retirement, disposition, and special incident procedures *(see Chapter 10)*
(10) Specific instructions, parameters or procedures applicable to ensembles or ensemble elements with unique properties or performance as necessary

N 4.2.4.5.3* The entity conducting the training shall provide documentation that the organization has received the required training.

N 4.2.4.5.4 Organizations shall obtain and complete within one year of the edition issuance date the training required in 4.2.4.5.2 each time a new edition of NFPA 1851 is issued or there is a change in personnel overseeing or performing the required aspects of an organization's program.

N 4.2.4.5.5 Organizations shall consult with an ensemble or ensemble element manufacturer when additional training is necessary for special requirements specific to products, components, or materials that are unique to a manufacturer.

4.2.5* The organization shall develop specific criteria for removal of protective clothing and equipment from service, in accordance with Chapter 10, Retirement, Disposition, and Special Incident Procedure. The criteria for retirement shall include, but not be limited to, issues that are specific to the ensembles or ensemble elements being used by the organization, the manufacturers' instructions, and the experience of the organization.

4.3 Records.

4.3.1* The organization shall compile and maintain records on its structural fire fighting protective ensembles and ensemble elements and proximity fire fighting protective ensembles and ensemble elements.

4.3.2* The records specified in 4.3.1 shall apply to fire fighting protective ensembles and ensemble elements that are utilized by the fire department, including rental or loaner protective ensembles and ensemble elements.

4.3.3 At least the following records shall be kept for each protective ensemble or ensemble element:

(1) Person to whom element is issued
(2) Date and condition when issued
(3) Manufacturer and model name or design
(4) Manufacturer's identification number, lot number, or serial number
(5) Month and year of manufacture
(6) Date(s) and findings of advanced inspection(s)
(7) Date(s) and findings of advanced cleaning, disinfection or sanitization, or specialized cleaning
(8) Reason(s) for and who performed advanced cleaning, disinfection or sanitization, or specialized cleaning
(9) Date(s) of repair(s), who performed repair(s), and brief description of repair(s)
(10) Date of retirement
(11) Date and method of disposal

4.3.4 The organization shall compile and maintain records as required by 4.3.3 on fire fighting protective ensembles with

liquid and particulate contaminant protection. The records shall include a list of specific required elements and interface components necessary for structural fire fighting protective ensembles with optional liquid and particulate contaminant protection and proximity fire fighting protective ensembles with optional liquid and particulate contaminant protection.

N **4.3.5*** Where an organization keeps an element(s) in a rotating exchange program and does not assign it to a member, the organization shall develop a program to clean and inspect these elements and the following records shall be kept:

(1) Manufacturer and model name or designation
(2) Manufacturer's identification number, lot number, or serial number
(3) Month and year of manufacture
(4) Date(s) and findings of advanced inspection(s)
(5) Date(s) and findings of advanced cleaning, disinfection or sanitization, or specialized cleaning
(6) Date(s) element is returned to rotating exchange inventory
(7) Reasons for and who performed advanced cleaning, disinfection or sanitization, or specialized cleaning
(8) Date(s) of repair(s), who performed repair(s), and brief description of repair(s)
(9) Date of retirement
(10) Date and method of disposal

4.4 Manufacturer's Instructions.

4.4.1 When issuing new structural fire fighting protective ensembles and ensemble elements or proximity fire fighting protective ensembles and ensemble elements, the organization shall provide users with the instructions provided by the manufacturer on the care, use, and maintenance of the protective ensembles or ensemble elements, including any warnings provided by the manufacturer. This information shall be permitted to be delivered from the manufacturer in various formats, including, but not limited to, printed materials or instructions to access the information electronically/digitally.

4.4.2* Where the manufacturer's instructions regarding the care or maintenance of the protective ensembles or elements differ from a specific requirement(s) in this standard, the manufacturer's instructions shall be followed for that requirement(s). Manufacturers shall not be permitted to override the requirements of this standard for third-party verification.

4.4.3 The organization shall retain and make accessible to fire department personnel a copy of manufacturers' instructions regarding the care, use, and maintenance of the protective ensembles for reference purposes.

4.5 Protecting the Public and Personnel from Exposure to Contaminated PPE.

4.5.1 The organization shall develop written SOPs that minimize the public's and the fire department personnel's exposure to soiled or contaminated structural or proximity fire fighting protective ensembles and ensemble elements.

4.5.2* The SOPs shall require that protective ensembles or ensemble elements not be worn or stored in the living areas of fire department facilities.

4.5.3* The public shall not be exposed at any time, except during emergency operations, to soiled or potentially contaminated protective ensembles or ensemble elements.

4.5.4* Soiled or potentially contaminated ensembles or ensemble elements shall not be brought into the home, taken to public facilities, or transported in private vehicles.

4.6 Reporting Personal Protective Equipment Health and Safety Concerns.

4.6.1* The organization shall report all personal protective equipment (PPE) health and safety concerns, if caused by a known or suspected element failure, to the element manufacturer and certification organization.

4.6.2* The organization shall notify the manufacturer and the certification organization in writing.

4.6.3 The organization shall request written acknowledgment that the report of health and safety concerns was received by the element manufacturer and certification organization. Written acknowledgment must be received within 30 days of the date of the report of health and safety concerns.

Chapter 5 Selection

5.1* Selection and Purchase.

5.1.1* Prior to starting the selection process of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements, the organization shall perform a risk assessment.

N **5.1.1.1** The organization shall distinguish between the use of structural fire fighting ensembles and proximity fire fighting ensembles based on the operating area and mission responsibilities of the organization. The risk assessment shall be based on both the frequency and severity of exposure to specific hazards as a means for determining the selection of appropriate fire fighting protective ensembles.

N **5.1.1.2** The organization shall review the risk assessment or conduct a new risk assessment at least every 2 years or under specific circumstances, including, but not limited to, the following:

(1) When there are changes that affect the findings of the current risk assessment in terms of the specific identification of hazards or availability of fire fighting ensemble product technology
(2) When there are changes in the organization's standard operating procedures (SOPs) for the use of structural fire fighting ensembles or proximity fire fighting ensembles
(3) When any personal protective ensemble or ensemble elements are being considered for selection and purchase

5.1.2 The risk assessment shall include, but not be limited to, the hazards that can be encountered by structural or proximity fire fighters based on the following:

(1)* Type of duties performed
(2) Distinguishing response activities for different potential incidents
(3) Organization's experiences
(4) Incident operations
(5) Geographic location and climate
(6)* Specific physical area of operation
(7)* Likelihood of or response to CBRN terrorism incident
(8) Need for two sets of ensemble elements or spare ensemble elements

Δ **5.1.3*** The organization shall review the current edition of NFPA 1971, NFPA 1994, NFPA 1500, NFPA 600, and any applicable federal or state OSHA standards relating to structural fire fighting protective ensembles and ensemble elements to determine how they affect the selection process.

Δ **5.1.4*** The organization shall ensure that elements under consideration are certified as being compliant with NFPA 1971 by a third-party certification organization.

5.1.5* Based on the risk assessment, the organization shall compile and evaluate information on the comparative strengths and weaknesses of the elements under consideration.

N **5.1.5.1*** Organizations shall specifically consider the tradeoffs in the level of thermal insulation versus thermal comfort or stress-related effects of the material composite in their selection of protective garments.

5.1.6* The organization shall ensure the proper interface between ensemble elements, including, but not limited to, coat-to-hood and helmet, coat-to-pant, coat-to-glove, and pants-to-footwear. Any other specialty equipment being used shall also be considered to ensure the equipment does not interfere with the proper function and interface of the protective ensemble or ensemble elements.

N **5.1.6.1*** Based on the risk assessment, the organization shall ensure that eye and face protection components or separate devices are specified to provide adequate eye and face protection for each type of incident identified in the risk assessment.

5.1.7* Where a field evaluation of an ensemble or ensemble element is conducted, the organization shall establish criteria to ensure a systematic method of comparing products in a manner related to their intended use and assessing their performance relative to the organization's expectations.

Δ **5.1.8*** Where the organization develops purchase specifications, at least the following criteria shall be included:

(1) Purchase specifications shall require that the ensemble or ensemble element(s) to be purchased shall be compliant with the current edition of NFPA 1971. Purchasers shall consider that ensembles that are certified to the optional liquid and particulate contamination protection requirement are tested and certified as ensembles and must be worn as an ensemble with all elements and interface components present as stated on the element label.
(2)* Where the organization selects criteria that exceed the minimum requirements of the current edition of NFPA 1971, such criteria shall be stipulated in the purchase specifications.
(3)* Purchase specifications shall require that submitted offers or bids include substantiation of certification for each element and model offered.
(4)* Where applicable, the purchase specifications shall define the process for determining proper fit.
(5)* The organization shall compare each bid submittal against purchase specifications.

5.1.9 Upon receipt, organizations shall inspect purchased protective ensemble element(s) to determine that they meet their specifications and that they were not damaged during shipment. Organizations shall also verify the quantity and sizes of the protective ensemble element(s) received.

5.1.10 Organizations shall examine information supplied with the products, such as instructions, warranties, and technical data.

5.1.11 Procedures shall be established for returning unsatisfactory products if the organization's specifications are not met.

Chapter 6 Inspection

6.1 General.

6.1.1 Universal precautions shall be observed, as appropriate, when handling ensemble elements. At a minimum, individuals conducting inspections shall wear examination gloves that are certified to NFPA 1999. Consideration shall also be given to having individuals conducting inspections of ensemble elements wear appropriate aprons with sleeves or respirators.

Δ **6.1.2** Any ensemble elements that are found to be soiled or contaminated shall be cleaned before any additional inspection is initiated. Where ensemble elements are found to be contaminated by CBRN agents, the ensemble shall be retired.

6.1.3* The organization shall establish guidelines for its members to follow in determining if an element is soiled to an extent that cleaning is necessary.

Δ **6.1.4** The organization shall determine appropriate actions to be taken if an element is found to be in need of cleaning or repair.

Δ **6.1.4.1** At a minimum, any necessary cleaning shall be done in accordance with the requirements specified in Chapter 7. Where a condition exists that is beyond preliminary exposure reduction in accordance with Section 7.2, the element shall be removed from service, tagged, and referred to personnel responsible for advanced cleaning.

6.1.4.2 At a minimum, any necessary repairs shall be made in accordance with the requirements specified in Chapter 8. Where a condition exists that is beyond basic garment element repair in accordance with Section 8.3, the element shall be removed from service, tagged, and referred to personnel responsible for repair.

6.1.4.3 At a minimum, any necessary testing shall be conducted in accordance with the methods specified in Chapter 12.

6.2 Routine Inspection.

6.2.1 Individual members shall conduct a routine inspection of their protective ensembles and ensemble elements upon issue, at the beginning of each duty period, and after each use.

6.2.2* The routine inspection shall include, at a minimum, the inspections specified in 6.2.2.1 through 6.2.2.7.

6.2.2.1 Coat and trouser garment elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage such as the following:
    (a) Rips, tears, and cuts
    (b) Damaged or missing hardware and closure systems
    (c) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
(4) Damaged or missing reflective trim

(5) Loss of seam integrity and broken or missing stitches
(6) Correct assembly and size compatibility of shell, liner, and the drag rescue device (DRD)

6.2.2.2 Hood elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage such as the following:
  (a) Rips, tears, and cuts
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
(4) Loss of face opening adjustment
(5) Loss of seam integrity and broken or missing stitches
(6)* Damage to the particulate-blocking layer (particulate-blocking hoods only)

6.2.2.3 Helmet elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage to the shell such as the following:
  (a) Cracks, crazing, dents, and abrasions
  (b) Thermal damage to the shell (such as bubbling, soft spots, warping, or discoloration)
(4) Physical damage to the earflaps such as the following:
  (a) Rips, tears, and cuts
  (b) Thermal damage (such as charring, burn holes, or melting)
(5) Damaged or missing components of the suspension and retention systems
(6)* Damaged or missing components of the faceshield/goggle system, including discoloration, crazing, and scratches to the faceshield/goggle lens limiting visibility
(7) Damaged or missing reflective trim
(8) Loss of seam integrity and broken or missing stitches

6.2.2.4 Glove elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage such as the following:
  (a) Rips, tears, and cuts
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
  (c) Inverted glove liner
(4) Shrinkage
(5) Loss of elasticity or flexibility
(6) Loss of seam integrity and broken or missing stitches

6.2.2.5 Footwear elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage such as the following:
  (a) Cuts, tears, and punctures
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
  (c) Exposed or deformed protective toe, protective midsole, or shank
(4) Loss of water resistance
(5) Closure system component damage and functionality
(6) Loss of seam integrity and broken or missing stitches

6.2.2.6 DRD components shall be inspected for the following:

(1) Installation in garment
(2) Soiling
(3) Contamination
(4) Physical damage such as the following:
  (a) Cuts, tears, punctures, cracking, or splitting
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration)
  (c) Loss of seam integrity and broken or missing stitches

6.2.2.7 Interface components shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage
(4) Loss or reduction of properties that allow component to continue as effective interface [e.g., loss of shape or inability to remain attached to the respective element(s) where attachment is required]
(5) Loss of seam integrity and broken or missing stitches

6.2.3 Additional Routine Inspection Requirements for Proximity Fire Fighting Protective Ensembles and Ensemble Elements.

6.2.3.1 Proximity fire fighting coat and trouser garment elements shall be inspected for the following:

(1) Loss of reflectivity
(2) Loss of reflective coating(s)
(3) Delamination as evidenced by separation or peeling of the outer shell

6.2.3.2 Proximity fire fighting helmet element overcover shall be inspected for the following:

(1) Loss of reflectivity
(2) Loss of reflective coating(s)
(3) Delamination as evidenced by separation or peeling of the outer shell
(4) Damaged or missing reflective trim, if applicable
(5) Damage and functionality of the overcover to helmet attachment

6.2.3.3 Proximity fire fighting shrouds shall be inspected for the following:

(1) Loss of reflectivity
(2) Loss of reflective coating(s)
(3) Delamination as evidenced by separation or peeling of the outer shell
(4) If applicable, damage and functionality of the shroud-to-helmet attachment
(5) Distortion of face opening resulting in gaps around the faceshield

6.2.3.4 Proximity fire fighting helmet elements shall be inspected for the following:

(1) Loss of faceshield reflectivity
(2) Loss of shell reflectivity, if applicable

6.2.3.5 Proximity fire fighting glove elements shall be inspected for the following:

(1) Loss of reflectivity
(2) Loss of reflective coating(s)

6.2.3.6 Proximity fire fighting footwear elements shall be inspected for the following:

(1) Loss of reflectivity
(2) Loss of reflective coating(s)

6.3 Advanced Inspection.

6.3.1 Advanced inspection and any necessary testing shall be performed by the element manufacturer, a manufacturer-trained organization, a verified organization, or a verified ISP.

6.3.2 The member(s) of the organization who has received training in the advanced inspection of the ensembles or ensemble elements shall be responsible for performing, managing, or coordinating advanced inspections or the advanced inspection process.

6.3.2.1* The ensemble or ensemble element manufacturer or a verified ISP and the organization shall determine the level of training required to perform advanced inspections. The ensemble or ensemble element manufacturer or verified ISP shall provide written verification of training. The organization shall be trained on advanced inspection procedures by either an element manufacturer or a verified ISP upon each new revision of this standard.

6.3.2.1.1 If the organization is a verified organization, it shall be permitted to determine the level of training necessary to perform the advanced inspection without any further written verification.

6.3.3* Advanced inspections of all protective ensemble elements that are issued shall be conducted annually and whenever a routine inspection determines potential damage.

6.3.3.1 Ensemble elements that have been properly stored in accordance with Chapter 9 and are not being used are not required to be subjected to advanced inspection.

6.3.4* The findings of the advanced inspection shall be documented.

Δ **6.3.5*** The advanced inspection shall include, at a minimum, the inspections specified in 6.3.5.1 through 6.3.7.3.

6.3.5.1* All separable layers of the garment elements shall be individually inspected for the following:

(1) Soiling
(2) Contamination
(3)* Physical damage to all layers, such as the following:
  (a) Rips, tears, cuts, and abrasions
  (b) Damaged or missing hardware
  (c) Thermal damage (charring, burn holes, melting, discoloration of any layer)
(4)* Loss of moisture barrier integrity as indicated by any of the following:
  (a) Rips, tears, cuts, or abrasions
  (b) Discoloration
  (c) Thermal damage
(5) Evaluation of system fit and coat/trouser overlap
(6) Loss of seam integrity and broken or missing stitches
(7)* Loss of material physical integrity [e.g., ultraviolet (UV) or chemical degradation] as evidenced by discoloration, significant changes in material texture, loss of material strength, loss of liner material, and shifting of liner material
(8) Loss of wristlet elasticity, stretching, runs, cuts, or burn holes
(9)* Reflective trim integrity, attachment to garment, reflectivity, or damage
(10)* Label integrity and legibility
(11) Hook and loop functionality
(12) Liner attachment systems
(13) Closure system functionality
(14) Accessories for compliance with 4.2.3
(15) Correct assembly and size compatibility of shell, liner, and DRD

6.3.5.2 Hood elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage, including, but not limited to, the following:
  (a) Rips, tears, and cuts
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
(4) Damage to or separation of any material as described by the manufacturer
(5)* Damage to the particulate-blocking layer, where present, as specified in Section 12.1 or Section 12.2
(6) Shrinkage
(7) Loss of material elasticity or stretching out of shape
(8) Loss of seam integrity or broken or missing stitches
(9) Loss of face-opening adjustment
(10)* Label integrity and legibility

6.3.5.3 Helmet elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage to the shell such as the following:
  (a) Cracks, dents, and abrasions
  (b) Thermal damage to the shell (such as bubbling, soft spots, warping, or discoloration)
(4) Physical damage to the ear flaps such as the following:
  (a) Rips, tears, and cuts
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
(5) Damaged or missing components of the suspension and retention systems
(6) Functionality of suspension and retention systems
(7) Damaged or missing components of the faceshield/goggle system, including discoloration or scratches to the faceshield/goggle lens limiting visibility
(8) Functionality of faceshield/goggle system
(9) Damage to the impact cap
(10) Damaged or missing reflective trim
(11) Accessories for compliance with 4.2.3
(12) Loss of seam integrity and broken or missing stitches
(13)* Label integrity and legibility

6.3.5.4 Glove elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3)* Physical damage such as the following:
  (a) Rips, tears, and cuts
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
  (c) Inverted glove liner
  (d) Loss of seam integrity or broken or missing stitches
(4) Shrinkage
(5) Loss of flexibility
(6) Loss of elasticity and shape in wristlets
(7) Accessories for compliance with 4.2.3
(8)* Label integrity and legibility

6.3.5.5 Footwear elements shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage such as the following:
  (a) Cuts, tears, punctures, cracking, or splitting
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration of any layer)
  (c) Exposed or deformed steel toe, steel midsole, or shank
  (d) Loss of seam integrity, delamination, or broken or missing stitches
(4) Loss of water resistance
(5) Closure system component damage and functionality
(6)* Excessive tread wear
(7) Condition of lining such as the following:
  (a) Tears
  (b) Excessive wear
  (c) Separation from outer layer
(8) Heel counter failure
(9) Accessories for compliance with 4.2.3
(10)* Label integrity and legibility

6.3.5.6 Interface components shall be inspected for the following:

(1) Soiling
(2) Contamination
(3) Physical damage
(4) Loss or reduction of properties that allow component to continue as effective interface, such as loss of shape or inability to remain attached to the respective element(s), if attachment is required
(5) Loss of seam integrity and broken or missing stitches

6.3.5.7 DRD components shall be inspected for the following:

(1) Installation in garment
(2) Soiling
(3) Contamination
(4) Physical damage such as the following:
  (a) Cuts, tears, punctures, cracking, or splitting
  (b) Thermal damage (such as charring, burn holes, melting, or discoloration)
  (c) Loss of seam integrity and broken or missing stitches
(5)* Label integrity and legibility

6.3.6 Additional Advanced Inspection Criteria for Proximity Fire Fighting Protective Ensembles and Ensemble Elements.

6.3.6.1 Proximity fire fighting garment elements shall be inspected for the following:

(1) Loss of radiant reflectivity
(2) Loss of radiant reflective coating(s)
(3) Delamination as evidenced by separation or peeling of the outer shell

6.3.6.2 Proximity fire fighting helmet overcover components shall be inspected for the following:

(1) Loss of radiant reflectivity
(2) Loss of radiant reflective coating(s)
(3) Damaged or missing reflective trim, if applicable
(4) Helmet attachment system for damage and functionality
(5) Delamination as evidenced by separation or peeling of the outer shell

6.3.6.3 Proximity fire fighting shroud components shall be inspected for the following:

(1) Loss of radiant reflectivity
(2) Loss of radiant reflective coating(s)
(3) Helmet attachment system, if applicable, for damage and functionality
(4) Distortion of face opening resulting in gaps around the faceshield
(5) Delamination as evidenced by separation or peeling of the outer shell

6.3.6.4 Proximity fire fighting helmet elements shall be inspected for the following:

(1) Loss of faceshield radiant reflectivity
(2) Loss of shell radiant reflectivity, if applicable

6.3.6.5 Proximity fire fighting glove elements shall be inspected for the following:

(1) Loss of radiant reflectivity
(2) Loss of radiant reflective coating(s)
(3) Delamination as evidenced by separation or peeling of the outer shell

6.3.6.6 Proximity fire fighting footwear shall be inspected for the following:

(1) Loss of radiant reflectivity
(2) Loss of radiant reflective coating(s)

6.3.7 Additional Advanced Inspection Criteria for Ensembles with Optional Liquid and Particulate Contaminant Protection.

6.3.7.1* Liquid and particulate contaminant protective ensembles shall be inspected according to the manufacturer's instructions.

6.3.7.2 Complete liner inspection of all garment elements shall be conducted at a minimum after 2 years in service and annually thereafter or whenever advance inspections indicate that a problem might exist.

6.3.7.3 Liquid and particulate contaminant protective ensembles shall be inspected for loss of integrity, including, but not limited to, the following:

(1) Loss of interface functionality
(2) Excessive material or component shrinkage or stretching

6.4 Complete Liner Inspection.

6.4.1 Complete liner inspection of all garment elements shall be performed by the garment manufacturer, a manufacturer-trained organization, a verified organization, or a verified ISP.

6.4.2 The member(s) of the organization who has received training in the complete liner inspection of the garment element shall be responsible for performing, managing, or coordinating the complete liner inspection or the complete liner inspection process.

6.4.2.1 The garment element manufacturer or a verified ISP and the organization shall determine the level of training required to perform complete liner inspections. The garment element manufacturer or verified ISP shall provide written verification of training.

6.4.2.1.1 If the organization is a verified organization, it shall be permitted to determine the level of training necessary to

perform the complete liner inspection without any further written verification.

6.4.3 Complete liner inspection of all garment elements shall be conducted as part of the advanced inspection annually and whenever a routine inspection determines potential damage. The liner system shall be opened to expose all layers for inspection and testing.

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6.4.4 The findings of the complete liner inspection shall be documented.

6.4.5 The complete liner inspection shall include, as a minimum, the inspection specified in 6.4.5.1 through 6.4.5.3.

6.4.5.1* The moisture barrier and the thermal barrier shall be inspected for the following:

(1) Physical damage to all layers and sides of each layer such as the following:
   (a) Rips, tears, cuts, and abrasions
   (b) Thermal damage (charring, burn holes, melting, or discoloration of any layer)
(2) Loss of seam integrity, broken or missing stitches, and loose or missing moisture barrier seam tape
(3) Material physical integrity; UV or chemical degradation as evidenced by discoloration, significant changes in material texture, loss of material strength, loss of liner material, or shifting of liner material
(4) Delamination as evidenced by separation of film from substrate fabric, flaking, or powdering

6.4.5.2 The moisture barrier shall be tested using the hydrostatic test to evaluate the water penetration barrier, as specified in Section 12.3, and shall show no leakage.

6.4.5.3 The result of each water penetration barrier evaluation shall be recorded.

Chapter 7 Cleaning and Decontamination

7.1* General.

Δ **7.1.1 Approach for Handling Ensemble Elements After Incident Response.** Organizations shall provide a means for cleaning ensemble elements.

N **7.1.1.1*** Cleaning capabilities shall be permitted to be conducted in-house by a manufacturer-trained organization, a verified organization, a verified cleaner, a manufacturer verified in cleaning, a verified ISP, or any combination thereof.

N **7.1.1.2** Organizations shall use the decision tool provided in Figure 7.1.1.2(a) and Figure 7.1.1.2(b) to assist in determining the appropriate cleaning procedures to follow as specified in Sections 7.2 through 7.5.

N **7.1.1.3*** With the exception of CBRN contamination or other forms of contamination, where further contact with specific hazardous contaminants requires immediate removal of ensembles or ensemble elements, preliminary exposure reduction procedures shall be applied as specified in Section 7.2 prior to any cleaning.

N **7.1.1.4** Organizations shall develop standard operating procedures for field use that reflect the specific decision-making process described in this section.

N **7.1.1.5** Soiled or contaminated elements shall not be brought into the home, washed in home laundries, or washed in public laundries.

N **7.1.1.6*** Commercial dry cleaning, particularly those processes using perchloroethylene or related solvents, shall not be used as a means of cleaning ensembles and ensemble elements unless approved by the ensemble or ensemble element manufacturer.

Δ **7.1.2* Approach for Deciding the Handling, Cleaning, and Disposition of Ensemble Elements.**

N **7.1.2.1** Ensembles and ensemble elements shall be evaluated by the wearer or a designated individual within the organization for application of preliminary exposure reduction, cleaning, disinfection, or sanitization after each use based on the guidance provided in Figure 7.1.1.2(a).

Δ **7.1.2.2** Ensembles and ensemble elements contaminated by CBRN terrorism agents shall be immediately retired after confirmed exposure and shall not be subjected to cleaning.

N **7.1.2.2.1** CBRN terrorism agent–contaminated ensembles and ensemble elements shall be doffed as soon as possible, bagged, and disposed of as hazardous waste in accordance with federal, state, and local regulations.

N **7.1.2.3** Ensembles and ensemble elements that were used in a hazardous materials incident shall be subject to preliminary exposure reduction as specified in Section 7.2 and then assessed by qualified members of the hazardous materials team or other qualified experts with knowledge about the specific exposures that took place.

N **7.1.2.3.1** The information gained from the hazardous materials team or other experts shall be used to determine whether cleaning is possible.

N **7.1.2.3.1.1** If it is determined that cleaning is possible, an appropriate form of specialized cleaning shall be applied to the affected ensembles and ensemble elements to remove contamination or reduce it to a safe level.

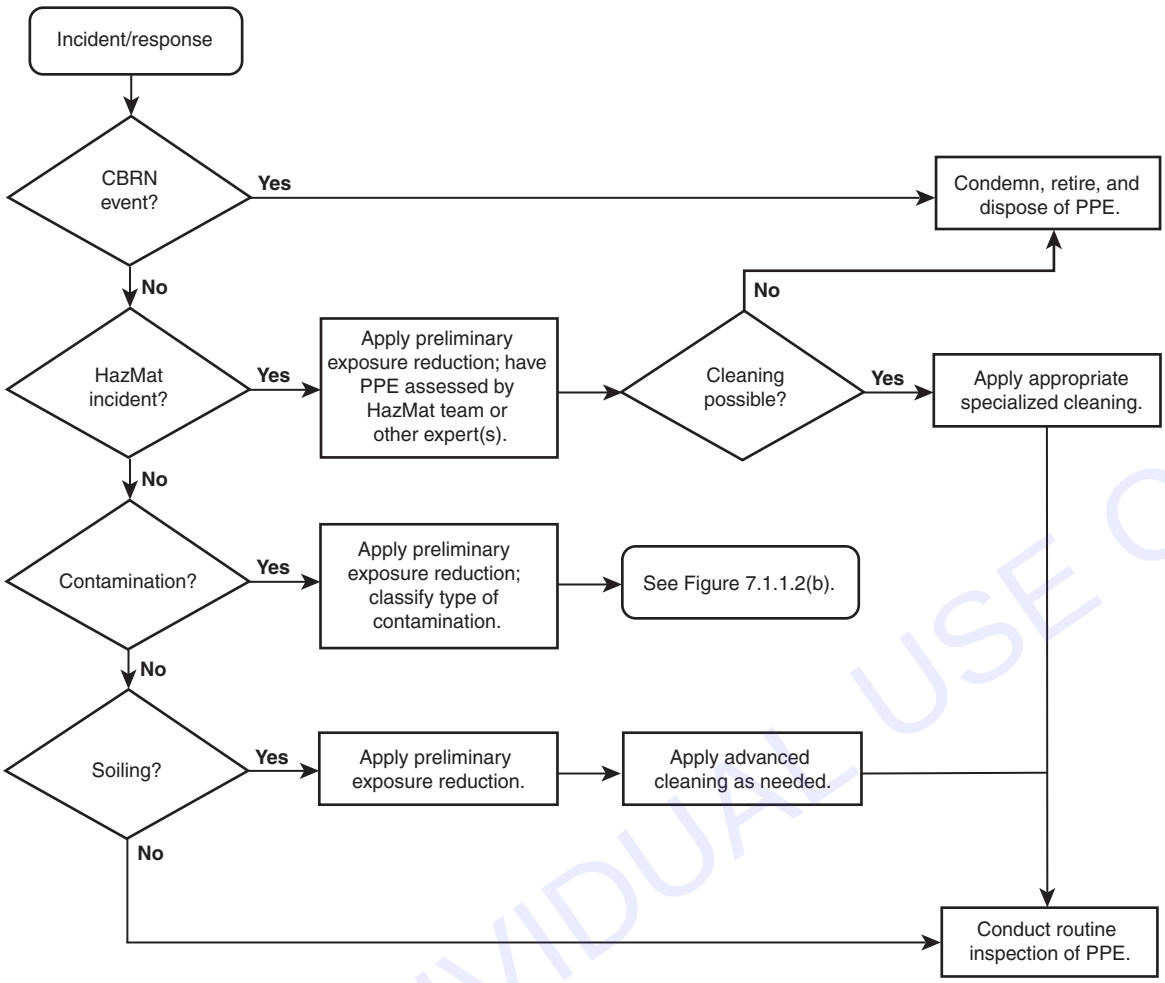
N **7.1.2.3.1.2** If it is determined that cleaning is not possible or that the ensemble or ensemble elements have been damaged beyond repair, the affected ensembles and ensemble elements shall be condemned, retired, and not subjected to cleaning.

N **7.1.2.3.2** Ensembles and ensemble elements that were contaminated during a hazardous materials incident and cannot be cleaned shall be disposed of as hazardous waste in accordance with federal, state, and local regulations.

7.1.2.4 Ensembles and ensemble elements that are known or suspected to be contaminated with bulk chemicals, asbestos, or other designated hazardous substances, body fluids, or other microbial contamination, or products of combustion from a structural or other fire shall be subject to preliminary exposure reduction as specified in Section 7.2.

N **7.1.2.5** Ensembles and ensemble elements that are soiled but not contaminated shall be subject to preliminary exposure reduction as specified in Section 7.2.

N **7.1.2.5.1** If the ensemble and ensemble elements have been subjected to soiling, the ensemble and ensemble elements shall be subjected to advanced cleaning as needed and as specified in Section 7.3.



Note: Contaminants shown in relative hierarchy of exposure risk. Multiple forms of contamination might apply. Clean according to highest risk.

N FIGURE 7.1.1.2(a) Approach for Deciding Handling, Cleaning, and Disposition of Ensemble Elements.

N 7.1.2.5.2 If the ensemble and ensemble elements are not soiled and do not require advanced cleaning, the ensemble and ensemble elements shall be subjected to routine inspection as specified in Section 6.2.

N 7.1.3* Approach for Addressing Specific Types of Contamination. Where ensembles and ensemble elements have been suspected or found to have contamination from bulk chemicals, asbestos, or other designated hazardous substances, body fluids, or other forms of microbial contamination, or products of combustion products from a structural or other fire, the organization shall apply the steps shown in Figure 7.1.1.2(b).

Δ 7.1.3.1 General Decontamination Actions.

N 7.1.3.1.1 Where the form of contamination cannot be identified, contaminated ensembles and ensemble elements shall be subject to preliminary exposure reduction, isolated, and removed from service until the suspected contaminant(s) is identified and the elements can receive advanced or specialized cleaning, as necessary, to remove it.

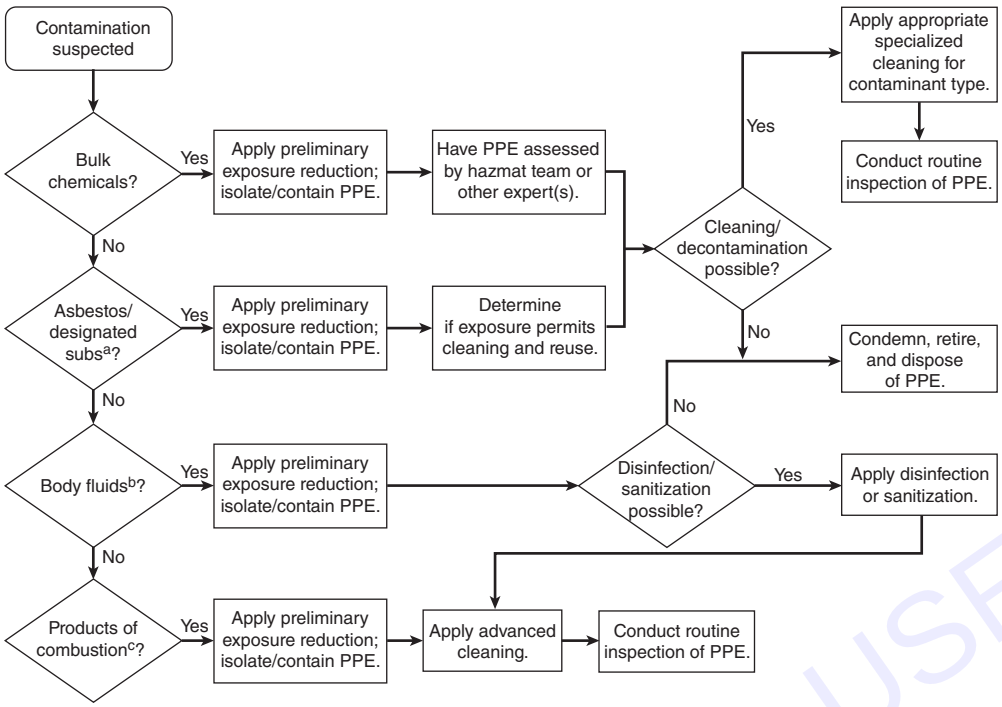
N 7.1.3.1.2 Where multiple forms of contamination are present, the actions for the handling and cleaning and disposition of ensemble and ensemble elements shall be according to the contamination posing the highest risk.

N 7.1.3.2 Bulk Chemical Decontamination Actions.

N 7.1.3.2.1 Ensembles and ensemble elements that are known or suspected to be contaminated with bulk chemicals shall be subject to preliminary exposure reduction as specified in Section 7.2 and isolated, tagged, and bagged at the incident scene.

N 7.1.3.2.2 The type of bulk chemical contamination shall be assessed by the organization's hazardous materials team or other qualified experts to determine if cleaning or decontamination of the ensembles and ensemble elements is possible.

Δ 7.1.3.2.2.1 Where the contaminant and its source have been identified, the organization shall consult the supplier of the contaminant, the manufacturer of the ensemble and ensemble elements, a verified cleaner, or a verified ISP for an appropriate decontamination agent and process.



Notes:
[a]And other designated substances
[b]Includes other microbial contamination
[c]Includes any significant structural fire exposure

N FIGURE 7.1.1.2(b) Approach for Addressing Specific Types of Contamination.

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N 7.1.3.2.2.2 Based on the assessment of the type of contamination conditions, if cleaning or decontamination is not possible, then the affected ensemble and ensemble elements shall be condemned, retired, and disposed of as hazardous waste in accordance with federal, state, and local regulations.

N 7.1.3.2.2.3 Based on the assessment of the contamination conditions, if cleaning or decontamination is considered possible, then the affected ensemble and ensemble elements shall be subjected to specialized cleaning as specified in Section 7.5.

N 7.1.3.3 Asbestos and Other Designated Hazardous Substance Decontamination Actions.

N 7.1.3.3.1 Ensembles and ensemble elements that are known or suspected to be contaminated with asbestos or other designated highly hazardous substances shall be subject to preliminary exposure reduction as specified in Section 7.2 and isolated, tagged, and bagged at the incident scene.

N 7.1.3.3.2 The organization's hazardous materials team or other qualified experts shall determine if cleaning or decontamination of the ensemble and ensemble elements is possible.

N 7.1.3.3.2.1 Based on the assessment of the contamination conditions, if cleaning or decontamination is not possible, then the affected ensemble and ensemble elements shall be condemned, retired, and disposed of as hazardous waste in accordance with federal, state, and local regulations.

N 7.1.3.3.2.2 Based on the assessment of the contamination conditions, if cleaning or decontamination is considered possible, then the affected ensemble and ensemble elements shall be subjected to specialized cleaning as specified in Section 7.5.

N 7.1.3.4 Body Fluid and Other Microbial Contamination Disinfection and Sanitization Actions.

N 7.1.3.4.1 Ensembles and ensemble elements that are known or suspected to be contaminated with body fluids or other forms of microbial contaminants shall be subject to preliminary exposure reduction as specified in Section 7.2 and isolated, tagged, and bagged at the incident scene.

N 7.1.3.4.2 The organization or qualified experts shall determine if disinfection or sanitization and cleaning of the ensemble and ensemble elements is possible.

N 7.1.3.4.2.1 Based on the assessment of the contamination conditions, if disinfection or sanitization and cleaning is not possible, then the affected ensemble and ensemble elements shall be condemned, retired, and disposed of as biological waste in accordance with federal, state, and local regulations.

N 7.1.3.4.2.2 Based on the assessment of the contaminant, if disinfection or sanitization is considered possible, then the affected ensemble and ensemble elements shall be subjected to disinfection or sanitization procedures, followed by advanced cleaning procedures as specified in Sections 7.4 and 7.3, respectively.

N 7.1.3.5 Products of Combustion Cleaning Actions.

N 7.1.3.5.1* Ensembles and ensemble elements that have been exposed to products of combustion shall be subject to preliminary exposure reduction as specified in Section 7.2 and isolated, tagged, and bagged at the incident scene.

N **7.1.3.5.2*** Following preliminary exposure reduction, ensembles and ensemble elements shall be subject to advanced cleaning as specified in Section 7.3 as soon as possible following the event.

N **7.1.3.6 Special Provisions for Ensemble Elements.** Where elements of an ensemble are connected, the following procedures shall be used:

(1) When one element is connected to another element and they are not permanently attached to each other, individual elements shall be disassembled from each other prior to beginning the cleaning process of elements and all disassembled elements shall undergo a separate cleaning process.

(2) When one element is connected to another element and they are not permanently attached to each other and are subsequently disassembled from each other prior to beginning the cleaning process, they shall be reassembled prior to any return to service in a like manner to their original manufactured state.

7.2* Preliminary Exposure Reduction.

N **7.2.1 General.**

N **7.2.1.1*** Organizations shall include preliminary exposure reduction as part of their overall program for the care and maintenance of structural fire-fighting ensembles and ensemble elements and proximity fire-fighting ensembles and ensemble elements.

7.2.1.2* Organizations shall be responsible for implementing preliminary exposure reduction procedures on scene for ensemble and ensemble elements.

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7.2.2 Preliminary Exposure Reduction Procedures.

7.2.2.1* End users shall carry out preliminary exposure reduction immediately after exiting the emergency scene at any incident where their protective ensemble or ensemble elements could have become soiled or contaminated.

7.2.2.2* Upon exiting the emergency scene, the end user shall remain on self-contained breathing apparatus (SCBA) air.

7.2.2.3 If returning to the emergency scene after an air cylinder change, any dry debris shall be brushed off the helmet, facepiece, and SCBA prior to changing out the cylinder.

N **7.2.2.4*** If the end user is completing their time on scene, dry or wet mitigation techniques shall be conducted prior to the removal of any ensemble or ensemble elements.

N **7.2.2.4.1*** The dry mitigation techniques shall be performed by brushing debris from the exterior of ensembles and ensemble elements with a soft bristle brush prior to removal.

7.2.2.4.2* The wet mitigation techniques shall be performed by gently rinsing the exterior of ensembles and ensemble elements using low-pressure and low-volume flow water.

N **7.2.2.4.2.1** A mild detergent shall be permitted to be used to aid in the wet mitigation technique, followed by gentle rinsing.

N **7.2.2.4.2.2** Heavy scrubbing or spraying with high-velocity water jets such as a power washer shall not be used.

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N **7.2.2.4.3** If used in combination, dry mitigation shall precede wet mitigation.

N **7.2.2.5*** Following dry or wet mitigation, ensemble or ensemble elements shall be isolated and bagged. Where possible, ensemble or ensemble elements, even when bagged, shall not be transported in the passenger areas of apparatus or personal vehicles.

N **7.2.2.6** Following preliminary exposure reduction, the ensemble or ensemble element(s) shall be subjected to the appropriate cleaning procedures specified in Section 7.1.

N **7.2.3 Additional Requirements for Preliminary Exposure Reduction of Hood Interface Components.** Following each structural fire or emergency service use, hood interface components shall be subjected to preliminary exposure reduction and advanced cleaning as specified in Section 7.3.

N **7.2.4* Additional Requirements for Preliminary Exposure Reduction of Eye and Face Protection Components.** After each use, eye and face protection components that are provided as part of the helmet or as separate devices shall be subjected to preliminary exposure reduction and wiped off and cleaned.

7.2.5 Additional Requirements for Preliminary Exposure Reduction of Proximity Fire-Fighting Ensembles and Ensemble Elements. During preliminary exposure reduction, the use of a brush or any other abrasive cleaning devices on radiant reflective outer shells and other components of proximity fire-fighting protective ensembles and ensemble elements shall not be permitted.

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Δ **7.3 Advanced Cleaning.**

7.3.1 Advanced cleaning shall be performed by an element manufacturer verified in cleaning, a verified cleaner, a manufacturer-trained organization, a verified organization, or a verified ISP.

N **7.3.1.1** In the absence of a method to verify effectiveness of cleaning, manufacturers of certified ensembles and ensemble elements shall be permitted to provide advanced cleaning.

7.3.1.2 The member(s) of the organization who has received training in the advanced cleaning of the ensembles or ensemble elements shall be responsible for performing, managing, or coordinating advanced cleaning or the advanced cleaning process.

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N **7.3.1.3*** Training shall meet the requirements specified in 4.2.4.5.

N **7.3.2** If the organization is a verified organization, it shall be permitted to determine the level of training that is needed for carrying out the advanced cleaning.

Δ **7.3.3*** Ensembles and ensemble elements that are soiled or contaminated shall receive advanced cleaning.

N **7.3.3.1** Ensembles or ensemble elements that have been exposed to blood or other body fluids shall be subjected to sanitization or disinfection prior to advanced cleaning as specified in Section 7.4.

N **7.3.3.2** Advanced cleaning shall be permitted prior to sanitization or disinfection if the procedures for advanced cleaning have proven effective for sanitization or disinfection of the ensemble or ensemble elements.

N **7.3.3.3** Ensembles or ensemble elements that have been exposed to bulk chemicals, unusual biological contaminants,

asbestos, or other substances of a highly hazardous or unusual nature shall be subjected to specialized cleaning as specified in Section 7.5 in lieu of advanced cleaning.

N **7.3.3.3.1** Advanced cleaning shall only be applied for the contaminants described in 7.3.3.3 if known to be effective for removing the specific contaminants.

7.3.4* Where not subjected to prior advanced cleaning, ensembles and ensemble elements that are issued and used shall receive advanced cleaning at least every six months, resulting in a minimum of two advanced cleanings in a 12-month period, with one of these advanced cleanings occurring at the time of annual advanced inspection.

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7.3.5* Where the use of machine cleaning is specified for ensembles and ensemble elements, advanced cleaning shall be conducted using a washer/extractor with the following characteristics unless specifically prohibited:

(1) The washer/extractor shall be programmable to permit multiple formulations for adjustments of detergent application, water temperature, water level, cycle type/function, and cycle time.
(2)* The washer/extractor shall not have a g-force that exceeds 100 G or shall have the capability of drum revolutions per minute (RPM) adjustment such that the g-force can be adjusted to not exceed 100 G for all washed ensembles and ensemble elements.

N **7.3.6*** Top-loading washing machines with or without a center post agitator shall not be used for advanced cleaning of ensembles and ensemble elements or components.

N **7.3.6.1*** Before using any cleaning device other than a washer/extractor, the element manufacturer, verified cleaner, or verified ISP shall be contacted for instructions on how to best clean the ensemble(s) or ensemble element(s) using the respective cleaning device.

N **7.3.7** Detergents and other cleaning or pretreatment chemicals used in the advanced cleaning of ensembles and ensemble elements shall be appropriate for the respective ensemble or ensemble element.

N **7.3.7.1** Chlorine bleach, chlorinated solvents, or solvents shall not be used without the ensemble or ensemble element manufacturer's or verified ISP's approval. *(See A.7.3.6.1.)*

N **7.3.7.2*** For advanced cleaning, a mild detergent with a pH range of not less than 6.0 pH and not greater than 10.5 pH as indicated on the product safety data sheet (SDS) or original product container shall be used.

N **7.3.7.3*** Selected detergents and cleaning agents shall not knowingly cause significant long-term degradation of ensemble or ensemble element performance when applied at the expected cleaning frequency over the service life of the ensemble or ensemble element.

N **7.3.7.4*** Any testing used in the evaluation of the cleaning effectiveness of specific ensembles or ensemble elements subjected to advanced cleaning procedures shall account for both contaminated and cleaned sample analyses.

N **7.3.8*** Universal precautions shall be applied in the washing of all soiled or contaminated ensembles or ensemble elements.

Δ **7.3.9** Where machine washing with a washer/extractor is specified, the following procedures shall be used:

(1)* The washer/extractor shall not be overloaded or under loaded.
(2)* Heavily soiled or spotted areas shall be pretreated.
(3) All closures, including pocket closures, hooks and loops, snaps, zippers, and hooks and dees, shall be fastened.
(4)* Water temperature shall not exceed 40°C (105°F).
(5)* The specific formulation for the washer/extractor shall include a series of steps for filling the wash basket, adding detergent, performing multiple rinses, and including separate extractions between wash and rinse steps.
(6) The element shall be inspected and rewashed if necessary.

Δ **7.3.10*** **Drying Procedures.**

N **7.3.10.1** Ensembles and ensemble elements shall be dried using one of the following procedures in:

(1)* Air drying, as follows:
  (a)* Place ensembles or ensemble elements in an area with good ventilation.
  (b)* Do not dry ensembles or ensemble elements in direct or indirect sunlight, under fluorescent light, or under UV light.
  (c) Do not allow the area used for drying to exceed 40°C (105°F).
(2)* A drying cabinet, as follows:
  (1) Place ensembles or ensemble elements in the drying cabinet to allow good air circulation between each ensemble or ensemble element.
  (2) Use a specific drying time and drying temperature to provide sufficient drying of the ensembles or ensemble elements.
  (3) Do not allow the area used for drying to exceed 40°C (105°F).

N **7.3.10.2*** When machine drying is used, the following procedures shall be followed:

(1) The recommended capacity of the machine shall not be exceeded.
(2) All closures, including pocket closures, hooks and loops, snaps, zippers, and hooks and dees, shall be fastened. A hook that is not part of a closure shall be covered with a piece of loop.
(3)* A "no heat" or "air dry" option shall be used, if available.
(4)* In the absence of a "no heat" or "air dry" option, the basket temperature shall not exceed 40°C (105°F).
(5)* The use of a heat cycle shall be discontinued prior to the removal of all moisture from the ensembles or ensemble elements.
(6)* The remainder of the drying process shall be accomplished by a "no heat" machine setting or removal of the ensembles or ensemble elements from the machine dryer to air dry.

N **7.3.10.3** Ensembles or ensemble elements that are not completely dry shall not be returned to service.

7.3.11 Additional Requirements for Advanced Cleaning of Garment Elements.

N **7.3.11.1** Garment elements shall be subjected to advanced cleaning using a washer/extractor with an appropriate formulation.

N **7.3.11.1.1** A top loading washing machine or utility sink shall not be used for advanced cleaning.

N **7.3.11.1.2** Separate washer/extractor formulations shall be permitted for garment outer shells and liners. *[See A.7.3.9(5).]*

N **7.3.11.2*** Where the shells and liners of protective garment elements are separable, those components shall be cleaned only with similar components.

N **7.3.11.2.1** Heavily soiled outer shells shall be permitted to be pretreated by soaking in an appropriate solution of detergent and water.

N **7.3.11.2.2** Separable liner systems shall be oriented such that the moisture barrier is on the inside for advanced cleaning for both laundering and drying.

N **7.3.11.2.3** Separate washer/extractor formulations shall be permitted for washing garment shells versus garment liners.

N **7.3.11.3** All closures, including pocket closures, hooks and loops, snaps, zippers, and hooks and dees, shall be fastened.

7.3.11.4 If the coat element has a drag rescue device (DRD) and the DRD is removable, the DRD shall be permitted to be laundered with the coat shell or coat liner.

N **7.3.11.4.1** Where recommended as being washed separately, removable DRDs shall be placed in a separate mesh bag for advanced cleaning.

N **7.3.11.4.2** DRDs placed in mesh bags shall be permitted to be washed with garment outer shells.

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N **7.3.11.5** If the garment includes fall protection components, and the fall protection components are removable, the fall protection components shall be removed prior to advanced cleaning.

N **7.3.11.5.1** If the fall protection components also require cleaning, the fall protection components shall be cleaned separately according to the manufacturer's instructions.

7.3.12 Additional Requirements for Advanced Cleaning of Helmet Elements.

7.3.12.1* Detachable or separate components, such as ear covers, suspensions covers, and goggles, shall be removed from the helmet and shall be washed and dried separately.

N **7.3.12.2*** Detachable components that are textile based shall either be separately hand washed or washed in a washer/extractor with other components such as garments or hoods as specified in 7.3.11.

7.3.12.3 Helmets shall not be machine cleaned or dried using equipment that produces mechanical action by tumbling or agitation.

N **7.3.12.4*** Unless otherwise specified, helmets shall be hand washed in a utility sink using the following procedures:

(1) The individual washing the helmet shall observe universal precautions and put on a pair of examination gloves, an apron and protective sleeves or coveralls, and a pair of safety glasses or goggles.
(2)* The utility sink shall be filled with warm water at temperature no warmer than 40°C (105°F) and a mild detergent having a pH of not less than 6.0 or more than 10.5 at the detergent manufacturer's recommended ratio of detergent to water.
(3) The individual shall use a soft bristle brush to reach between components and scrub both the exterior and interior of the helmet.
(4) The helmet shall be thoroughly rinsed following washing.
(5) Following rinsing, the helmet shall be air dried. It shall be permitted to use a soft towel to aid in drying the helmet after cleaning.

N **7.3.12.5** Attached faceshields shall be hand washed with a soft cloth.

Δ **7.3.13 Additional Requirements for Advanced Cleaning of Glove Elements.**

N **7.3.13.1*** Gloves shall not be machine dried using equipment that produces mechanical action by tumbling or agitation.

N **7.3.13.2** Unless otherwise specified, gloves shall be hand washed in a utility sink or other container of sufficient size using the following procedures:

(1) The individual washing the gloves shall observe universal precautions and shall put on a pair of examination gloves, an apron and protective sleeves or coveralls, and a pair of safety glasses or goggles.
(2)* The utility sink shall be filled with warm water at temperature no warmer than 40°C (105°F) and a mild detergent having a pH of not less than 6.0 or more than 10.5 at the detergent manufacturer's recommended ratio of detergent to water.
(3) The individual shall then don the fire-fighting gloves over the examination gloves and shall briskly rub the gloves together, ensuring the cleaning of all surfaces. A soft bristle brush shall be permitted to scrub the exterior of the gloves.
(4)* The individual shall then remove the fire-fighting gloves and refill the utility sink with clean water.
(5) The interior and exterior of the gloves shall be thoroughly rinsed with clean water.
(6) Gloves shall not be wrung out, but instead slightly squeezed to remove excess water.
(7)* Gloves shall be dried using ambient or slightly raised temperatures no warmer than 40°C (105°F). Equipment that provides airflow into the interiors of gloves shall be permitted to aid the faster drying of gloves.

Δ **7.3.14 Additional Requirements for Advanced Cleaning of Footwear Elements.**

N **7.3.14.1*** Footwear shall not be machine cleaned or dried using equipment that produces mechanical action by tumbling or agitation.

N **7.3.14.2** Unless otherwise specified, footwear shall be hand washed in a utility sink or other container of sufficient size using the following procedures:

(1) The individual washing the footwear shall observe universal precautions and put on a pair of examination gloves, an apron and protective sleeves or coveralls, and a pair of safety glasses or goggles.
(2)* The utility sink shall be filled with warm water at a temperature no warmer than 40°C (105°F) and a mild detergent having a pH of not less than 6.0 or more than 10.5 at the detergent manufacturer's recommended ratio of detergent to water.
(3)* The individual shall first scrub the interior of the footwear with a soft bristle brush.

(4) The individual shall then scrub the exterior of the footwear with a soft bristle brush, ensuring the cleaning of all exterior surfaces.
(5) The interior and exterior of the footwear shall be thoroughly rinsed with clean water.
(6)* In the absence of specialized drying equipment, the footwear shall be suspended upside down to dry, with attention that water runoff does not create a slip hazard.
(7) If specified by the manufacturer, a sealant, conditioning, or polish shall be applied to leather footwear after the footwear has completely dried.

Δ **7.3.15 Additional Requirements for Advanced Cleaning of Hood Elements.**

N **7.3.15.1** Hoods shall be permitted to be hand or machine washed, independently or with garment liners, as allowed by the hood manufacturer. The hood manufacturer's instructions shall be consulted for further cleaning instructions.

N **7.3.15.2** If hoods are hand washed in a utility sink or other suitable container, hoods shall not be wrung out to dry, but instead slightly squeezed to remove excess water after rinsing.

N **7.3.15.3** Hoods shall be permitted to be air dried or machine dried.

N **7.3.15.4** Special care shall be applied to the advanced cleaning of particulate-blocking hoods. Advanced cleaning of particulate-blocking hoods shall be in accordance with procedures provided by the manufacturer.

N **7.3.15.5** Where hoods are subjected to hand cleaning and unless otherwise specified, hoods shall be hand washed in a utility sink or other container of sufficient size using the following procedures:

(1) The individual washing the hood shall observe universal precautions and put on a pair of examination gloves, an apron and protective sleeves or coveralls, and a pair of safety glasses or goggles.
(2) The utility sink shall be filled with warm water at temperature no warmer than 40°C (105°F) and a mild detergent having a pH of not less than 6.0 or more than 10.5 at the detergent manufacturer's recommended ratio of detergent to water.
(3) After allowing the hood to presoak for a period of at least 10 minutes, the individual shall lightly rub the hood material together, starting with the exterior and then turning the hood inside out and similarly rubbing the material against itself. A soft wash cloth shall be permitted for washing the hoods.
(4) Stretching or wringing the hood out shall be avoided during hand washing.
(5) The hood shall be thoroughly rinsed following washing.
(6) Following rinsing, if using air drying, the hood shall be air dried by laying on a drying rack or other surface that helps promote draining of water from the hood.

7.3.16 Additional Requirements for Advanced Cleaning of Proximity Fire-Fighting Ensembles and Ensemble Elements.

N **7.3.16.1** Except as noted in 7.3.16.2, proximity fire-fighting protective ensembles and ensemble elements shall be cleaned in accordance with the same requirements as non-proximity fire-fighting protective ensembles and ensemble elements.

Δ **7.3.16.2** Outer shell and other radiant reflective components of proximity fire-fighting protective ensembles and ensemble elements shall be cleaned in accordance with the following:

(1) They shall not be cleaned with a brush or other abrasive cleaning devices.
(2) They shall not be machine washed or dried.
(3) They shall be wiped with a moist soft cloth or sponge.
(4) They shall be hung without any folding of the shell and air dried without any mechanical action.

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7.3.17 Additional Requirements for Advanced Cleaning of Ensembles Certified to the Optional Liquid and Particulate Contaminant Protection Requirements of NFPA 1971. The manufacturer shall be consulted to determine if any special handling procedures or the removal of interface components or other components must be undertaken prior to advanced cleaning.

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N **7.4 Disinfection or Sanitization and Biological Decontamination.**

N **7.4.1** Processes for disinfecting or sanitizing, cleaning, and decontaminating protective ensembles and ensemble elements that have been contaminated with body fluids and other potentially infectious materials shall be performed by a manufacturer verified in cleaning, a verified cleaner, a manufacturer-trained organization, a verified organization, or a verified ISP.

N **7.4.1.1** In the absence of a method to verify effectiveness of cleaning, manufacturers of certified protective ensembles and ensemble elements shall be permitted to perform disinfection or sanitization and biological decontamination.

N **7.4.2*** Organizations and other facilities that engage in disinfection or sanitization and biological decontamination of protective ensembles and ensemble elements contaminated with body fluids and other potentially infectious materials shall comply with the applicable regulations in 29 CFR 1910.1030, "Bloodborne Pathogens."

N **7.4.3*** Protective ensembles and ensemble elements that are contaminated with body fluids and other potentially infectious materials shall be subject to either disinfection or sanitization.

N **7.4.3.1** If not already part of an advanced cleaning process, disinfection or sanitization shall be followed by advanced cleaning depending on the type of disinfection or sanitization, the cleaning agents and processes that are available, and the type and composition of the ensemble or ensemble element.

N **7.4.3.2*** Disinfectants and sanitizers shall be registered with the EPA for efficacy for hard surfaces or fabrics and textiles, whichever is applicable.

N **7.4.3.3*** Where disinfectants and sanitizers are used, they shall not degrade the performance properties of the protective ensemble or ensemble elements.

N **7.4.3.4** Disinfectants and sanitizers shall be used in accordance with the instructions provided by the supplier.

N **7.4.3.5*** It shall be permitted to include disinfection or sanitization as part of the advanced cleaning process only when its effectiveness has been demonstrated as providing the disinfection or sanitization required for the specific ensemble or ensemble element.

N **7.4.3.6*** In cases where the area of contamination is limited and clearly visible, spot sanitization or disinfection followed by

spot cleaning shall be permitted for the sanitization or disinfection of the affected contaminated area of the ensemble or ensemble element.

N 7.4.4 Additional Requirements for Sanitization and Cleaning of Garment Elements.

N 7.4.4.1* Garment elements shall be subjected to a minimum of sanitization.

N 7.4.4.2 The sanitizer or process used for the sanitization of the garment element shall meet the verification testing requirements in 11.3.7.5.

N 7.4.4.3* Handling of garment elements shall be kept to a minimum prior to sanitization.

N 7.4.4.4 Where specific components such as the DRD or fall protection devices are provided as part of garment elements, these items shall only be removed from the garment if their presence will interfere with the sanitization process.

N 7.4.4.5 Advanced cleaning procedures that are used in conjunction with or that follow sanitization for removal of soils associated with body fluids or other infectious materials shall meet the applicable garment requirements specified in Section 7.3.

N 7.4.4.6 Advanced cleaning or specialized cleaning shall be performed after sanitization.

N 7.4.4.6.1 Advanced cleaning shall be permitted prior to sanitization or disinfection if the procedures for advanced cleaning have proven effective for sanitization or disinfection of the ensemble or ensemble elements.

N 7.4.5 Additional Requirements for Disinfection or Sanitization and Cleaning of Helmet Elements.

N 7.4.5.1* Detachable or separate components shall be removed from the helmet and shall be sanitized or disinfected separately.

N 7.4.5.2 Detachable components that are textile based shall be sanitized as specified in 7.4.4 for garment elements.

N 7.4.5.3* Hard surface components of the helmet shall be subject to disinfection using an appropriate disinfection process.

N 7.4.5.4 Subsequent advanced cleaning of helmets following their disinfection or sanitization shall meet the requirements specified in 7.3.12.

N 7.4.6 Additional Requirements for Sanitization and Cleaning of Glove Elements.

N 7.4.6.1* Sanitizers or processes for sanitization of gloves shall be selected as appropriate for the materials used in the construction of the glove.

N 7.4.6.2 Subsequent advanced cleaning of gloves following their sanitization shall meet the requirements specified in 7.3.13.

N 7.4.7 Additional Requirements for Sanitization and Cleaning of Footwear Elements.

N 7.4.7.1* Sanitizers or processes for sanitization of footwear shall be selected as appropriate for the materials used in the construction of the footwear.

N 7.4.7.2 Subsequent advanced cleaning of footwear following their sanitization shall meet the requirements specified in 7.3.14.

N 7.4.8 Additional Requirements for Sanitization and Cleaning of Hood Elements.

N 7.4.8.1* Hoods shall be sanitized as specified in 7.4.4 for garment elements.

N 7.4.8.2 Subsequent advanced cleaning of hoods following their sanitization shall meet the requirements specified in 7.3.15.

N 7.4.9 Additional Requirements for Sanitization and Cleaning of Proximity Fire-Fighting Ensembles and Ensemble Elements.

N 7.4.9.1 Any sanitizer or process used for sanitization shall not degrade the radiant reflective outer shell or other radiant reflective elements of the ensemble or ensemble elements.

N 7.4.9.2 Any additional cleaning of proximity fire-fighting ensembles and ensemble elements shall meet the requirements specified in 7.3.16.

N 7.4.9.3 Nonreflective portions of the ensemble or ensemble elements shall be treated as specified in 7.4.4.

N 7.4.10 Additional Requirements for Sanitization and Cleaning of Ensembles and Ensemble Elements Certified to the Optional Liquid and Particulate Contaminant Protection Requirements of NFPA 1971. The manufacturer shall be consulted to determine if any special handling procedures exist for the sanitization or disinfection and subsequent cleaning of the elements of the protective ensemble or ensemble element.

N 7.5 Specialized Cleaning.

N 7.5.1 Specialized cleaning of protective ensembles and ensemble elements shall be performed by a manufacturer verified in cleaning, a manufacturer-trained organization, a verified organization, a verified cleaner, or a verified ISP.

N 7.5.1.1 In the absence of a method to verify effectiveness of cleaning for specific types of soils or contaminants, manufacturers of certified ensembles or ensemble elements shall be permitted to perform specialized cleaning.

N 7.5.2* Organizations shall employ specialized cleaning when the ensemble or ensemble elements cannot be adequately cleaned with advanced cleaning.

N 7.5.2.1 Organizations shall apply disinfection or sanitization in accordance with Section 7.4 with specialized cleaning for the removal of body fluids or other infectious materials that cannot be removed using disinfection or sanitization with advanced cleaning.

N 7.5.3* Organizations shall designate any specific substances or contaminants that warrant specialized cleaning and shall determine specific approaches for decontamination for these substances, if warranted.

N 7.5.4 Organizations shall rely on expertise from hazardous materials teams, infection control specialists, verified independent service providers, or other individuals knowledgeable for the type of contaminant and how it can be removed from protective clothing and equipment.

N 7.5.4.1 The expertise described in 7.5.4 shall be relied upon for determining whether the type of contamination can be

effectively removed and for determining the procedures to be used for the removal of the specific contaminant(s), if applicable.

N **7.5.4.2** Where deemed appropriate for the purpose of specialized cleaning of garment elements, a maximum washer/extractor water temperature shall be permitted to be 60°C (140°F) for those ensembles or ensemble elements that are specified for advanced cleaning using a washer/extractor. *[See A.7.3.9(4).]*

N **7.5.4.3** Where it is determined that the contaminant(s) cannot be sufficiently removed, the ensembles or ensemble elements shall be condemned and disposed of in accordance with federal, state, and local regulations for the handling and disposal of hazardous materials.

N **7.5.4.4*** Where it is determined that the contaminant(s) can be sufficiently removed, specific procedures shall be conducted for cleaning, treating, or decontaminating the contaminated ensembles or ensemble elements based on one of the following:

(1) Evidence is provided from a documented source that the applied procedures have shown effectiveness in the past under similar exposure circumstances and contamination conditions.
(2) Testing of the contaminated clothing items is performed that provides detailed results showing the absence of any residual contamination or showing levels of contaminants that are deemed to be safe.

N **7.5.4.5*** Any testing procedures that are used for assessing residual levels of contamination shall be specific to the contaminants of concern and shall be performed by a laboratory that is accredited for the specific types of analysis carried out on the ensembles or ensemble elements.

N **7.5.4.6** When specialized cleaning is applied for the cleaning of ensembles or ensemble elements involving highly hazardous contaminants, consideration should be given to the disposition of the effluent from the cleaning process and whether disposal into the local sewer system is acceptable according to federal, state, and local regulations.

Chapter 8 Repair

8.1 Requirements for All Ensembles and Ensemble Elements.

Δ **8.1.1** All repairs shall be performed by the original manufacturer, a verified ISP, or a member of the organization who has received training.

8.1.1.1 Training shall be provided by an element manufacturer of the same element type or by a verified ISP in the repair of ensembles or ensemble elements.

8.1.1.2 Requirements for garment element repair shall be specified in Sections 8.2 through 8.4.

8.1.2 The member(s) of the organization who has received training in the repair of the ensembles or ensemble elements shall be responsible for performing or managing repairs.

8.1.3 Ensembles or ensemble elements shall be subjected to advanced cleaning, when necessary, before any repair work is undertaken. Ensembles contaminated by CBRN terrorism agents shall be immediately retired after CBRN exposure is confirmed and shall not be reused.

Δ **8.1.4*** All repairs and alterations to the ensemble or ensemble element shall be done in a manner and using like materials and components that are compliant with NFPA 1971.

8.1.5 Due to the different methods of construction, the ensemble or ensemble element manufacturer shall be contacted if the organization or verified ISP is unsure of whether a repair can be accomplished without adversely affecting the integrity of the ensemble or ensemble element.

8.1.6 Replacement interface components shall be installed in a manner consistent with the ensemble or ensemble element manufacturer's method of construction.

8.2 Requirements for Both Basic and Advanced Garment Element Repair.

8.2.1 All repairs and alterations shall be performed in the same manner and using like materials as the garment element manufacturer, including, but not limited to, fabric, thread type, seam construction, hardware, and hardware backing, unless approved by the garment element manufacturer.

8.2.2 Repairs shall be made to all components and to all layers of the composite that have been damaged or that have been affected by the repair.

Δ **8.2.3** Repairs of minor tears, char marks, ember burns, and abraded areas shall be limited to those where the damaged area can be covered by a maximum 160 cm^2 (25 $in.^2$) patch of the same material that is compliant with NFPA 1971. For any tears, char marks, ember burns, and abraded areas that require a patch larger than 160 cm^2 (25 $in.^2$), the manufacturer or the verified ISP, in conjunction with the organization, shall be consulted.

8.2.3.1 The finished edges of the patch shall extend at least 25 mm (1 in.) in all directions beyond the damaged area.

8.2.3.2 To prevent fraying, the patch shall have no raw edges.

Δ **8.2.3.3** Where tears, holes, or abrasions are being repaired, the damaged areas shall be mended using flame-resistant (FR) thread that is compliant with NFPA 1971 to prevent further damage prior to application of the patch.

Δ **8.2.3.4** Where moisture barrier tears, holes, or abrasions are being repaired, the repair tape shall be required to extend at least 12.5 mm (½ in.) in all directions beyond the edge of the repaired damage. Where the moisture barrier has a hole or abrasion measuring more than 12.5 mm (½ in.) in diameter in any direction or a tear greater than 75 mm (3 in.) in length, a patch consisting of the same moisture barrier fabric shall be used for repair. Where a moisture barrier manufacturer provides repair tape in various sizes, it shall be permitted to be used for the repair.

8.2.4* Replacement hardware shall be installed in a manner consistent with the garment element manufacturer's method of construction.

8.2.4.1 When hardware is replaced, the reinforcement backing material shall be reinstalled or, if it is no longer serviceable, the backing material shall be replaced.

8.2.5 If the complexity of the repair is uncertain, the garment element manufacturer shall be consulted.

8.2.6 Replacement visibility markings shall be installed in a manner consistent with the garment element manufacturer's method of construction, unless an alternative method is approved by the garment element manufacturer.

8.2.6.1 Visibility markings being replaced shall be completely removed so that no new visibility marking is sewn over an older sewn visibility marking. New visibility markings shall be permitted to be applied over older visibility markings by alternative methods where approved by the garment manufacturer.

Δ **8.2.6.2** No repair or alteration shall result in the reduction of the minimum required visibility marking pattern specified in Section 6.2 of NFPA 1971.

8.2.6.3 Visibility marking patches that do not exceed 75 mm (3 in.) in length shall be permitted. The visibility marking patch shall extend 25 mm (1 in.) beyond the damaged area. A maximum of two visibility marking patches per stripe shall be permitted.

8.2.6.4 Where a repair or alteration necessitates replacing visibility markings, an equal amount of visibility markings shall be installed.

8.2.6.5 Where the complexity of the visibility marking repair is uncertain, the garment element manufacturer shall be consulted.

8.3 Additional Requirements for Basic Garment Element Repair. The repairs specified in this section shall be performed by the element manufacturer, the organization, manufacturer-trained organizations, verified organizations, or verified ISPs. Basic repairs shall be limited to the following:

(1) Patching of minor tears, char marks, and ember burns to a separable outer shell
(2) Repairing of skipped, broken, and missing stitches to a separable outer shell
(3) Replacement of missing hardware, excluding positive closure systems to a separable outer shell
(4) Reclosing of the liner of a garment after inspection

8.4 Additional Requirements for Advanced Garment Element Repair.

8.4.1* The repairs specified in this section shall be conducted only by the element manufacturer, a verified organization, or a verified ISP meeting the requirements as specified in Chapter 11, Verification.

8.4.2 Repairs to the garment outer shell shall be performed consistent with the garment element manufacturer's methods. The garment element manufacturer shall be contacted if the organization is unsure of the complexity of the repair.

8.4.3* All repairs to the garment moisture barrier shall be performed consistent with the moisture barrier manufacturer's methods. The original garment element manufacturer shall be contacted if the organization is unsure as to whether an area to be repaired contains a moisture barrier.

8.4.4* Repairs to garment thermal liners shall be permitted provided the repair does not result in any stitching through the moisture barrier.

8.4.5* Due to labeling requirements, as well as the complexity and specialized equipment needed to replace entire garment element component layers (e.g., the outer shell, moisture barrier, or thermal liner), only the garment element manufacturer or the garment element manufacturer's designated verified ISP shall replace entire garment component layers.

8.4.6 Restitching of more than 25 mm continuous (1 in. continuous) of a Major A seam shall require consulting the garment element manufacturer and shall be conducted in a manner consistent with the garment element manufacturer's methods.

8.4.7 Repairs to Major B seams in the moisture barrier shall require consulting the garment element manufacturer and shall be conducted in a manner consistent with the barrier manufacturer's recommendations.

8.4.7.1 Repairs to Major B seams in the thermal liner that do not affect any moisture barrier material shall be permitted. Restitching of more than 25 mm continuous (1 in. continuous) of any Major B seams shall require consulting the garment element manufacturer and shall be conducted in a manner consistent with the garment element manufacturer's methods.

8.4.8* All repaired stress areas shall be reinforced in a manner consistent with the garment element manufacturer's methods.

8.4.9 If replacing trim necessitates sewing into a Major A seam, trim replacement shall be conducted in a manner consistent with the garment element manufacturer's methods.

8.4.10* Replacement zippers shall be installed in a manner consistent with the garment element manufacturer's method of construction. If the complexity of the repair is uncertain, the garment element manufacturer shall be consulted.

8.4.11* Replacement hook-and-loop fastener tape shall be installed in a manner consistent with the garment element manufacturer's method of construction. If the complexity of the repair is uncertain, the garment element manufacturer shall be consulted.

8.4.12* Replacement reinforcement materials shall be installed in a manner consistent with the garment element manufacturer's method of construction.

8.5 Helmet Element Repair.

8.5.1 In addition to the requirements in Section 8.1, all repairs to helmet components other than as specified herein shall be performed in accordance with the helmet element manufacturer's instructions.

8.5.2* Where there is an indication of a crack, dent, abrasion, bubbling, soft spot, discoloration, or warping in the helmet shell, the helmet element manufacturer shall be contacted to determine serviceability.

8.5.3 Small surface nicks shall be repaired in accordance with the helmet element manufacturer's instructions.

8.5.4 Small scratches on the helmet shell shall be permitted to be removed by using mildly abrasive compounds recommended by the helmet element manufacturer.

8.5.5 Helmet faceshield and goggle components that become cracked or badly scratched shall be replaced.

8.6 Glove Element Repair. In addition to the requirements in Section 8.1, all repairs to glove components shall be performed in accordance with the glove element manufacturer's instructions.

8.7 Footwear Element Repair.

8.7.1 In addition to the requirements in Section 8.1, all repairs to footwear components shall be performed in accordance with the footwear manufacturer's instructions.

8.7.2 Other than for the replacement of bootlaces and zipper assemblies, the footwear manufacturer shall be contacted to determine feasibility of the repair.

8.7.3 All replacement bootlaces and zippers shall be provided by the footwear element manufacturer.

8.8 Structural Fire Fighting Hood and Proximity Fire Fighting Helmet Overcover and Proximity Fire Fighting Shroud Repair. In addition to the requirements in Section 8.1, all repairs to hoods, helmet covers, and proximity shrouds shall be performed in accordance with the element manufacturers' instructions. Repairs of these interface components containing a particulate blocking layer shall not be undertaken unless authorized by the manufacturer.

8.9 Additional Requirements for Structural Fire Fighting Ensembles and Proximity Fire Fighting Ensembles with Optional Liquid and Particulate Contaminant Protection. In addition to the requirements in Section 8.1, all repairs to ensembles with optional liquid and particulate contaminant protection shall be referred to the ensemble manufacturer.

Chapter 9 Storage

9.1* All Ensembles and Ensemble Elements.

9.1.1* Ensembles or ensemble elements not in use shall not be exposed to lighting that emits UV rays, including, but not limited to, fluorescent lighting, direct sunlight, and indirect sunlight.

9.1.2* Ensembles and ensemble elements shall be clean and dry before storage.

9.1.3 Ensemble and ensemble elements shall not be stored in airtight containers unless they are new and unissued.

9.1.4* Ensembles and ensemble elements shall not be stored at temperatures below –32°C (–25°F) or above 82°C (180°F).

9.1.5 Ensembles and ensemble elements shall not be stored or transported in compartments or trunks with sharp objects, tools, or other equipment that could damage the ensembles or ensemble elements. Where ensembles or ensemble elements must be transported or stored in such environments, the ensemble or element(s) shall be placed in a protective case or bag to prevent damage.

9.1.6* Issued ensembles and ensemble elements shall not be allowed in living quarters. Contaminated or soiled clothing shall not be transported in the cab of fire department apparatus when not being worn for operational duties unless placed in an airtight protective case or bag to prevent cross contamination. If placed in a protective case or bag, the ensemble(s) or ensemble element(s) shall be removed from such environments as soon as possible following transport. Wet ensembles or ensemble elements shall not be stored in a protective case or bag used for transport.

9.1.7* Ensembles and ensemble elements shall not be stored in contact with contaminants such as, but not limited to, oils, solvents, acids, or alkalis.

9.1.8 Proximity fire fighting protective coat and trouser elements shall be stored by hanging to limit the damage caused by creasing and shall not be stored folded.

N **9.1.9** Eye and face protection shall be readily accessible to the user and, when not in use, shall be stored in such a manner so as to prevent at least the following:

(1) Thermal damage
(2) Mechanical damage
(3) Hazardous materials contamination

9.1.10 Ensemble and ensemble element storage areas shall be clean, dry, and well ventilated.

Chapter 10 Retirement, Disposition, and Special Incident Procedure

10.1 Retirement.

10.1.1* The organization shall develop specific criteria for removal of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements from service, which includes, but is not limited to, issues that are specific to the ensembles or ensemble elements being used by the organization, the manufacturer's instructions, and the experience of the organization.

10.1.2* Structural fire fighting ensembles and ensemble elements shall be retired in accordance with 10.2.1 or 10.2.2, no more than 10 years from the date the ensembles or ensemble elements were manufactured.

10.1.3 Proximity fire fighting ensembles and ensemble elements shall be retired in accordance with 10.2.1 or 10.2.2, no more than 10 years from the date the ensembles or ensemble elements were manufactured.

10.1.3.1* In all cases, the radiant reflective outer shell of the garment element shall be replaced no more than 5 years from the date the ensembles or ensemble elements were manufactured.

Δ **10.1.4*** Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are worn or damaged to the extent that the organization deems it not possible or cost effective to repair shall be retired in accordance with 10.2.1.

10.1.5* Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that were not in compliance with the edition of the applicable NFPA standard that was current when the ensembles

and ensemble elements were manufactured shall be retired in accordance with 10.2.1.

10.1.6 Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are contaminated to the extent that the organization deems it not possible or cost effective to clean them shall be retired in accordance with 10.2.1.

10.1.7 Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are contaminated by CBRN terrorism agents shall be immediately retired as specified in 10.2.1 after confirmed exposure and shall not be reused.

10.1.8* Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are no longer of use to the organization for emergency operations service but are not contaminated, defective, or damaged shall be retired in accordance with 10.2.1 or 10.2.2.

10.2 Disposition of Retired Elements.

10.2.1 Retired structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements shall be destroyed or disposed of in a manner ensuring that they will not be used in any fire fighting or emergency activities, including live fire training.

10.2.2 Retired structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements determined to be no longer of use in accordance with 10.1.8 shall be permitted to be used as follows:

(1) For training that does not involve live fire, provided the ensembles and ensemble elements are appropriately marked as being for non–live fire training only
(2) As determined by the organization

10.3 Special Incident Procedure.

10.3.1* The organization shall have procedures for the handling and custody of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that were worn by fire fighters who were victims at incidents where serious injuries or fatalities to the fire fighters occurred.

10.3.2 In the absence of any other prevailing rules of evidence, the organization's procedures shall include at least the following:

(1) Provisions shall be made for the immediate removal from service and preservation of all structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements utilized by the injured or deceased fire fighter.
(2) Custody of such ensembles and ensemble elements shall be maintained at a secure location with controlled, documented access.
(3) All such structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements shall be nondestructively tagged and stored only in paper or cardboard containers to prevent further degradation or damage. Plastic or airtight containers shall not be used.
(4) Examination of the structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements shall be made by qualified members of the organization or by outside experts to determine the condition thereof.

10.3.3 The organization shall determine a specific period of time for retaining custody of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements.

Chapter 11 Verification

11.1 General.

11.1.1 In order for an organization, ISP, cleaner, or manufacturer to be verified, it shall meet the requirements of this chapter.

11.1.1.1* Verification of the organization or ISP shall include advanced inspection, advanced cleaning, sanitization, and advanced repairs of garment elements only as specified in Table 11.1.1.1.

N **11.1.1.1.1** Cleaning and sanitization verification of the organization or ISP shall not apply to helmet elements, glove elements, footwear elements, hood elements, or optional liquid and particulate contaminant protective ensembles.

N **11.1.1.1.2** Cleaning and sanitization verification of cleaners and manufacturers shall not apply to helmet elements, glove elements, footwear elements, hood elements, or optional liquid and particulate contaminant protective ensembles.

11.1.1.2 An organization or manufacturer shall be permitted to be verified for any combination of advanced cleaning, sanitization, advanced inspection, and repairs.

N **11.1.1.2.1** An ISP shall be verified for advanced cleaning, sanitization, advanced inspection, and repairs but shall not be permitted to be verified for advanced cleaning and advanced inspection only.

N **11.1.1.2.2** A cleaner shall only be verified for advanced cleaning and sanitization of garment elements.

N **11.1.1.2.3** Manufacturers verified in cleaning shall be verified per the verified cleaner requirements in accordance with Table 11.1.1.1 and shall be permitted to perform advanced inspection and advanced repair.

11.1.1.3 Where an organization or ISP is verified for conducting repairs, the organization or ISP shall also be verified for advanced cleaning, sanitization, and advanced inspection.

11.1.1.4 The verified organization, verified ISP, manufacturer verified in cleaning, or verified cleaner shall be listed.

N **11.1.1.4.1** The listing shall specify the services the listee is verified to conduct.

N **11.1.1.4.2** Repair categories shall be garment outer shell repairs, garment moisture barrier repairs, and garment thermal barrier repairs.

11.1.1.5 Where the certification listing includes the moisture barrier repair category, the listing shall include the moisture barrier manufacturer and trade name designation, and the repair tape manufacturer and trade name or part number.

N **Table 11.1.1.1 ISP and Organization Verification Designation Criteria**

Function/Capability	Verified ISP or Verified Organization	Verified Cleaner
Advanced cleaning	Required	Required
Heavy metals cleaning efficiency	≥70% for each metal	≥70% for each metal
Semivolatile organic compound cleaning efficiency	≥50% average of all compounds	≥50% average of all compounds
Biological sanitization effectiveness — *Staphylococcus aureus*	3 log reduction or better	3 log reduction or better
Biological sanitization effectiveness — *Klebsiella pneumoniae*	3 log reduction or better	3 log reduction or better
Advanced inspection	All ensembles and ensemble elements of structural and proximity fire fighter protective clothing	Not allowed
Advanced repair	All ensembles and ensemble elements capable of being repaired for structural and proximity fire fighter protective clothing that they have been specifically verified to repair	No repairs allowed
Advanced repairs for moisture barriers	ISPs have a choice of which moisture barriers to verify	Not allowed
Verification testing timing	Every two years, or when processes change	Every two years, or when processes change
Verification facility quality review and inspection	Every six months	Every six months

Δ **11.1.2** All verification of the organization, ISP, manufacturer verified in cleaning, or verified cleaner shall be performed by a certification organization that meets at least the requirements specified in Section 11.2 and that is accredited for personal protective equipment (PPE) 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*.

11.1.3 The verified organization, verified ISP, manufacturer verified in cleaning, or verified cleaner shall not use the NFPA name or the name or identification of this standard, NFPA 1851, in any statements about its services unless the services are verified as compliant to this standard.

11.1.3.1* No provider of the services covered by this standard shall claim to be an ISP, a verified ISP, a verified organization, a manufacturer verified in cleaning, or a verified cleaner unless they comply with all of the requirements in this standard and are third-party verified in accordance with the requirements of this chapter.

11.1.4 The certification organization shall not issue any new verifications to the 2014 edition of NFPA 1851 on or after the NFPA effective date for the 2020 edition.

11.1.5 Organizations, ISPs, or manufacturers verified to the 2014 edition of NFPA 1851 shall undergo verification to the 2020 edition of NFPA 1851 within 12 months of the NFPA effective date for the 2020 edition.

11.2 Verification Program.

11.2.1* The certification organization shall not be owned or controlled by the organization or the ISP being verified.

11.2.2 The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the organization's, ISP's, or manufacturer's ultimate profitability.

Δ **11.2.3** The certification organization shall be accredited for PPE 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*.

11.2.4 The certification organization shall refuse to verify services to this standard that do not comply with all applicable requirements of this standard.

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

11.2.6 The certification organization shall not offer or confer any conditional or temporary verification.

Δ **11.2.7*** The certification organization shall have laboratory facilities and equipment available for conducting proper tests to determine compliance.

11.2.8 The certification organization's 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.

11.2.9 The certification organization's 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.

11.2.10 The certification organization shall require the organization or the ISP to establish and maintain a quality management program that meets the requirements of Section 11.4.

11.2.11 The certification organization and the organization, ISP, or manufacturer verified in cleaning shall evaluate any changes affecting function of the compliant services to determine continued certification to this standard.

Δ **11.2.12*** The certification organization shall have a follow-up inspection program of the facilities of the compliant services with at least one random and unannounced visit in accordance with Table 11.1.1.1.

11.2.13 The certification organization shall be permitted to conduct additional specific testing to verify continued compliance.

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

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

N **11.2.16*** The certification organization shall have a procedure for investigating noncompliant verified cleaning or repairs that addresses complaints related to cleaning or repairs performed by verified ISPs or verified organizations that are not in compliance with the requirements of this standard.

N **11.2.16.1** Where a complaint of noncompliant cleaning or repairs for a verified ISP or verified organization is received by the certification organization, the validity of the report shall be investigated and, if necessary, corrective action shall be taken.

11.3 Inspection and Testing.

11.3.1 For verification of the compliant services, the certification organization shall conduct both inspection and testing as specified in this section.

11.3.2 All inspections, evaluations, conditioning, and testing for verification of the organization, ISP, verified cleaner, or manufacturer verified in cleaning 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*.

11.3.3 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 PPE.

11.3.4 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*.

11.3.5 A certification organization shall be permitted to utilize conditioning and testing results conducted by an organization or an ISP for verification, provided the organization or the ISP testing laboratory meets the requirements specified in 11.3.5.1 through 11.3.5.5.

11.3.5.1 Where an organization or an ISP provides conditioning and testing results to the certification organization, the organization's or ISP's testing laboratory shall be accredited in accordance with the requirements of ISO 17025, *General requirements for the competence of testing and calibration laboratories*.

11.3.5.2 The organization or ISP testing laboratory's scope of accreditation to ISO 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of PPE.

11.3.5.3 The accreditation of an organization's or ISP'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*.

11.3.5.4 The certification organization shall also approve the organization's or ISP's testing laboratory.

11.3.5.5 The certification organization shall determine the level of supervision and witnessing of the conditioning and testing for verification conducted at the organization's or ISP's testing laboratory.

11.3.6 Sampling levels for testing and inspection shall be established by the certification organization and the organization or the ISP to ensure reasonable and acceptable reliability at a reasonable and acceptable confidence level that repair services are compliant to this standard, unless such sampling levels are specified herein.

N **11.3.6.1** Where an organization, ISP, or manufacturer operates multiple facilities in different locations, each separate location shall be subject to verification.

N **11.3.6.2*** For the purpose of verification of advanced cleaning and sanitization, the certification organization shall review the respective facility to determine the equipment and procedures that, through engineering judgment, will result in the lowest level of cleaning. The equipment and procedures shall be selected and subjected to the verification procedures in 11.3.7.

11.3.7* For ISPs, cleaners, manufacturers, and organizations that are subject to cleaning verification, the certification organization shall evaluate their advanced cleaning and sanitization procedures in accordance with Sections 7.3 and 7.4.

N **11.3.7.1** For verification of cleaning, the certification organization shall evaluate the effectiveness of the ISP's, cleaner's, manufacturer's, or organization's cleaning processes against the requirements specified in 11.3.7.3 and 11.3.7.4.

N **11.3.7.2** For verification of the ability to sanitize and clean protective garments, the certification organization shall evalu-

ate the effectiveness of the ISP's, cleaner's, manufacturer's, or organization's sanitization processes against the requirement specified in 11.3.7.5.

N **11.3.7.3** When tested for removal of selected products of combustion as specified in Section 12.4, the cleaning process shall provide for a 50 percent or greater cleaning efficiency for the average of all surrogate heavy metal contaminants.

N **11.3.7.4** When tested for removal of selected products of combustion as specified in Section 12.4, the cleaning process shall provide for a 50 percent or greater average cleaning efficiency for the average of all surrogate semi-volatile organic compounds.

N **11.3.7.5** When tested for the neutralization and sanitization of biological contaminants as specified in Section 12.5, the sanitization process shall provide for at least $\log_{10}3$ reduction of challenge microorganisms.

11.3.8 For verification of an organization's or an ISP's advanced inspection services, the certification organization shall evaluate the organization's or ISP's procedures in accordance with Sections 6.3 and 6.4 of this standard.

11.3.9 For verification of an organization's or an ISP's repair services, the following series of tests shall be required for each repair category for which the organization or the ISP is verified. Testing shall be conducted using new materials as outlined in Table 11.3.9(a) through Table 11.3.9(c). Initial samples submitted by the organization or ISP for verification shall be permitted to be prepared by that organization or ISP.

11.3.9.1 For repairs to tears in the outer shell, moisture barrier, and thermal barrier, the certification organization shall inspect the tear in the material(s) to be repaired in accordance with Figure 11.3.9.1 and shall witness the repair of the samples to be tested.

Δ **11.3.9.2** For moisture barrier pinhole repairs, the certification organization shall inspect the pinholes in the material(s) to be repaired and shall witness the repair of the samples to be tested. The pinholes shall be created in the material(s) by using a size 8 gauge sewing needle to completely puncture the moisture barrier five times in a 25 mm (1 in.) square located in the center of a 305 mm × 305 mm (12 in. × 12 in.) sample. The 1 in. square shall be clearly marked to identify the damaged area.

N **11.3.9.2.1** The damaged and repaired samples specified in 11.3.9.1 and 11.3.9.2 shall be prepared for the conditioning specified in Table 11.3.9(c).

N **11.3.9.2.2** Samples for conditioning shall be at least 305 mm (12 in.) square and shall consist of a composite constructed using a layer of 3.8 oz/yd^2 ± 0.3 oz/yd^2 aramid needle-punched nonwoven material, quilted to 3.4 oz/yd^2 ± 0.2 oz/yd^2 aramid woven plain weave thermal barrier material, and the repaired moisture barrier layer. The two-layer composite shall be stitched around the entire periphery in the orientation used in a garment.

Δ **Table 11.3.9(a) Outer Shell Repairs**

Who Makes Repair	Sample	Material	Test or Evaluation
Organization	5 ft felled seam 5 ft overedge seam	Outer shell material(s) utilized by the organization	NFPA 1971 — 7.1.13
	Small tear patch	Patched tear made from the outer shell material utilized by the organization	NFPA 1851 — 8.2.3
ISP	5 ft felled seam 5 ft overedge seam	7.5 osy Nomex IIIa plain weave fabric	NFPA 1971 — 7.1.13
	Small tear patch	Patched tear made from 7.5 osy Nomex IIIa plain weave fabric	NFPA 1851 — 8.2.3

Δ **Table 11.3.9(b) Thermal Liner Repairs**

Who Makes Repair	Sample	Material	Test or Evaluation
Organization	5 ft felled seam 5 ft overedge seam	Thermal liner material(s) utilized by the organization	NFPA 1971 — 7.1.13
	Small tear patch	Patched tear made from the thermal liner material utilized by the organization	NFPA 1851 — 8.2.3
ISP	5 ft felled seam 5 ft overedge seam	Blended filament/spun face cloth quilted to two layers of E89	NFPA 1971 — 7.1.13
	Small tear patch	Patched tear made from blended filament/spun face cloth quilted to two layers of E89	NFPA 1851 — 8.2.3

Δ Table 11.3.9(c) Moisture Barrier Repairs

Who Makes Repair	Sample	Material	Test or Evaluation
Organization	5 ft seam	Moisture barrier material(s) utilized by the organization	NFPA 1971 — 7.1.13
	Pinhole repair	Pinhole repair made from the moisture barrier material(s) utilized by the organization	NFPA 1851 — 8.2.3 and NFPA 1851 — Section 12.3 conditioning in NFPA 1971 — 8.1.2
	Tear patch	Patched tear made from the moisture barrier material(s) utilized by the organization	NFPA 1851 — 8.2.3 and NFPA 1851 — Section 12.3 conditioning in NFPA 1971 — 8.1.2
ISP	5 ft seam	All moisture barrier materials repaired by the ISP	NFPA 1971 — 7.1.13
	Pinhole repair	Pinhole repair made from the moisture barrier material(s) utilized by the ISP	NFPA 1851 — 8.2.3 and NFPA 1851 — Section 12.3 conditioning in NFPA 1971 — 8.1.2
	Tear patch	Patched tear made from the moisture barrier materials repaired by the ISP	NFPA 1851 — 8.2.3 and NFPA 1851 — Section 12.3 conditioning in NFPA 1971 — 8.1.2

***N* 11.3.9.2.3** The moisture barrier layer shall be removed from the two-layer composite samples after all conditioning has been completed and shall become the moisture barrier specimen.

***N* 11.3.9.2.4** Testing shall be performed as specified in Section 12.3.

11.3.9.3 Sample seams shall be prepared and submitted to the certification organization for verification testing by an NFPA 1971–certified manufacturer, verified organization, or verified ISP.

11.3.9.3.1 Where a verified organization or verified ISP performs repairs for more than one garment manufacturer, then only one set of seam samples shall be required for verification testing.

11.3.9.3.2 For moisture barrier seam repairs, the certification organization or ISP shall damage the sample seams by cutting multiple stitches and the seam tape to a distance of 75 mm (3 in.) +12.5 mm/–0.00 mm (+½ in./–0 in.). The certification organization shall inspect the damaged seams and witness the repair of the samples to be tested.

11.3.9.3.3 For outer shell and thermal barrier seam repairs, the certification organization or ISP shall damage the sample seams by cutting multiple stitches to a distance of 75 mm (3 in.) +12.5 mm/–0.00 mm (+½ in./–0 in.). The certification organization shall inspect the damaged seams and witness the repair of the samples to be tested.

11.3.9.4 The certification organization shall not allow test samples 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.

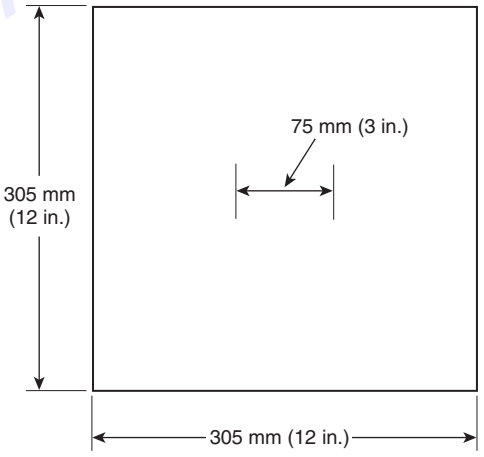


FIGURE 11.3.9.1 Tear Repairs.

11.3.10 For verification of an organization's or ISP's advanced inspection services, the documentation and measurements specified in Table 11.3.10 shall be evaluated and verified to be compliant by the certification organization.

11.3.11 For verification of an organization's or ISP's advanced cleaning services, the documentation and measurements specified in Table 11.3.11 shall be evaluated and verified to be compliant by the certification organization.

Δ Table 11.3.10 Advanced Inspection Evaluation

NFPA 1851 Clause to Be Evaluated	Method of Evaluation
6.3.2	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.3.4	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.3.5.1 (1)–(4) and (6)–(15)	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.3.5.7	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.3.6.1	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.4.2	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.4.4	Audit or review of organization's or ISP's procedures and documentation by certification organization
6.4.5	Audit or review of organization's or ISP's procedures and documentation by certification organization

Δ Table 11.3.11 Advanced Cleaning Evaluation

NFPA 1851 Clause to Be Evaluated	Method of Evaluation
7.3.4	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.5	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.6	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.9(1)–(3) and 7.3.9(5)–(6)	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.9(4)	Direct measurement or observation by a representative of the certification organization
7.3.11	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.16	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.10	Audit or review of organization's or ISP's procedures and documentation by certification organization
7.3.10.1(1)(c), 7.3.10.1(2)(c), or 7.3.10.2(4)	Direct measurement or observation by a representative of the certification organization

11.3.12 The organization or the ISP shall maintain all inspection and test data from the certification organization used in the verification of the organization's or the ISP's services. The organization or ISP shall provide such data, upon request, to the purchaser or authority having jurisdiction.

11.3.13 All repair categories that are verified in accordance with this standard shall undergo verification on an annual basis.

11.4 Organization or ISP Quality Management Program.

11.4.1 The organization's or the ISP's management shall define and document its policy and objectives for and commitment to quality and shall ensure that this policy is understood, implemented, and maintained at all levels in the organization or the ISP.

11.4.2 The organization or the ISP shall operate an effective quality system appropriate to the type, range, and volume of work performed.

11.4.3 The management of the organization or the ISP shall designate a person who, irrespective of other duties, shall have defined authority and responsibility for quality assurance within the organization or ISP. The quality system shall be maintained relevant and current under the responsibility of the same person.

11.4.3.1 If the verified ISP or verified organization changes the designated person, the verified ISP or verified organization shall notify the certification organization.

11.4.4 The quality system shall be fully documented. There shall be a Quality Manual, which shall contain at least the following information:

(1) General information (name, addresses, phone numbers, and legal status)
(2) Management statement on the organization's or ISP's policy on, objectives for, and commitment to quality
(3) Management statement assigning a responsible person for quality assurance
(4) Description of the organization's or ISP's areas of activity and competence
(5) Organization chart(s)
(6) Relevant job descriptions
(7) Policy statement on qualification and training of personnel
(8) Procedures for control of documents
(9) Procedures for internal audits
(10) Procedures for feedback and corrective action
(11) Procedures for management review of the quality system
(12) Distribution list for the Quality Manual
(13) Work instructions or process manuals
(14) Procedure for handling returns and complaints

11.4.5 The organization or ISP shall maintain a system for control of all documentation relating to its activities and shall ensure the following:

(1) That the current revisions of the appropriate documentation are available at all relevant locations and to all relevant staff
(2) That all amendments to documents are authorized and processed in a manner that will ensure timely availability at the appropriate location

(3) That superseded documents are removed from use throughout the organization but that one copy is filed for a determined period
(4) That other parties, as necessary, are notified of changes

11.4.6 The organization or the ISP shall carry out a system of planned and documented internal quality audits to verify compliance with the criteria of this standard and the effectiveness of the quality system. The personnel performing the audits shall be suitably qualified and independent from the functions being audited.

11.4.7 The organization or the ISP shall have documented procedures for dealing with feedback and corrective action whenever discrepancies are detected in the quality system or in the performance of inspections.

11.4.8 The management of the organization or the ISP shall review the quality system at least annually to ensure its continuing suitability and effectiveness. The results of such reviews shall be recorded.

Chapter 12 Test Procedures

N 12.1 Light Evaluation of Hood Particulate-Blocking Layers.

N 12.1.1* Application. This evaluation method shall apply to particulate-blocking protective hood interface components that are in service.

N 12.1.2 Evaluation Areas.

N 12.1.2.1 All portions of the hood interface component that contain a particulate-blocking layer, including seams, shall be evaluated.

N 12.1.2.2 As a minimum, four areas of the hood shall be evaluated as follows:

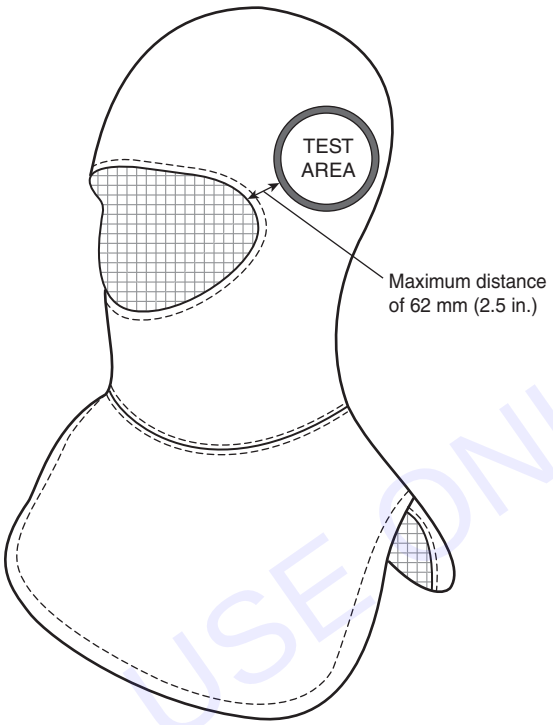
(1) The left side of the hood with the edge of the test area within 62 mm (2.5 in.) of the hood opening *[see Figure 12.1.2.2(a)]*
(2) The right side of the hood with the edge of the test area within 62 mm (2.5 in.) of the hood opening *[see Figure 12.1.2.2(b)]*
(3) The back of the hood *[see Figure 12.1.2.2(c)]*
(4) The middle of any seam area joining two pieces of the particulate-blocking layer

N 12.1.2.3 Other hood areas subject to 12.1.2.1 shall be permitted to be evaluated.

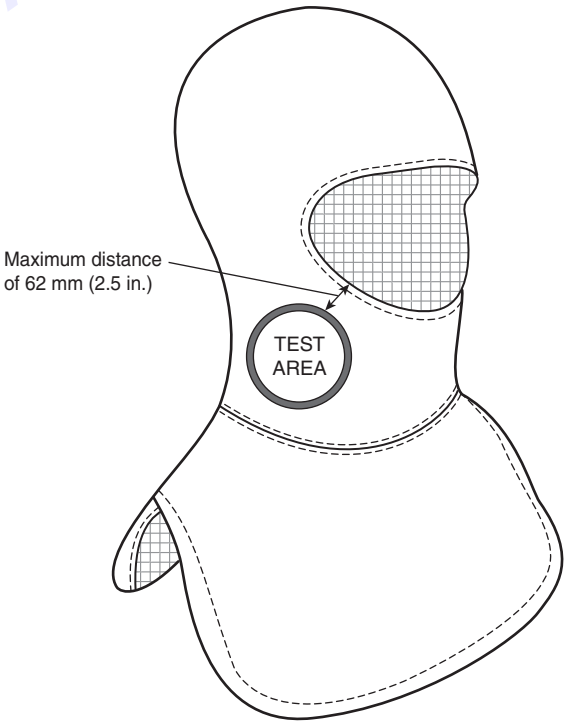
N 12.1.3 Evaluation Apparatus.

N 12.1.3.1* An apparatus that consists of a clear head form combined with a bright enough light source to show the changes in density of the liner materials when viewed shall be used. The light source shall be mounted at the center of the head form interior and have a means for turning the light on and off and for its replacement.

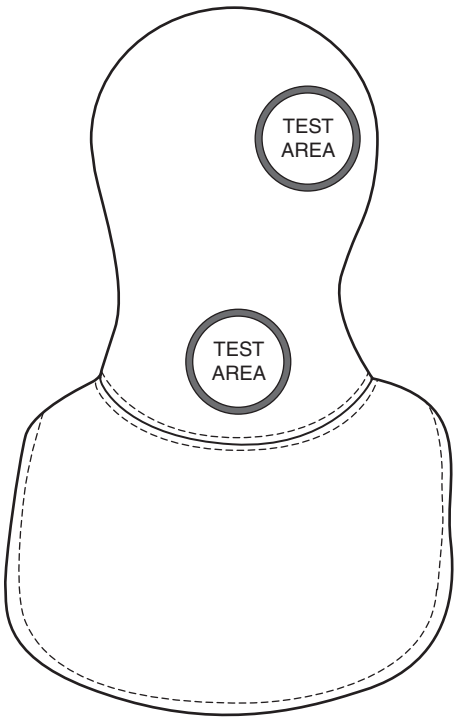
N 12.1.3.2* A special fixture shall be permitted to be used that allows portions of the hoods that measure at least 75 mm (3 in.) in diameter to be nondestructively clamped on a holder where a light source is placed below the viewing area.



N FIGURE 12.1.2.2(a) Minimum Light Evaluation Areas on Left Front Side of Particulate-Blocking Hood.



N FIGURE 12.1.2.2(b) Minimum Light Evaluation Areas on Right Front Side of Particulate-Blocking Hood.



N **FIGURE 12.1.2.2(c) Minimum Evaluation Areas on Back of Particulate-Blocking Hood.**

N **12.1.4 Procedure.**

N **12.1.4.1** The evaluation procedure shall be conducted indoors in an area that can be darkened so as to provide for optimum viewing of potential damage to the particulate-blocking layer of the hood interface component.

N **12.1.4.2** The evaluation shall be conducted using the following procedure:

(1) Don the hood on the head form or position the area of the hood to be examined on the fixture.
(2) Turn on the light inside the head form or fixture.
(3) Evaluate areas of the hood that have a particulate-blocking layer in place, including seams.
(4) For comparison purposes, use a new, unused hood to distinguish the normal appearance of light through an undamaged hood.

N **12.1.5 Results.** Results shall be determined by evaluating areas where the light is brighter through some areas than others.

N **12.1.6* Interpretation.** Brighter areas shall be considered a possible indication of a defect or other damage that compromises the hood's performance.

N **12.2 Smoke Evaluation of Hood Particulate-Blocking Layers.**

N **12.2.1 Application.**

N **12.2.1.1** This evaluation method shall apply to particulate-blocking protective hood interface components that are in service.

N **12.2.1.2*** This evaluation method shall be conducted either qualitatively or quantitatively.

N **12.2.2 Evaluation Areas.**

N **12.2.2.1** All portions of the hood interface component that contain a particulate-blocking layer, including seams within areas having a particulate-blocking layer, shall be evaluated.

N **12.2.2.2** As a minimum, four areas of the hood shall be evaluated as follows:

(1) The left side of the hood with the edge of the test area at least 62 mm (2.5 in.) away from the hood opening *[see Figure 12.2.2.2(a)]*
(2) The right side of the hood with the edge of the test area at least 62 mm (2.5 in.) away from the hood opening *[see Figure 12.2.2.2(b)]*
(3) The back of the hood *[see Figure 12.1.2.2(c)]*
(4) The middle of any seam area joining two pieces of the particulate-blocking layer

N **12.2.2.3** Other hood areas subject to 12.2.2.1 shall be permitted to be evaluated.

N **12.2.3* Evaluation Apparatus.**

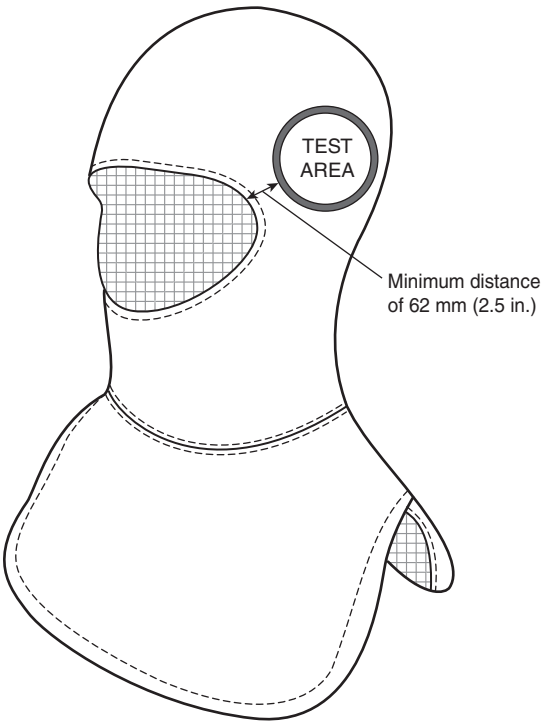
N **12.2.3.1 Approaches.**

N **12.2.3.1.1 Qualitative.** The overall evaluation apparatus for the qualitative approach shall consist of a sample clamping device, a smoke generator, and a flowmeter.

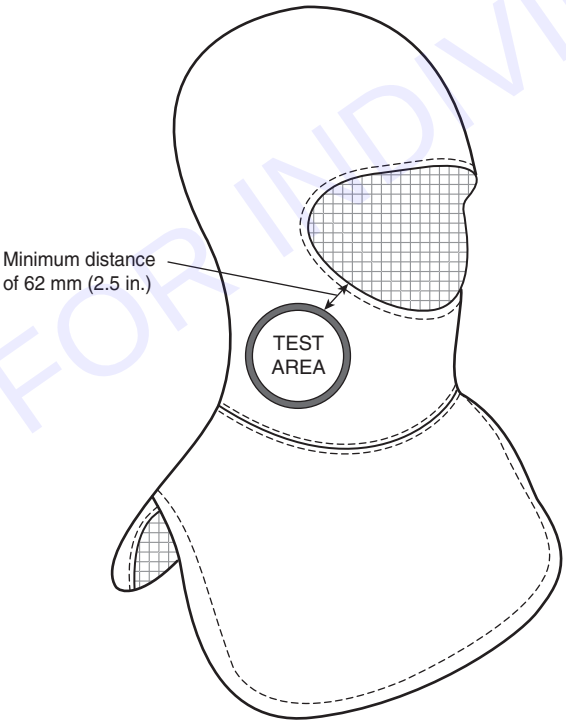
N **12.2.3.1.2 Quantitative.** The overall evaluation apparatus for the quantitative approach shall include a light transmission meter in addition to the same equipment used for the qualitative approach listed in 12.2.3.1.1.

N **12.2.3.2*** A sample clamping device shall be used that has the following characteristics:

(1) The device shall provide a transparent cylindrical reservoir of a diameter of 100 mm ± 25 mm (4.0 in. ± 1.0 in.), a height of 140 mm ± 50 mm (5.5 in. ± 2.0 in.), and a wall thickness of at least 6 mm (0.25 in) and shall have a minimum volume of 800 mL (50 $in.^3$).
(2) A cylinder cap shall be placed on top of the reservoir that provides a minimum viewing area of 60 mm (2.4 in.) in diameter and shall provide a clamping surface that includes a rubber gasket between the cylinder cap and the reservoir.
(3) The device shall have a means of clamping the portion of the hood interface component on top of the open cylindrical reservoir with a clamp such that all areas of the hood interface component incorporating the particulate-blocking layer can be evaluated and which creates an effective seal between the clamping mechanism and the clamping surface of the transparent cylindrical reservoir.
(4) The device's transparent cylindrical reservoir shall have a fitting that permits a leak-free connection with a hose connected to the smoke generator.
(5) A leak-free connection shall also be provided to the transparent cylindrical reservoir for the measurement of pressure inside the reservoir using a pressure gauge in kPa (psi).



N **FIGURE 12.2.2.2(a) Minimum Smoke Evaluation Areas on Left Front Side of Particulate-Blocking Hood.**



N **FIGURE 12.2.2.2(b) Minimum Smoke Evaluation Areas on Right Front Side of Particulate-Blocking Hood.**

N **12.2.3.3*** A smoke generator shall be used that has the following characteristics and capabilities:

(1) The smoke generator shall have the capability of providing smoke through an orifice that establishes a direct, leak-free connection between the smoke generator and the sample clamping device.
(2) The smoke generator shall have the ability to adjust the flow of smoke and shall have the capability to produce smoke at a rate of at least 1.0 to 2.5 L/min.
(3) The smoke generator shall generate visible smoke based on a cosmetic grade mineral oil or an aqueous-based smoke-generating agent that provides smoke particles ranging from 1 to 10 microns.
(4) When connected to the sample clamping device, the smoke generator shall not create a pressure greater than 1.0 kPa (0.15 psi) when operating for a period of 1 minute.

N **12.2.3.4** A flowmeter, or a rotometer or other flow measurement device capable of measuring air flow rate in L/min to the nearest 0.1 L/min, shall be placed in the connection line from the smoke generator to the device's transparent cylindrical reservoir.

N **12.2.3.5*** A light transmission meter that consists of a light source and light receiver with the following characteristics shall be used for quantitative evaluation approaches:

(1) The light source shall be a light-emitting diode (LED) source that generates a continuous tight beam of light.
(2) The light receiver shall be a photoresistor capable of reporting light transmission from 0 to 100 percent on a digital display with an optional RS232 port for recording measurements.
(3) The light transmission device shall be capable of being mounted on the sample clamping device such that the light beam is generated and received parallel to the test hood surface at a height of 34 mm ± 3 mm (1.3 in. ± 0.1 in.) and that there is a distance between the light source and light receiver of 90 mm ± 10 mm (3.5 in. ± 0.3 in.).

N **12.2.4 Procedure.**

N **12.2.4.1** The evaluation procedure shall be conducted indoors in a well-lit area that is free from air currents and provides good visibility.

N **12.2.4.2** The qualitative evaluation approach shall be conducted using the following procedure:

(1) The smoke generator shall be operated in accordance with the manufacturer's instructions by adding the appropriate smoke-generating liquid and any other supplies for its operation.
(2) Prior to testing, the smoke generator shall be turned on and allowed to generate smoke for 5 minutes.
(3) After 5 minutes, the smoke generator shall be switched to air to clean out the remaining smoke-generating liquid in the hose and to prepare for testing.
(4) With the smoke generator still generating air and the hose not connected to the cylindrical reservoir, the hose shall be connected to the flowmeter and the flow rate shall be adjusted to 1.7 L/min ± 0.1 L/min.
(5) Following adjustment of the flow rate, the smoke generator shall be switched to smoke and the hose shall be securely attached to the transparent cylindrical reservoir.

(6) The hood shall be inverted (i.e., turned inside out) and the portion of the hood to be tested shall be positioned over the top of the transparent cylindrical reservoir and securely clamped into position.
(7) The viewing area within the cylindrical clamping fixture shall be observed for up to 120 seconds for the presence of smoke coming through the clamped area of the hood interface component.
(8) After 120 seconds, the smoke generator shall be turned off and the cylindrical chamber shall be flushed with air.
(9) The hood interface component shall be removed from the sample clamping device, inspected, and subjected to an advanced cleaning, if necessary.
(10) The interior of the cylindrical reservoir shall be wiped to remove any chemical residue and the hose shall be detached and turned upside down to clear out any residual smoke or smoke-generating liquid.
(11) Each area of the hood specified in 12.2.2 shall be evaluated.
(12) The level of smoke-generating liquid shall be checked at the conclusion of testing to ensure that it has not decreased more than 50 percent, in which case additional smoke-generating liquid shall be added to bring the liquid reservoir up to its full capacity.
(13)* Following testing, the hood interface component shall be cleaned to remove any residue remaining from the smoke content.

N **12.2.4.3** The quantitative evaluation approach shall be conducted using the same procedures in 12.2.4.2 with the following additional procedures:

(1)* The light transmission meter shall be calibrated before each set of measurements using a standard reference material that provides a range of light transmission from 40 percent to 90 percent.
(2) Light transmission readings shall be taken every 10 seconds for the last 60 seconds of the 120 seconds required in 12.2.4.2(7).

N **12.2.5 Results.**

N **12.2.5.1** For the qualitative evaluation approach, observations of smoke coming out of each evaluated area of the hood interface component shall be reported.

N **12.2.5.2** For the quantitative evaluation approach, the measured light transmission values recorded from 60 to 120 seconds shall be reported and the average transmission value for each hood shall be calculated.

N **12.2.6 Interpretation.**

N **12.2.6.1** For the qualitative evaluation approach, any observed smoke coming out of the test hood relative to an unused, pristine hood shall be considered as a possible indication of a defect or other damage that compromises the hood's performance.

N **12.2.6.2*** For the quantitative evaluation approach, any decrease in a light transmission value of 5 percent or more relative to an unused, pristine hood shall be considered as possible evidence of a defect or other damage that compromises the hood's performance.

12.3 Water Penetration Barrier Evaluation.

12.3.1 Application. This evaluation method shall apply to moisture barrier materials and moisture barrier seams found in structural or proximity fire fighting protective garment elements that are in service.

12.3.2 Evaluation Areas.

12.3.2.1 A minimum of three moisture barrier material areas and a minimum of three moisture barrier areas with a seam shall be tested on each garment element.

12.3.2.1.1 Moisture barrier material areas shall be from high-abrasion areas of the garment elements, including, but not limited to:

(1) Broadest part of the shoulders
(2) Back waist area of the coat
(3) Knees
(4) Crotch area
(5) Seat area

12.3.2.1.2 In addition to the areas listed in 12.3.2.1.1 where potential damage to the garment outer shell or the thermal barrier has been detected, the evaluation shall be conducted on the corresponding area of the moisture barrier. Where potential damage to the garment moisture barrier has been detected, the evaluation shall also be conducted on that area of the moisture barrier.

12.3.2.2 Moisture barrier material areas shall be positioned in the evaluation apparatus such that the side of the barrier that is against the outer shell faces the water in the evaluation apparatus.

12.3.2.3 Moisture barrier material areas with seams shall be positioned on the evaluation apparatus so that the seam divides the specimen into two equal halves.

12.3.3 Evaluation Apparatus.

12.3.3.1* The apparatus used to evaluate water penetration shall have the following characteristics:

(1) The apparatus shall consist of a means of clamping the area to be evaluated in a horizontal position, providing a watertight seal with the pressurized portion of the apparatus and water reservoir.
(2) The apparatus shall accommodate evaluations of moisture barriers and seams without the removal of the specimens.
(3) The apparatus shall have a clamping area that provides a water exposure and viewing area that is at least 50 mm (2 in.) in diameter.
(4) The apparatus shall have a water reservoir containing sufficient water for carrying out the evaluation.
(5) The apparatus shall provide for the pressurization of water against the garment element moisture barrier area at a pressure of 6.9 kPa (1 psi) for at least 15 seconds. The 6.9 kPa (1 psi) pressure shall be achieved within 10 seconds.
(6) The apparatus shall be equipped with a pressure gauge that is accurate to the nearest 0.2 kPa (0.1 psi).
(7) The apparatus shall be equipped with a means of bleeding air pressure and permit the drainage of water from the pressurized portion of the apparatus.

12.3.3.2 A stopwatch or other timer shall be used to ensure that pressure is applied for the specified duration of 15 seconds.

12.3.4 Procedure.

12.3.4.1 The evaluation shall be conducted using the following procedure:

(1) The selected area of moisture barrier shall be placed in the apparatus and clamped to provide a watertight seal with the apparatus.
(2) A water pressure of 1 psi shall be introduced against the moisture barrier for a period of not less than 15 seconds.
(3) The visible side of the moisture barrier shall be visually inspected after 15 seconds to determine if water penetration has occurred.

12.3.5 Results.

12.3.5.1 If any water passes through the moisture barrier or moisture barrier seam, the liner shall be removed from service and repaired or replaced.

12.3.5.2 If no water passes through the moisture barrier or moisture barrier seam, the liner shall be allowed to dry completely before being returned to service.

***N* 12.4 Chemical Decontamination Efficacy Test.**

***N* 12.4.1* Application.** This test method shall determine the chemical decontamination efficacy for outer shell materials in protective garments that are subjected to advanced cleaning procedures by a cleaning facility for the removal of products of combustion from structural fire-fighting protective garments.

***N* 12.4.2* General Procedures.**

***N* 12.4.2.1** The certification organization or its designated laboratory shall contaminate separate sets of selected outer shell material specimens with semivolatile organic compounds and heavy metals.

***N* 12.4.2.2** Chemically contaminated and noncontaminated specimens of the selected outer shell material shall be prepared, appropriately packaged, and sent by the certification organization to the respective cleaning facility with the supplies necessary for subjecting the specimens to the cleaning facility's advanced cleaning procedures.

***N* 12.4.2.3** Under the supervision of a representative from the certification organization, ISP personnel shall insert the chemically contaminated and noncontaminated outer shell specimens into surrogate clothing samples that shall then be specially placed with designated ballast materials in the cleaning facility's advanced cleaning equipment to form the wash load.

***N* 12.4.2.4** The surrogate clothing samples with chemically contaminated and noncontaminated outer shell specimens and designated ballast material shall be subjected to one full cycle of the cleaning facility's advanced cleaning procedures.

***N* 12.4.2.5** Following the completion of the cleaning facility's advanced cleaning procedures and under the supervision of a representative from the certification organization, the washed chemically contaminated and noncontaminated outer shell specimens shall be removed by cleaning facility personnel, placed in suitable containers, and shipped back to the certification organization or its designated laboratory.

***N* 12.4.2.6** The certification organization or its designated laboratory shall analyze the washed chemically contaminated and noncontaminated specimens as well as control specimens (i.e., contaminated but not laundered) and determine the cleaning efficiency of the cleaning facility's advanced cleaning procedures for each of the specified chemical contaminants.

***N* 12.4.2.7** The certification organization shall separately interpret the cleaning efficiency results for both heavy metals and semivolatile organic compounds to determine compliance with the criteria for the respective cleaning facility cleaning efficiency specified in 11.3.7.

***N* 12.4.3 Specimen Preparation.**

***N* 12.4.3.1** The garment outer shell used for specimens shall be an undyed 60 percent para-aramid/40 percent polybenzimidazole (PBI) base fabric with a reinforcement grid meeting the following specifications:

(1) The outer shell fabric shall have a unit area weight of 240 to 268 g/m^2 (7.1 to 7.9 oz/yd^2).
(2) The outer shell fabric shall have a thickness of 0.584 ± 0.254 mm (0.023 ± 0.10 in.).
(3) The outer shell fabric shall have a water absorption resistance of less than 5 percent when tested in accordance with Section 8.25 of NFPA 1971.

***N* 12.4.3.2** Outer shell fabric used for testing shall be prepared by laundering for 10 cycles as specified in AATCC 135, *Dimensional Changes of Fabrics after Home Laundering*, using Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai. A 1.82 kg ± 0.1 kg (4.0 lb ± 0.2 lb) load shall be used. A laundry bag shall not be used.

***N* 12.4.3.3 Semivolatile Organic Compounds.**

***N* 12.4.3.3.1** A minimum of six specimens shall be contaminated with selected semivolatile organic compounds as specified in 12.6.1 and 12.6.2.

***N* 12.4.3.3.1.1** The number of contaminated specimens required by 12.4.3.3.1.1 shall be permitted to be reduced from six to five specimens if the certification organization can demonstrate that the transportation of the specimens to the cleaning facility does not affect the travel specimen's condition or the contaminant concentrations.

***N* 12.4.3.3.2** Four additional specimens shall be prepared as specified in 12.4.3.2 but not contaminated.

***N* 12.4.3.3.2.1** The number of noncontaminated specimens required by 12.4.3.3.2 shall be permitted to be reduced from four to three specimens if the certification organization can demonstrate that the transportation of the specimens to the receiving facility does not affect the travel specimen's condition.

***N* 12.4.3.3.3** One contaminated specimen and one noncontaminated specimen shall remain at the certification organization or its designated laboratory.

***N* 12.4.3.4 Heavy Metals.**

***N* 12.4.3.4.1** A minimum of six specimens shall be contaminated with selected heavy metals as specified in 12.7.1 and 12.7.2.

***N* 12.4.3.4.1.1** The number of contaminated specimens required by 12.4.3.4.1 shall be permitted to be reduced from six to five specimens if the certification organization can demonstrate that the transportation of the specimens to the cleaning facility does not affect the travel specimen's condition or the contaminant concentrations.

N **12.4.3.4.2** Four additional specimens shall be prepared as specified in 12.4.3.2 but not contaminated.

N **12.4.3.4.2.1** The number of noncontaminated specimens required by 12.4.3.4.2 shall be permitted to be reduced from four to three specimens if the certification organization can demonstrate that the transportation of the specimens to the receiving facility does not affect the travel specimen's condition.

N **12.4.3.4.3** One contaminated specimen and one noncontaminated specimen shall remain at the certification organization or its designated laboratory.

N **12.4.4 Specimen Handling, Sample Wash Load Assembly, and Cleaning.**

N **12.4.4.1 General.** Each individual contaminated and noncontaminated specimen shall be placed in a separate contamination-free container with a label identifying the specimen and shipped overnight by the certification organization or its designated laboratory to the cleaning facility for receipt on the scheduled day of testing.

N **12.4.4.2 Surrogate Garments.**

N **12.4.4.2.1** The certification organization or its designated laboratory shall provide surrogate garments that have been prepared as specified in 12.9.1.

N **12.4.4.2.2** The surrogate garments shall be permitted to be provided separately from the contamination and noncontaminated specimens.

N **12.4.4.3 Ballast Material Panels.**

N **12.4.4.3.1** The certification organization shall either provide or have the cleaning facility use a white, plain weave, 100 percent polyester ballast fabric that conforms to the following specifications:

(1) The ballast fabric shall have a unit area weight of 346 ± 34 g/m^2 (10.2 ± 1.0 oz/yd^2).
(2) The ballast fabric shall have a construction of at least 35 threads in the warp direction and at least 20 threads in the fill or weft direction.
(3) The ballast fabric shall be uncoated and have a durable water repellent finish that results in a horizontal wicking of less than 10 mm (0.40 in.) in any direction when tested as specified in AATCC 198, *Horizontal Wicking of Textiles*, after the fabric has been washed a total of 5 cycles as specified in AATCC 135, *Dimensional Changes of Fabrics after Home Laundering*.
(4) The ballast fabric shall have a tensile strength of at least 1560 N (350 lb) when tested as specified in ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*.
(5) The ballast fabric shall have a tear strength of at least 116 N (26 lb) when tested as specified in ASTM D2261, *Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-of-Extension Tensile Testing Machine)*.

N **12.4.4.3.2** An alternative ballast material shall be permitted if it is shown to have at least the same weight range specified in 12.4.4.3.1(1) and meets the horizontal wicking requirement in 12.4.4.3.1(3).

N **12.4.4.3.3** A sufficient number of different cut and shaped ballast fabric–based wash panels for creating the wash load shall be prepared in advance of the testing as specified in 12.9.2.

N **12.4.4.4 Handling and Disposition of Contaminated Specimens.**

N **12.4.4.4.1*** Under the supervision of a representative from the certification organization, the chemically contaminated and noncontaminated outer shell fabric test specimens shall be unpacked with the following disposition as related separately to both semivolatile organic compounds and heavy metals:

(1) One contaminated specimen and one noncontaminated specimen shall remain in their containers, untouched at the receiving facility, and shall be identified as the "travel specimens." These specimens shall be permitted to be excluded if the certification organization can demonstrate that the transportation of the specimens to the cleaning facility does not affect the specimen's condition or the contaminant concentrations.
(2) One noncontaminated specimen shall be inserted in Specimen Pocket 1 of the surrogate coat; one individual contaminated specimen shall be inserted in Specimen Pocket 2 of the surrogate coat, while a second individual contaminated specimen shall be inserted in Specimen Pocket 3 of the surrogate coat.
(3) One noncontaminated specimen shall be inserted in Specimen Pocket 1 of the surrogate pant; one individual contaminated specimen shall be inserted in Specimen Pocket 2 of the surrogate pant, while a second individual contaminated specimen shall be inserted in Specimen Pocket 3 of the surrogate pant.

N **12.4.4.4.2** The individual handling the specimens shall be wearing clean disposable gloves and shall use either metal tweezers for semi-volatile organic compound–contaminated specimens or plastic tweezers for heavy metal–contaminated specimens provided by the certification organization for inserting the specimens into the surrogate clothing item pockets.

N **12.4.4.4.3** The tweezer surfaces that contact the specimens shall be cleaned with an alcohol solution–based disposable wipe between uses.

N **12.4.4.5 Assembly of Wash Load and Application of Wash Load.**

N **12.4.4.5.1** The wash load shall be assembled as specified in 12.9.3 and adjusted according to the cleaning facility's procedures for load size.

N **12.4.4.5.2** If the cleaning facility's procedures for advanced cleaning involve a pretreatment, such as a presoaking of clothing prior to placement in a washer/extractor or other type of laundering machine, then it shall be permitted to subject only the surrogate clothing with inserted outer shell specimens to the pretreatment without the ballast materials.

N **12.4.4.5.3** The wash load consisting of the surrogate clothing items with inserted outer shell fabric specimens, along with the specified number and types of ballast fabric–based wash panels, shall be subject to the cleaning facility's advanced cleaning procedures for which verification is being performed.

N **12.4.4.5.3.1** The inserted outer shell specimens shall be permitted to be removed from the respective surrogate clothing items for faster drying using appropriate tweezers for the type of sample and minimizing any contact or handling with the specimen before drying is complete.

N **12.4.4.5.4** To shorten the drying time, the surrogate clothing items with inserted outer shell specimens shall be allowed to dry without the ballast fabric–based wash panels.

N **12.4.4.6 Removal and Shipping.** Following the advanced cleaning and under the supervision of a representative from the certification organization, the specimens shall be removed from the surrogate clothing items using tweezers, placed in labeled, contamination-free containers, and packaged for overnight shipment to the certification organization or its designated laboratory for evaluation.

N **12.4.5 Specimen Evaluation.**

N **12.4.5.1** Test specimens for semivolatile organic compound contamination removal shall be subject to the extraction and analysis procedures specified in 12.6.3 through 12.6.5.

N **12.4.5.2** Test specimens for heavy metal contamination removal shall be subject to the extraction and analysis procedures specified in 12.7.3 and 12.7.4.

N **12.4.6 Report.** The following information shall be reported for each contaminant:

(1) Contaminant concentration in the contaminated specimen that stayed at the certification organization or its designated laboratory
(2) Contaminant concentration in the contaminated, traveling specimen, if applicable
(3) Contaminant concentration in the unwashed, traveling specimen, if applicable
(4) Contaminant concentration in each of the washed specimens
(5) Average contaminant concentration of the washed specimens
(6) Contaminant concentration in the washed, blank specimen
(7) Calculated cleaning efficiency by contaminant
(8) The average calculated cleaning efficiency for all contaminants

N **12.4.7 Interpretation.**

N **12.4.7.1** Overall compliance with the requirement for chemical decontamination involving semivolatile organic compound contaminants shall be based on the average calculated cleaning efficiency for all chemical contaminants.

N **12.4.7.2** Overall compliance with the requirement for chemical decontamination involving heavy metals shall be based on the average calculated cleaning efficiency for all chemical contaminants.

N **12.5 Biological Decontamination Efficacy Test.**

N **12.5.1* Application.** This test method shall determine the biological decontamination efficacy for outer shell materials in protective garments that are subjected to cleaning facility procedures for the disinfection or sanitization of structural firefighting protective garments.

N **12.5.2* General Procedures.**

N **12.5.2.1** The certification organization or its designated laboratory shall contaminate sets of selected outer shell material specimens with the two specific microorganisms.

N **12.5.2.2** Biologically contaminated and noncontaminated specimens of the selected outer shell material shall be prepared, appropriately packaged, and sent by the certification organization to the respective ISP with the supplies necessary for subjecting the specimens to the cleaning facility's sanitization procedures.

N **12.5.2.3** Under the supervision of a representative from the certification organization, cleaning facility personnel shall insert the biologically contaminated and noncontaminated outer shell specimens into surrogate clothing samples that shall then be specially placed with designated ballast materials in the cleaning facility's sanitization equipment to form the wash load.

N **12.5.2.4** The surrogate clothing samples with biologically contaminated and noncontaminated outer shell specimens and designated ballast material shall be subjected to one full cycle of the cleaning facility's sanitization procedures.

N **12.5.2.5** Following completion of the cleaning facility's sanitization cleaning procedures and under the supervision of a representative from the certification organization, the washed biologically contaminated and noncontaminated outer shell specimens shall be removed by cleaning facility personnel, placed in suitable containers, and shipped back to the certification organization or its designated laboratory.

N **12.5.2.6*** The certification organization or its designated laboratory shall analyze the washed biologically contaminated and noncontaminated specimens as well as control specimens (contaminated but not laundered) and determine the log reduction of the cleaning facility's advanced sanitization procedures for each of the specified biological contaminants.

N **12.5.2.7** The certification organization shall separately interpret the log reduction results for each selected microorganism to determine compliance with the criteria for the respective cleaning facility sanitization efficiency specified in 11.3.7.

N **12.5.3 Specimen Preparation.**

N **12.5.3.1** The garment outer shell material used for specimens shall be an undyed 60 percent para-aramid/40 percent PBI base fabric with a reinforcement grid and shall meet the following specifications:

(1) The outer shell fabric shall have a unit area weight of 240 to 268 g/m^2 (7.1 oz/yd^2 to 7.9 oz/yd^2).
(2) The outer shell fabric shall have a thickness of 0.584 mm ± 0.254 mm (0.023 in. ± 0.10 in.).
(3) The outer shell fabric shall have a water absorption resistance of less than 5 percent when tested in accordance with Section 8.25 of NFPA 1971.

N **12.5.3.2** A total of two specimens shall be prepared for each bacterium as specified in Section 12.8, and outer shell fabric to be used for testing shall be prepared by laundering for 10 cycles as specified in AATCC 135, *Dimensional Changes of Fabrics after Home Laundering*, using Machine Cycle 1, Wash Temperature V, and Drying Procedure Ai. A 1.82 kg ± 0.1 kg (4.0 lb ± 0.2 lb) load shall be used. A laundry bag shall not be used.

N **12.5.3.3** A minimum of six specimens shall be contaminated with each bacterium as specified in 12.8.2.

N **12.5.3.3.1** The number of contaminated specimens required by 12.5.3.3 shall be permitted to be reduced from six to five specimens if the certification organization can demonstrate that the transportation of the specimens to the cleaning facility

does not affect the travel specimen's condition or the bacterial contamination level.

N **12.5.3.4** Four additional specimens shall be prepared for each type of bacteria as specified in 12.5.3.2 but not contaminated.

N **12.5.3.4.1** The number of noncontaminated specimens required by 12.5.3.4 shall be permitted to be reduced from four to three specimens if the certification organization can demonstrate that the transportation of the specimens to the cleaning facility does not result in the inadvertent biocontamination of the travel specimen.

N **12.5.3.5** One contaminated specimen and one noncontaminated specimen shall remain at the certification organization or its designated laboratory.

N **12.5.4 Specimen Handling, Sample Load Assembly, and Sanitization.**

N **12.5.4.1 General.** Each individual contaminated and noncontaminated specimen shall be placed in a separate sterile container with a label identifying the specimen and shipped overnight by the certification organization or its designated laboratory to the cleaning facility for receipt on the scheduled day of testing.

N **12.5.4.1.1** Specimens shall be shipped in a manner to maintain their temperature at 4°C (39°F) prior to testing at the cleaning facility.

N **12.5.4.2 Surrogate Garments.**

N **12.5.4.2.1** The certification organization or its designated laboratory shall provide surrogate garments that have been prepared as specified in 12.9.1.

N **12.5.4.2.2** Prior to shipping, each surrogate garment shall be autoclaved for 90 minutes at 121°C (250°F) and then packaged in a manner to maintain the garments' sterility prior to use at the cleaning facility.

N **12.5.4.2.3** The surrogate garments shall be permitted to be provided separately from the contamination and noncontaminated specimens.

N **12.5.4.3 Ballast Material Panels.**

N **12.5.4.3.1** The certification organization shall either provide or have the cleaning facility use a white, plain weave, 100 percent polyester ballast fabric that conforms to the following specifications:

(1) The ballast fabric shall have a unit area weight of 346 g/m^2 ± 34 g/m^2 (10.2 oz/yd^2 ± 1.0 oz/yd^2).
(2) The ballast fabric shall have a construction of at least 35 threads in the warp direction and at least 20 threads in the fill or weft direction.
(3) The ballast fabric shall be uncoated and have a durable water repellent finish that results in a horizontal wicking of less than 10 mm (0.40 in) in any direction when tested as specified in AATCC 198, *Horizontal Wicking of Textiles*, after the fabric has been washed a total of 5 cycles as specified in AATCC 135, *Dimensional Changes of Fabrics after Home Laundering*.
(4) The ballast fabric shall have a tensile strength of at least 1560 N (350 lb) when tested as specified in ASTM D5034, *Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)*.
(5) The ballast fabric shall have a tear strength of at least 116 N (26 lb) when tested as specified in ASTM D2261, *Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-of-Extension Tensile Testing Machine)*.

N **12.5.4.3.2** An alternative ballast material shall be permitted if it is shown to have at least the same weight range specified in 12.4.4.3.1(1) and meets the horizontal wicking requirement in 12.4.4.3.1(3).

N **12.5.4.3.3** A sufficient number of different cut and shaped ballast fabric–based wash panels for creating the wash load shall be prepared in advance of the testing as specified in 12.9.2.

N **12.5.4.4 Handling and Disposition of Contaminated Specimens.**

N **12.5.4.4.1*** Under the supervision of a representative from the certification organization, the biologically contaminated and noncontaminated outer shell fabric test specimens shall be unpacked with the following disposition as related separately to both types of bacteria:

(1) One contaminated specimen and one noncontaminated specimen shall remain in their containers, untouched at the cleaning facility, and shall be identified as the "travel specimens." These specimens shall be permitted to be excluded if the certification organization can demonstrate that the transportation of the specimens to the cleaning facility does not affect the travel specimen's condition or the biological contamination level.
(2) One noncontaminated specimen shall be inserted in Specimen Pocket 1 of the surrogate coat; one individual contaminated specimen shall be inserted in Specimen Pocket 2 of the surrogate coat, while a second individual contaminated specimen shall be inserted in Specimen Pocket 3 of the surrogate coat.
(3) One noncontaminated specimen shall be inserted in Specimen Pocket 1 of the surrogate pant; one individual contaminated specimen shall be inserted in Specimen Pocket 2 of the surrogate pant, while a second individual contaminated specimen shall be inserted in Specimen Pocket 3 of the surrogate pant.

N **12.5.4.4.2** The individual handling the specimens shall be wearing clean disposable gloves and shall use tweezers provided by the certification organization for inserting the specimens into the surrogate clothing item pockets.

N **12.5.4.4.3** The tweezer surfaces that contact the specimens shall be cleaned with an alcohol solution–based disposable wipe between uses.

N **12.5.4.5 Assembly of Sanitization Load and Application of Sanitization.**

N **12.5.4.5.1** The sanitization load shall be assembled as specified in 12.9.3 and adjusted according to the cleaning facility's procedures for load size.

N **12.5.4.5.2** If the cleaning's procedures for sanitization involve a pretreatment, such as a presoaking of clothing prior to placement in a washer/extractor or other type of laundering machine, then it shall be permitted to subject only the surrogate clothing with inserted outer shell specimens to the pretreatment without the ballast materials.

N **12.5.4.5.3** The sanitization load consisting of the surrogate clothing items with inserted outer shell fabric specimens, along with the specified number and types of ballast fabric–based wash panels, shall be subject to the cleaning facility's sanitization procedures for which verification is being performed.

N **12.5.4.5.4** To shorten the drying time, the surrogate clothing items with inserted outer shell specimens shall be allowed to dry without the ballast fabric–based wash panels.

N **12.5.4.5.4.1** It shall be permitted to remove the inserted outer shell specimens from the respective surrogate clothing items for faster drying using appropriate tweezers for the type of sample and minimizing any contact or handling with the specimen before drying is complete.

N **12.5.4.5.5** Following the sanitization process and under the supervision of a representative from the certification organization, the specimens shall be removed from the surrogate clothing items using tweezers, placed in labeled, contamination-free containers, and packaged for overnight shipment to the certification organization or its designated laboratory for evaluation.

N **12.5.5 Specimen Evaluation.** Test specimens for determining sanitization shall be subject to the extraction and analysis procedures specified in 12.8.3.

N **12.5.6 Report.** The following information shall be reported for each bacterial contaminant in each outer shell material:

(1) Original bacterial count applied to each specimen
(2) Post-cleaning bacterial count for the unwashed, traveling specimen, if applicable
(3) Post-cleaning bacterial count for each of the washed specimens, if applicable
(4) Average post-cleaning bacterial count for the washed specimens
(5) Post-cleaning bacterial count for the washed, blank specimen
(6) Calculated $\log_{10}$ reduction

N **12.5.7 Interpretation.** Overall compliance with the requirements for biological decontamination shall be based on the individual reported $\log_{10}$ reduction for each biological contaminant.

N **12.6 Semi-Volatile Organic Compound Contained Specimen Preparation, Extraction, and Analysis.**

N **12.6.1 Selection of Contaminants.** The following semivolatile organic compounds shall be prepared at a concentration of 200 ppm in a 1:1 mixture of benzene and methylene chloride:

(1) Acenaphthene (CAS No. 83-32-9)
(2) Anthracene (CAS No. 120-12-7)
(3) Diethyl phthalate (CAS No. 84-66-2)
(4) Di-n-octyl phthalate (CAS No. 117-84-0)
(5) Fluorene (CAS No. 86-73-7)
(6) Phenanthrene (CAS No. 85-01-8)
(7) Pyrene (CAS No. 129-00-0)
(8) 2-Nitrophenol (CAS No. 88-75-5)
(9) Phenol (CAS No. 108-95-2)
(10) 2,4,6-Trichlorophenol (CAS No. 88-06-2)

N **12.6.2 Procedures for Contamination of Specimens.**

N **12.6.2.1** Outer shell fabric prepared as specified in 12.4.3.2 shall be cut into 75 mm × 150 mm (3 in. × 6 in.) specimens.

N **12.6.2.2** Using a gastight syringe, a volume of 300 µL of the polycyclic aromatic hydrocarbons (PAH)/phthalate/phenols contamination mixture specified in 12.6.1 shall be dispensed uniformly onto each specimen by drawing the solution into the syringe and slowly depressing the plunger onto the specimen while gently rubbing the end of the syringe onto the specimen.

N **12.6.2.3** Contaminated specimens shall be permitted to dry under ambient laboratory conditions for no more than 30 minutes following the application of the PAH/phthalate/phenols mixture.

N **12.6.2.4** The specimen shall be placed in a labeled jar or other container and kept in a refrigerator at 4°C (39°F) until ready for shipping.

N **12.6.2.5** Alternative techniques for contaminating the specimens shall be permitted if it can be demonstrated that the selected technique provides a specimen concentration of the specific contaminant(s) that are ±20 percent of the target concentration following the application of the technique.

N **12.6.3 Extraction of Specimens.**

N **12.6.3.1** All labware, jars, or extraction vessels made of glass or other degradation-resistant and contamination-free materials shall be thoroughly cleaned, rinsed, and dried.

N **12.6.3.1.1** Where specified, other types of labware shall be substituted if it can be demonstrated that the labware will not contribute to cross contamination of the extraction liquids.

N **12.6.3.2** An extraction solvent of 50 percent methylene chloride, 25 percent acetonitrile, 25 percent cyclohexane shall be prepared.

N **12.6.3.3** A PAH/phthalate/phenols dilution solution of a 1:1 ratio of benzene and methylene chloride shall be prepared.

N **12.6.3.4** The specimen to be analyzed shall be cut into eight smaller pieces and placed in a 300 mL (10.1 oz) extraction vessel with a lid.

N **12.6.3.5** Six 16 mm (⅝ in.) polytetrafluoroethylene (PTFE) bearing balls shall be placed in the extraction vessel with the cut specimen pieces.

N **12.6.3.6** A volume of 50 mL (1.7 oz) of the extraction solvent prepared per 12.6.3.2 shall be added to the extraction vessel.

N **12.6.3.7** The extraction vessel shall be placed on a platform shaker set at 230 RPM ± 10 RPM and shall be shaken for 30 minutes.

N **12.6.3.8** The extraction vessel shall be removed from the platform shaker and shall be placed in a sonicator for 20 minutes at a "no heat" condition.

N **12.6.3.9** Immediately after sonification has been concluded, the extraction vessel shall be vented by lifting the lid to prevent the creation of a vacuum within the vessel.

N **12.6.3.10** The specimens shall be allowed to rest in the extraction vessel until it has returned to room temperature after approximately 10–15 minutes.

N **12.6.3.11** The resulting solution in the extraction vessel shall be filtered using a glass vacuum filtration flask assembly, with a 45 mm (1.77 in.) glass fiber filter placed on the fritted surface of the filtration apparatus and the apparatus then clamped to the flask and connected to a laboratory vacuum line.

N 12.6.3.12 The glass filtration flask and specimen pieces shall be rinsed with 5 mL of extraction solvent.

N 12.6.3.13 Any excess solvent shall be squeezed from the specimen pieces into the filtration flask.

N 12.6.3.14 The liquid content of the vacuum filtration flask shall be transferred to an oil tube or other graduated condensation vessel suitable for measuring extract evaporation using a small glass funnel.

N 12.6.3.15 Modifications to the specimen extraction procedures provided in 12.6.3.1 through 12.6.3.13 shall be permitted, provided that extraction recovery average efficiencies of 80 percent or better can be demonstrated.

N 12.6.4 Preparation of Extract for Analysis.

N 12.6.4.1* The condensation vessel and contents prepared as specified in 12.6.3 shall be placed on the rack under a miniature evaporator/concentrator that is connected to ultra-high-purity nitrogen, and the contents shall be evaporated to less than or equal to 2 mL.

N 12.6.4.2 After reconstitution, the condensation vessel shall be placed in a vortex tube and vortexed 10–15 seconds to incorporate any solids that have dried on the side of the tube.

N 12.6.4.3 The contents of the vortex tube shall be measured using a disposable sterile pipette and the volume shall be recorded.

N 12.6.4.4 The contents of the vortex tube shall be returned to the oil tube with an appropriate amount of solvent to increase the final volume to 2 mL.

N 12.6.4.5 The oil tube shall be vortexed and the contents shall be transferred with a disposable glass pipette into 10 mL glass beaker.

N 12.6.4.6 The contents from the beaker shall be removed using a 3 mL syringe with an attached polyvinylidene fluoride (PVDF) 0.45 µm syringe.

N 12.6.4.7 The contents of the syringe shall be filled into autosampler vial.

N 12.6.4.8* Alternative procedures for preparing the extract for analysis shall be permitted, provided that extraction recovery average efficiencies of 80 percent or better can be demonstrated.

N 12.6.5 Analysis of Specimens.

N 12.6.5.1 Calibration curves shall be prepared for each contaminant by applying known concentrations to specimen fabrics and extracting the specimens using the procedures specified in 12.6.3 and 12.6.4 using the analysis conditions specified in 12.6.5.2.

N 12.6.5.2 Extracts prepared as specified in 12.6.4 shall be analyzed using gas chromatography and mass spectroscopy using the following analysis parameters:

(1) A fused silica nonpolar 30 m, 0.25 mm ID, 0.50 µm mass spectroscopy column with a guard column that has been deactivated but not coated with stationary phase
(2) Inlet temperature of 200°C (392°F)
(3) Transfer line temperature of 300°C (572°F)
(4) Ion source temperature of 300°C (572°F)
(5) Oven temperature of 60°C (140°F); held for 2 minutes
(6) Temperature ramp of 7°C (44.6°F) per minute to 310°C (590°F); held for 10 minutes
(7) A carrier gas of ultra-high-purity helium at 1.2 L/min (40.6 oz)
(8) 1 µL sample splitless injection via autosampler into inlet containing split/splitless straight with wool topaz liner

N 12.6.5.3 The output from the gas chromatography and mass spectroscopy shall be used to integrate and calculate the concentration of each chemical per mass of specimen remaining with the percentage removal based on the calibration curves.

N 12.6.5.3.1 The concentration in each specimen shall be reported in µg/g specimen.

N 12.6.5.4 Cleaning efficiency shall be calculated for each contaminant with the following equation and as specified in 12.6.5.4.1 and 12.6.5.4.2:

[12.6.5.4]

$$\text{cleaning efficiency} = 1 - \left[\frac{(C_C - C_M) - (C_W - C_P)}{(C_C - C_M)} \right] \times 100$$

where:
C_C = contaminated specimen
C_M = material specimen (unwashed, not contaminated)
C_W = contaminated specimen (washed)
C_P = material specimen (washed, not contaminated)

N 12.6.5.4.1 The actual masses used in the calculation of cleaning efficiency shall be the specific measured concentration of contaminant.

N 12.6.5.4.2 If the measured mass is below the detection limit, a value of "0" shall be used.

N 12.6.5.5 The average cleaning efficiency shall be determined for all contaminants.

N 12.6.5.5.1 If any cleaning efficiencies are indicated as being above 100 percent, a cleaning efficiency of 100 percent shall be used for the purpose of calculating the average cleaning efficiency.

N 12.6.5.5.2 If any cleaning efficiencies are indicated as being below 0 percent, a cleaning efficiency of 0 percent shall be used for the purpose of calculating the average cleaning efficiency.

N 12.6.5.5.3 If any analytical anomaly that cannot be rationalized on the basis of the data set and other measurements is encountered for the analysis of a specific contaminant, discarding one contaminant from the calculation of the average cleaning efficiency shall be permitted.

N 12.6.5.6* Alternative procedures for the analysis of specimens specified in 12.6.5.1 through 12.6.5.3 shall be permitted, provided that the procedures take the concentrations of the controls into account by providing sufficient sensitivity to allow for the measurement of a 1.0 percent difference or lower in cleaning efficiency.

N 12.7 Heavy Metal Contaminated Specimen Preparation, Extraction, and Analysis.

N 12.7.1 Selection of Contaminants.

N 12.7.1.1 A certified solution shall be obtained that contains the following metals, each at a concentration of 100 ppm:

(1) Antimony
(2) Arsenic
(3) Cadmium
(4) Chromium
(5) Cobalt
(6) Lead

N 12.7.1.2 Alternative techniques for preparing a mixture of the target heavy metal contaminants shall be permitted if it can be demonstrated that the heavy metal concentrations are 100 ppm ± 10 ppm.

N 12.7.2 Procedures for Contamination of Specimens.

N 12.7.2.1 All handling of specimens and metal solutions shall be performed while wearing disposable gloves. Use of glassware for contamination or extraction shall not be permitted as the use of these items can lead to cross contamination.

N 12.7.2.2 Outer shell fabric prepared as specified in 12.4.3.2 shall be cut into 25 mm × 50 mm (1 in. × 2 in.) specimens, and the weight of each specimen shall be recorded in grams to the nearest 0.001 g.

N 12.7.2.3* Using tweezers, one specimen shall be horizontally placed on a wire rack or other suitable support structure that minimizes the contact of the bottom surface of the specimens with the table or counter service.

N 12.7.2.4 A volume of 1.0 mL of a 100 ppm metals standard solution shall be pipetted onto each fabric specimen.

N 12.7.2.4.1 The operator shall ensure that the specimen is at the bottom of the plastic tube and sufficiently wetted by the metals standard solution.

N 12.7.2.4.2 A total volume of 500 µL of the metals standard solution shall be pipetted and allowed to dry before pipetting the remaining 500 µL.

N 12.7.2.4.3* The operator shall ensure that all applied metals standard solution remains on the specimen.

N 12.7.2.4.4 Contaminated specimens shall be permitted to be dried in an oven at 50°C ± 5°C for up to 60 minutes.

N 12.7.2.5 The weight of the contaminated specimens shall be recorded in grams to the nearest 0.001 g.

N 12.7.2.6 After the specimens have been allowed to fully dry, plastic tweezers shall be used to insert specimens into metal-free plastic tubes.

N 12.7.2.7 The amount of standard solution on the specimen shall be verified using the following equation:

[12.7.2.7]

$$\text{amount of standard solution applied } (\mu g) = \left[\text{final specimen weight } (g) - \text{initial specimen weight } (g)\right] \times 1000\ \mu g/g$$

N 12.7.3 Extraction of Specimens.

N 12.7.3.1 Acid Digestion.

N 12.7.3.1.1 Each specimen shall be added to an individual PFA microwave reaction vessel.

N 12.7.3.1.2 A volume of 10 mL (⅓ oz) concentrated nitric acid, approximately 70 percent weight/volume, shall be added to each PFA reaction vessel.

N 12.7.3.1.3 Each PFA reaction vessel shall be microwaved at 1600 W, 90 percent power, for 20 minute at 170°C (338°F) and held for 30 minutes for a total 50-minute cycle.

N 12.7.3.1.4 The specimens in the PFA reaction vessels shall be allowed to cool for approximately 30 minutes.

N 12.7.3.1.5* Modifications to the specimen acid digestion procedures provided in 12.7.3.1.1 through 12.7.3.1.4 shall be permitted, provided that extraction recovery average efficiencies of 90 percent or better can be demonstrated.

N 12.7.3.2 Filtration.

N 12.7.3.2.1 The gravitation filtration system shall be set up using a grade 40 quantitative ashless (0.007 percent ash maximum) filter paper and plastic beakers for the filter solution.

N 12.7.3.2.2 The PFA microwave reaction vessel shall be carefully opened in the vent hood away from lab technicians due to the potential release of nitric acid fumes.

N 12.7.3.2.3 A volume of 10 mL (⅓ oz) deionized water shall be added to the microwave reaction vessel and the reaction vessel shall be turned over three times.

N 12.7.3.2.3.1 The reaction vessel shall be permitted to "breathe" if needed by opening the lid to off-gas.

N 12.7.3.2.4 Deionized water and the acid-digested sample mixture shall be poured into the filter setup.

N 12.7.3.2.5 The addition of deionized water shall be repeated to microwave reaction vessel two more times, for a total of 30 mL deionized water rinsed through microwave reaction vessel.

N 12.7.3.2.6 The resulting solution shall be filtered thoroughly once, then a second time, rinsing the filter paper with a small amount (<5 mL) of deionized water both times.

N 12.7.3.2.7 Each sample solution shall be brought to a volume of 40 mL (1.35 oz) volume using deionized water.

N 12.7.3.2.8 The sample solution shall be vortexed.

N 12.7.3.2.9* Modifications to the specimen filtration procedures provided in 12.7.3.2.3.1 through 12.7.3.2.8 shall be permitted, provided that extraction recovery average efficiencies of 80 percent or better can be demonstrated.

N 12.7.3.3 Instrument Sample Preparation.

N 12.7.3.3.1 An internal standard shall be prepared in a 100 mL (3.38 oz) volumetric flask to receive 10 ppb using the following constituents:

(1) 2 percent nitric acid
(2) 0.2 mL of 100 ppm Ga
(3) 0.2 mL of 100 ppm In
(4) 0.2 mL of 100 ppm La

N 12.7.3.3.2 A 1 mL volume of the extracted sample and a 25 µL volume of the internal standard shall be added to a 10 mL volumetric flask and diluted to volume with 2 percent nitric acid, and the resultant sample shall be vortexed.

N 12.7.3.3.3 A 10 mL (⅓ oz) sample of each instrument calibration standard shall be prepared at the following concentrations using 2 percent nitric acid to bring volume to 10 mL (⅓ oz):

(1) 0 ppb (to serve as blank)
(2) 100 ppb
(3) 1 ppm
(4) 10 ppm
(5) 100 ppm

N 12.7.3.3.4 The internal standard shall be added.

N 12.7.3.3.4.1 Once the test method recovery is established, the use of the internal standard shall be permitted to be optional.

N 12.7.3.3.5 All samples shall be vortexed.

N 12.7.3.3.6 Alternative sample preparation up procedures in lieu of 12.7.3.3.2 and 12.7.3.3.3 shall be permitted if a suitable scheme for demonstrating calibration of the respective metals achieved a linear correlation coefficient of 0.90 or better.

N 12.7.4 Analysis of Specimens.

N 12.7.4.1 Instrumentation Set-Up.

N 12.7.4.1.1 An inductively coupled plasma-mass spectrometer (ICP-MS) shall be prepared using the following method parameters to include those metals of interest:

(1) Sweeps/readings: 20
(2) Readings/replicates: 1
(3) Number of replicates: 3
(4) Dwell time: 50.0 ms
(5) Mode: KED
(6) RPq: 0.25
(7) Detector mode: Dual
(8) Measurement units: Counts
(9) Automatic lens: On
(10) Spectral peak processing: Sum
(11) Signal profile processing
(12) Baseline readings: 0
(13) Smoothing: Yes, Factor 5

N 12.7.4.1.2 The blank, all samples, and instrument calibration standards shall be run on ICP-MS.

N 12.7.4.1.3* An alternative analytical technique shall be permitted if it demonstrates sensitivity to the respective metals to a minimum of 100 ppb, provides for a linear calibration for determining each metal concentration with a correlation coefficient of 0.90 or better, and permits the ability for discerning a difference of 1.0 percent or lower in cleaning efficiency.

N 12.7.4.2 Data Analysis.

N 12.7.4.2.1 The slope, intercept, and regression coefficient shall be calculated using standard metal solutions (0 ppb–100 ppm).

N 12.7.4.2.2 The calculated slope and intercept shall be used to calculate the concentration of each individual metal each digested fabric swatch (ppb) in the 10 mL vial described in 12.7.3.3.1 using the following equation:

[12.7.4.2.2]

$$\text{metal concentration (ppb)} = \frac{\text{metal ion counts} - \text{metal ion intercept}}{\text{metal ion slope}}$$

N 12.7.4.2.3 The calculated concentration in ppb shall be used to calculate the mass in µg of each metal in the original 40 mL vial described in 12.7.3.3.3.

N 12.7.4.2.3.1 A correction factor of 0.401 shall be used as calculated by the two dilution factors in the following equation:

[12.7.4.2.3.1]

$$0.010025\ \text{L} \times 0.040\ \text{L} = 0.000401\ \text{L}$$

N 12.7.4.2.4 The blank and blank specimen from each contaminated specimens shall be subtracted.

N 12.7.4.2.5 The cleaning efficiency shall be calculated using the following equation:

[12.7.4.2.5]

$$\text{cleaning efficiency} = \frac{\mu\text{g metals}_1 - \mu\text{g metals}_f}{\mu\text{g metals}_i} \times 100 \text{ percent}$$

N 12.7.4.2.5.1 If any cleaning efficiencies are indicated as being above 100 percent, a cleaning efficiency of 100 percent shall be reported.

N 12.7.4.2.5.2 If any cleaning efficiencies are indicated as being below 0 percent, a cleaning efficiency of 0 percent shall be reported.

N 12.7.4.2.5.3 If any analytical anomaly that cannot be rationalized on the basis of the data set and other measurements is encountered for the analysis of a specific contaminant, discarding one contaminant from being reported and interpreted for the determination of heavy metal cleaning efficiencies shall be permitted.

N 12.7.4.2.6 The percent recovery shall be calculated using the following equation:

[12.7.4.2.6]

$$\frac{\mu\text{g extracted}}{\mu\text{g deposited onto individual fabric swatch}} \times 100 \text{ percent}$$

N 12.8 Bacterial Contaminated Specimen Preparation, Extraction, and Analysis.

N 12.8.1 Preparation of Test Microorganisms.

N 12.8.1.1 Testing shall be performed in accordance with Section 9 of ASTM E2274, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants*, with the following modifications:

(1) The test microorganisms shall be *Klebsiella pneumoniae* (ATCC 4352) and *Staphylococcus aureus* (ATCC 6538).
(2) A soil load shall not be added to the inoculum.

N 12.8.1.2* Modifications in the procedures for the preparation of test microorganisms shall be permitted if the laboratory can demonstrate viability of alternate procedures used to prepare cultures for both *Klebsiella pneumoniae* (ATCC 4352) and *Staphy-*

lococcus aureus (ATCC 6538) to be used in the contamination step specified in 12.8.2.

N 12.8.2 Procedures for Contamination of Specimens.

N 12.8.2.1 All handling of specimens and metal solutions shall be performed while wearing disposable gloves.

N 12.8.2.2 Outer shell fabric prepared as specified in 12.5.3.2 shall be cut into 25 mm × 38 mm (1 in. × 1.5 in.) specimens.

N 12.8.2.2.1 An additional outer shell specimen shall be prepared as specified in 12.8.2.2 for the verification of the sterilization process specified in 12.8.2.3 and subjected to suitable sterilization assurance procedures.

N 12.8.2.3 The outer shell specimens shall be wrapped in aluminum protective foil and autoclaved for 90 minutes at 121°C (250°F).

N 12.8.2.4 Each specimen to be contaminated shall be inoculated with 0.03 mL of the prepared inoculum for the respective type of bacteria by dispersing the inoculum in such a way that covers as much of the specimen area as possible.

N 12.8.2.4.1 Individual specimens shall be inoculated with only one type of bacteria.

N 12.8.2.5 The contaminated specimens shall be placed in an individual petri dish and incubated at 37°C (98.6°F) for 30 minutes.

N 12.8.2.6 Following incubation, the specimen shall be kept in a refrigerator at 4°C (39°F) until ready for shipping.

N 12.8.2.7* Modifications to the procedures in 12.8.2.1 and 12.8.2.2 for the contamination of specimens shall be permitted if the laboratory can demonstrate consistency of bacterial counts as part of alternative procedures in the preparation of contaminated specimens for each bacterium.

N 12.8.3 Analysis of Specimens for Bacterial Contamination.

N 12.8.3.1 Specimens shall be analyzed for bacterial contamination in accordance with Sections 12.12, 13, and 15 of ASTM E2274, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants*, with the following modifications:

(1) A 5-hour threshold shall be used to calculate the initial concentration of viable bacterial cells attached to the specimen that could not be estimated at the initial inoculation.
(2) A polymerase chain reaction (PCR) detection method shall be permitted to be used to identify and quantify the levels of microorganisms present on the test specimens.
(3) Viable bacterial levels shall be determined by colony-counting techniques for establishing the number of colony forming units (CFU).
(4) A minimum average of 1.0×10^3 CFU/specimen shall be able to be recovered for a valid test.

N 12.8.3.2 The $\log_{10}$ reduction shall be determined using the following steps:

(1) The average bacterial count for contaminated specimens that were subjected to sanitization will be determined separately for each bacterium and shall be converted to a $\log_{10}$ value.
(2) The bacterial count for the contaminated, traveling specimen shall be converted to a $\log_{10}$ value.
(3) The $\log_{10}$ reduction shall be calculated using the equation below:

[12.8.3.2]

$$\log_{10} \text{ reduction} = \log_{10}(\text{contaminated, traveling}) - \log_{10}(\text{average contaminated, sanitized})$$

(4) The $\log_{10}$ value for the bacterial count of the contaminated, control specimens shall be permitted to be used in place of the contaminated, travel specimen, subject to the requirement in 12.5.4.4.1(1).

N 12.8.3.3 Other control specimens including the noncontaminated specimens shall be used to assess the viability of the procedures and the potential for cross-contamination with foreign bacteria as needed to determine $\log_{10}$ reduction due to the application of sanitization procedures.

N 12.8.3.4* Modifications to the analysis procedures provided in 12.8.3.1 through 12.8.3.3 shall be permitted if the alternative methods are able to achieve viable bacterial counts in specimens subjected to the sanitization process for determination of $\log_{10}$ reductions for the "sanitized" contaminated specimens as compared to the contaminated, traveling specimens.

N 12.9 Preparation and Handling of Contaminated Specimens and Surrogate Clothing.

N 12.9.1 Preparation of Surrogate Garments.

N 12.9.1.1 Surrogate garment outer shells shall be made from an undyed 60 percent para-aramid/40 percent polybenzimidazole (PBI) base fabric with a reinforcement grid meeting the following specifications:

(1) The outer shell fabric shall have a unit area weight of 240 g/m^2 to 268 g/m^2 (7.1 oz/yd^2 to 7.9 oz/yd^2).
(2) The outer shell fabric shall have a thickness of 0.584 mm ± 0.254 mm (0.023 in. ± 0.10 in.).
(3) The outer shell fabric shall have a water absorption resistance of less than 5 percent when tested in pristine condition in accordance with Section 8.25 of NFPA 1971.

N 12.9.1.2 Fabric used for the creation of the sample mesh pockets on each garment shall be an aramid-based, warp-knit, mesh-style fabric having an open area of 40 to 60 percent and a unit area weight ranging from 220 g/m^2 to 270 g/m^2 (6.5 oz/yd^2 to 8.0 oz/yd^2).

N 12.9.1.3 Surrogate garments shall consist of a surrogate coat and surrogate pants.

N 12.9.1.4 Surrogate coats shall be made from a single layer of outer shell fabric using appropriate seams, finished edges, and mesh pockets with thread that complies with the respective requirements of NFPA 1971, and shall be fabricated as shown in Figure 12.9.1.4 with the following additional specifications:

(1) Surrogate coats shall be prepared with a body width of 74 cm ± 5 cm (29 in. ± 2 in.) and a sleeve length of 47 cm ± 5 cm (18½ in. ± 2 in.) when measured from the top of coat seam to the end of the sleeve hem.
(2) Surrogate coats shall not have front closures, collars, coat sleeve end reinforcements, hardware, or any other materials not specified in this section.
(3) Each surrogate coat shall have a 254 mm × 254 mm (10 in. × 10 in.) outer shell pocket positioned on the front lower left side of the garment, approximately 50 mm (2 in.) from the bottom hem and 50 mm (2 in.)

from the left side seam, that is secured using a double needle seam and has a top finished edge with a 152 mm (6 in.) strip of hook-and-loop closure to secure the top of the pocket.

(4) Each surrogate coat shall have a 75 mm (3 in.) wide strip of reflective trim compliant with the respective requirements of NFPA 1971 sewn 75 mm (3 in.) above the bottom hem of the coat and on each sleeve at 75 mm (3 in.) above the bottom edge of the sleeve end.

(5) Each surrogate coat shall have three 152 mm × 152 mm (6 in. × 6 in.) sample mesh pockets in accordance with the following requirements:

(a) The pockets shall be positioned on the front of the garment and numbered as indicated in Figure 12.9.1.4.

(b) One pocket shall be positioned on top right side (Pocket 1), a second pocket shall be positioned in the center inside of the lower left side pocket (Pocket 2), and a third pocket shall be positioned on the upper right sleeve (Pocket 3).

(c) The openings of all three pockets shall be oriented toward the top.

(d) The pockets shall include a 101 mm (4 in.) strip of 21 mm (0.8125 in.) hook-and-loop tape for securing the open end of the pocket.

N **12.9.1.5** Surrogate pants shall be made from a single layer of outer shell fabric using appropriate seams, finished edges, and mesh pockets with thread that complies with the respective requirements of NFPA 1971, and shall be fabricated as shown in Figure 12.9.1.5 with the following additional specifications:

(1) Surrogate pants shall be prepared with a 56 cm ± 5 cm (22 in. ± 2 in.) width at the garment waist and an inseam length of 76.2 cm ± 5.0 cm (30 in. ± 2 in.) as measured from the garment crotch to the bottom of the pant leg hem.

(2) Surrogate pants shall not have fly closures, suspender hardware, pant hem reinforcements, other hardware, or any other materials not specified in this section.

(3) Each surrogate pant shall have a 254 mm × 254 mm (10 in. × 10 in.) outer shell pocket positioned in the middle of the upper right leg of the garment that is secured using a double needle seam and has a top finished edge with a 152 mm (6 in.) strip of hook-and-loop closure to secure the top of the pocket.

(4) Each surrogate pant shall have a 254 mm × 254 mm (10 in. × 10 in.) coated outer shell fabric reinforcement in the middle of left leg that is secured using a double needle seam and has a top finished edge with a 152 mm (6 in.) strip of hook-and-loop closure to secure the top of the reinforcement.

(5) Each surrogate pant shall have a 75 mm (3 in.) wide strip of reflective trim compliant with the respective requirements of NFPA 1971 attached circumferentially around each lower leg of the garment at 75 mm (3 in.) above the bottom hem of the leg.

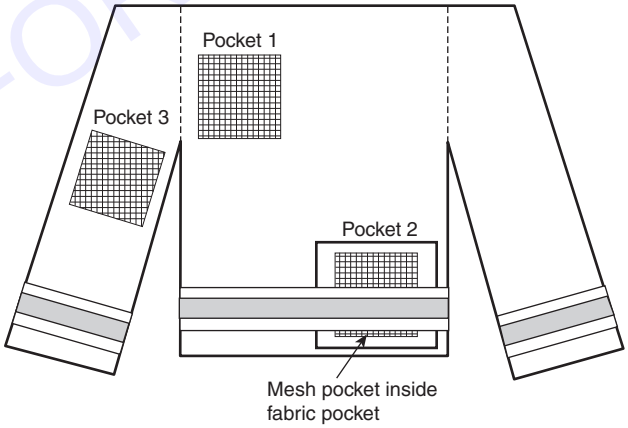
(6) Each surrogate pant shall have three 152 mm × 152 mm (6 in. × 6 in.) sample mesh pockets in accordance with the following requirements:

(a) The pockets shall be positioned on the front of the garment.

(b) One pocket shall be positioned in the middle approximately 101 mm (4 in.) from the waistline (Pocket 1), a second pocket shall be centered inside of the right leg outer shell pocket (Pocket 2), and a third pocket shall be centered inside of the left knee reinforcement pocket (Pocket 3).

(c) The openings of all three pockets shall be oriented toward the top, as shown in Figure 12.9.1.5.

(d) The pockets shall include a 101 mm (4 in.) strip of 21 mm (0.8125 in.) hook-and-loop tape for securing the open end of the pocket.



N **FIGURE 12.9.1.4 Design and Locations of Sample Mesh Pockets on Surrogate Coats.**

N **12.9.1.6** Surrogate garments shall be subjected to an advanced cleaning by the verification organization prior to use by the cleaning facility.

N **12.9.2 Preparation of Ballast Fabric-Based Wash Panels.**

N **12.9.2.1** Four different ballast fabric–based wash panels — Panel A, Panel B, Panel C, and Panel F — shall be prepared from the ballast materials specified in 12.4.4.3 according to the instructions provided in 12.9.2.2 through 12.9.2.5. All panel edges shall be unfinished. Panel D shall be the surrogate coat and Panel E shall be the surrogate pants prepared according to 12.9.1.

N **12.9.2.2** Panel A shall be a 686 mm × 686 mm (27 in. × 27 in.) square with two 508 mm (20 in.) slits set 152 mm (6 in.) from each edge as shown in Figure 12.9.2.2.

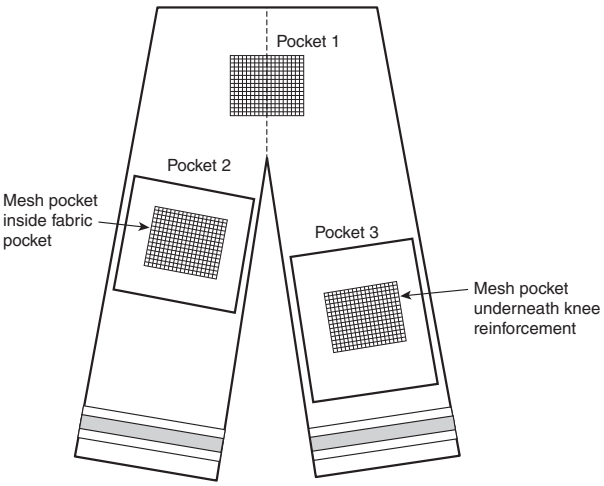
N **12.9.2.3** Panel B shall be a 686 mm × 1500 mm (27 in. × 59 in.) rectangle with two bisecting 560 mm (22 in.) slits originating from opposite sides on the shorter dimensions of the shape as shown in Figure 12.9.2.3.

N **12.9.2.4** Panel C shall be a 686 mm × 1500 mm (27 in. × 59 in.) rectangle with two sets of two bisecting 560 mm (22 in.) slits originating from opposite sides on the shorter dimensions of the shape, spaced at 229 mm (9 in.) intervals from each edge and from each other, as shown in Figure 12.9.2.4.

N **12.9.2.5** Panel F shall be a total of three rectangular panels that measure 228 mm × 750 mm (9 in. x 29.5 in.) as shown in Figure 12.9.2.5.

N **12.9.2.6** Panel D shall be depicted as shown in Figure 12.9.2.6.

N **12.9.2.7** Panel E shall be depicted as shown in Figure 12.9.2.7.



N FIGURE 12.9.1.5 Design and Locations of Sample Mesh Pockets on Surrogate Pants.

N 12.9.3 Preparation of Wash Load.

N 12.9.3.1 Panel A shall be folded and placed into the wash load as shown in Figure 12.9.3.1.

N 12.9.3.2 Panel B shall be folded and placed into the wash load as shown in Figure 12.9.3.2.

N 12.9.3.3 Panel C shall be folded and placed into the wash load as shown in Figure 12.9.3.3.

N 12.9.3.4 Panel D shall be folded and placed into the wash load as shown in Figure 12.9.3.4.

N 12.9.3.5 Panel E shall be folded and placed into the wash load as shown in Figure 12.9.3.5.

N 12.9.3.6 Panel F shall be folded and placed into the wash load as shown in Figure 12.9.3.6.

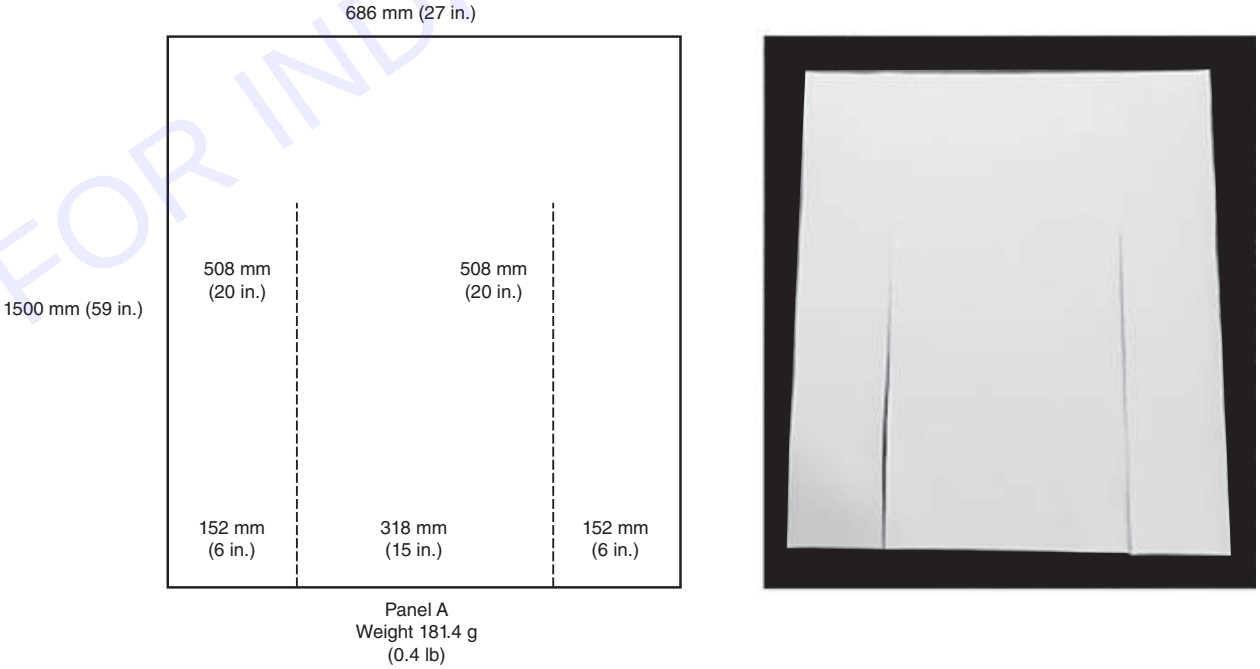
N 12.9.3.7 The panels shall be placed in the washer/extractor according to the sequence provided in Figure 12.9.3.7(a), starting at the bottom, and depicted in Figure 12.9.3.7(b) through Figure 12.9.3.7(f).

N 12.9.3.7.1 It shall be permitted to place the wash load with all of the panels at a 90-degree angle with respect to their orientations shown in 12.9.3.7.

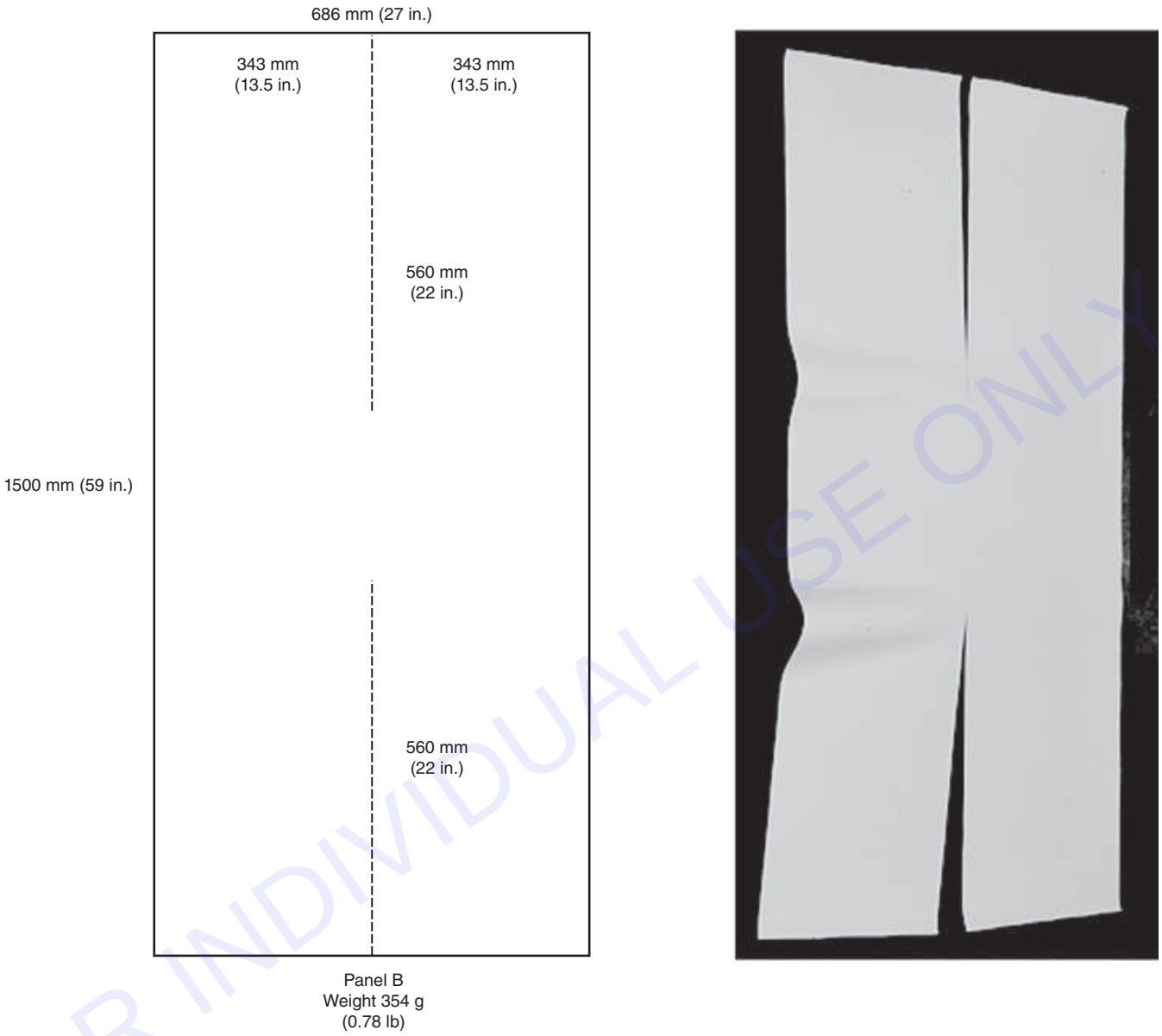
N 12.9.3.8* The sequencing of panels shall be as follows:

(1) The sequencing shall be repeated for attaining a wash load with the mass capacity, ± 5 percent, as specified by the cleaning facility.
(2) Panel D and Panel E shall be alternated in the sequencing.
(3) A total of three panels each shall be used for Panel D and Panel E.
(4) Panel D and Panel E shall alternatively be evenly distributed within the wash load so that there are a near equal number of nonsurrogate panels between each surrogate garments (Panel D or Panel E).
(5) It shall be permissible to adjust the sequence of the panels to meet the requirements of 12.9.3.8(1) through 12.9.3.8(4) in order to attain the target wash load mass capacity.

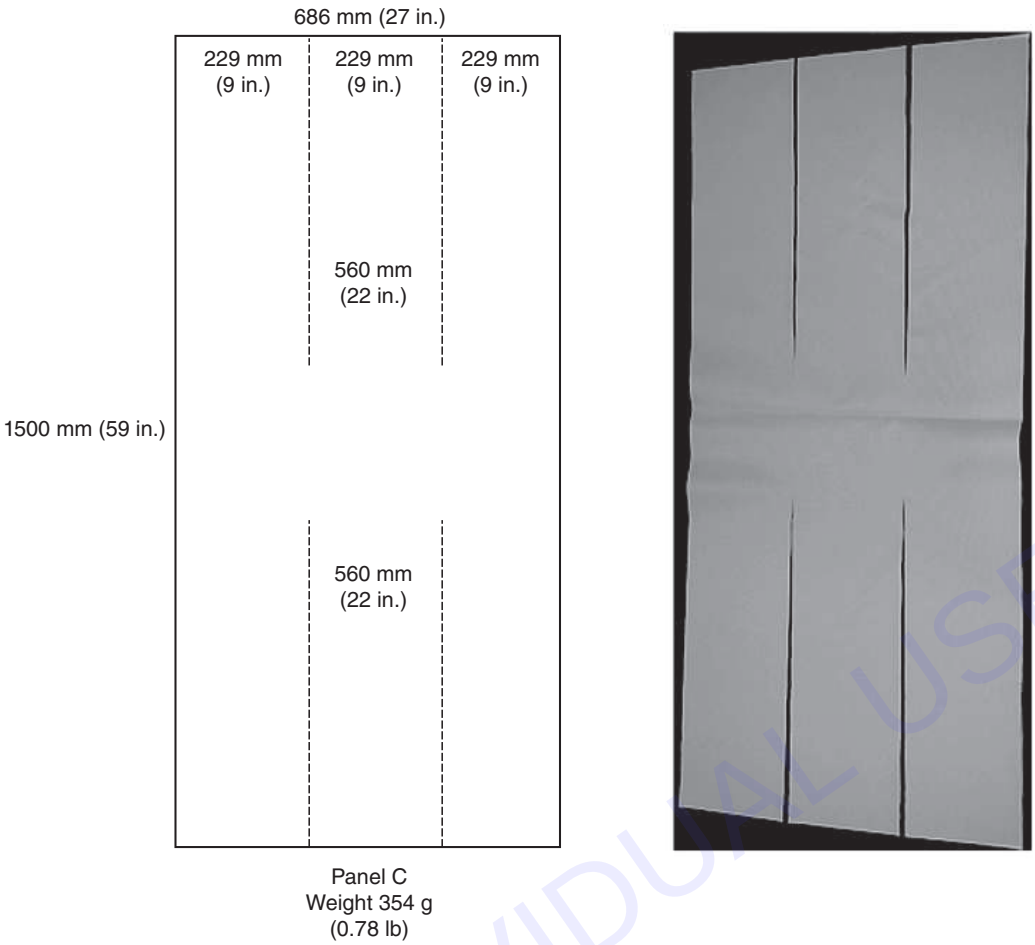
N 12.9.3.9* Adjustments to the use and sequencing of the panels is permitted to attain proper load capacity where the panels open during the cleaning process.



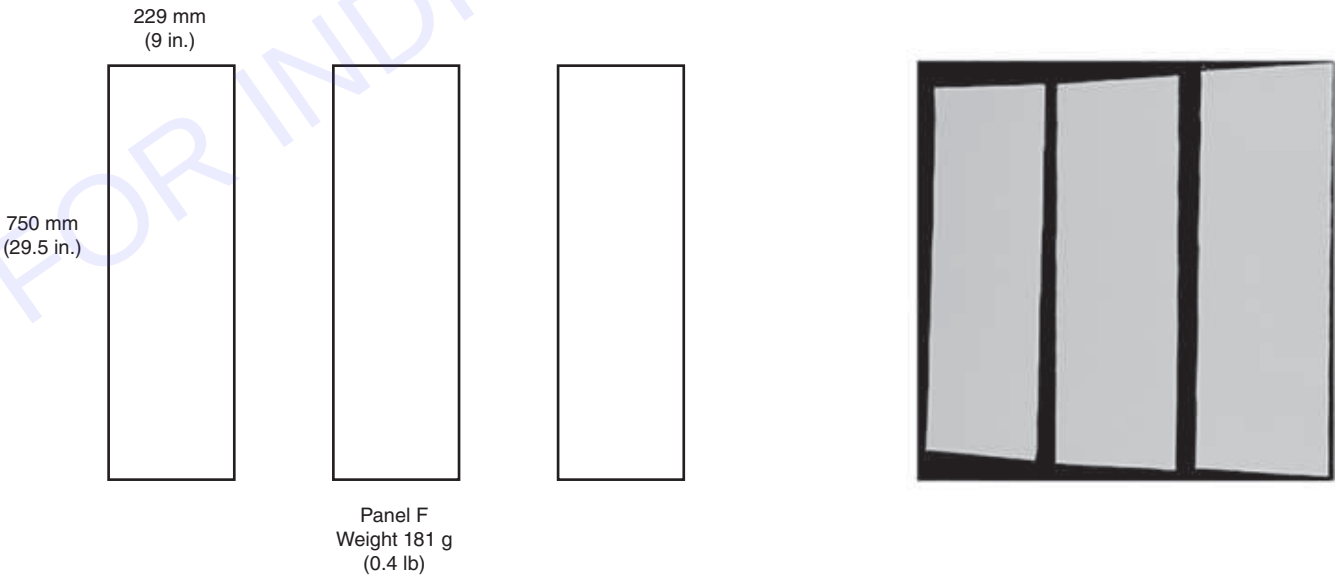
N FIGURE 12.9.2.2 Specifications and Photograph for Panel A.



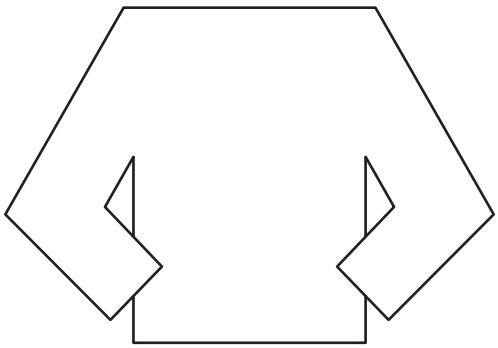
N FIGURE 12.9.2.3 Specifications and Photograph for Panel B.



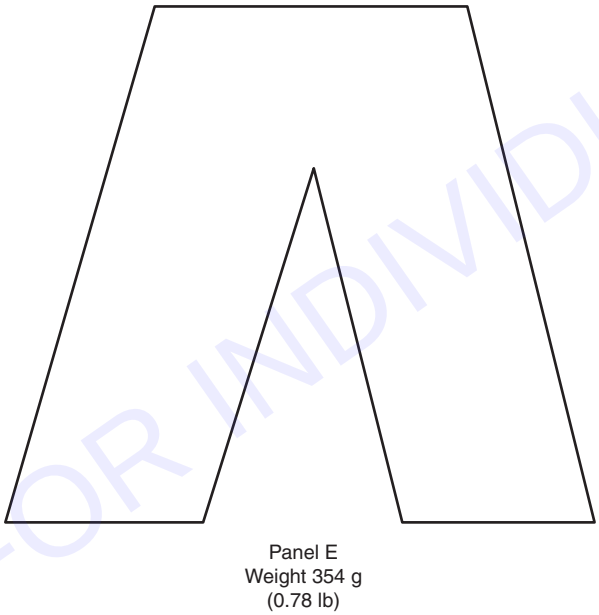
N FIGURE 12.9.2.4 Specifications and Photograph for Panel C.

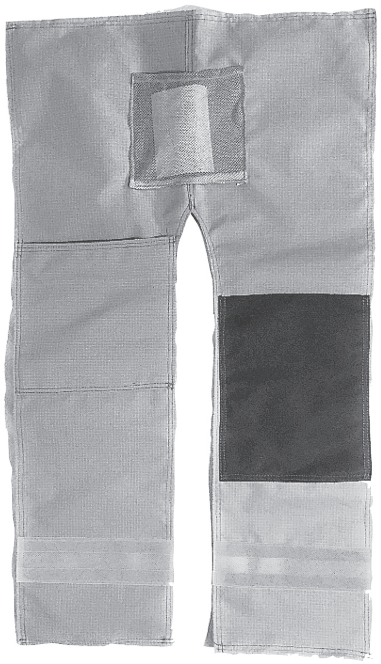


N FIGURE 12.9.2.5 Specifications and Photograph for Panel F.

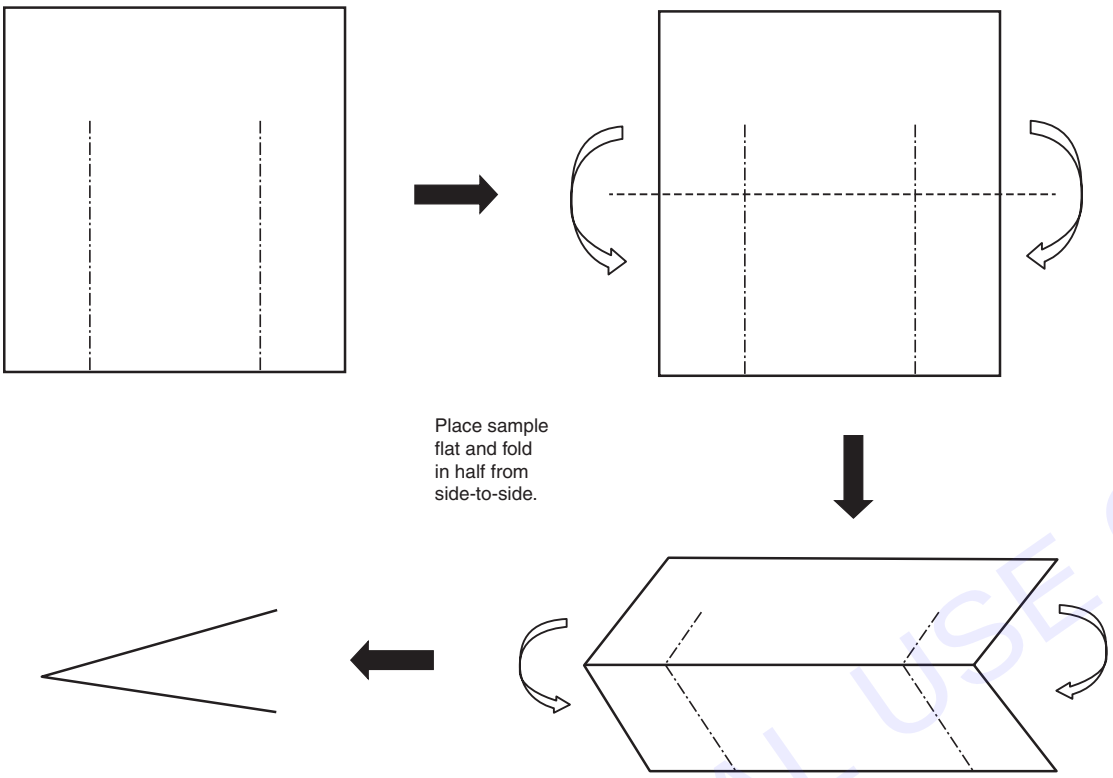


N **FIGURE 12.9.2.6 Diagram and Photograph for Panel D.**

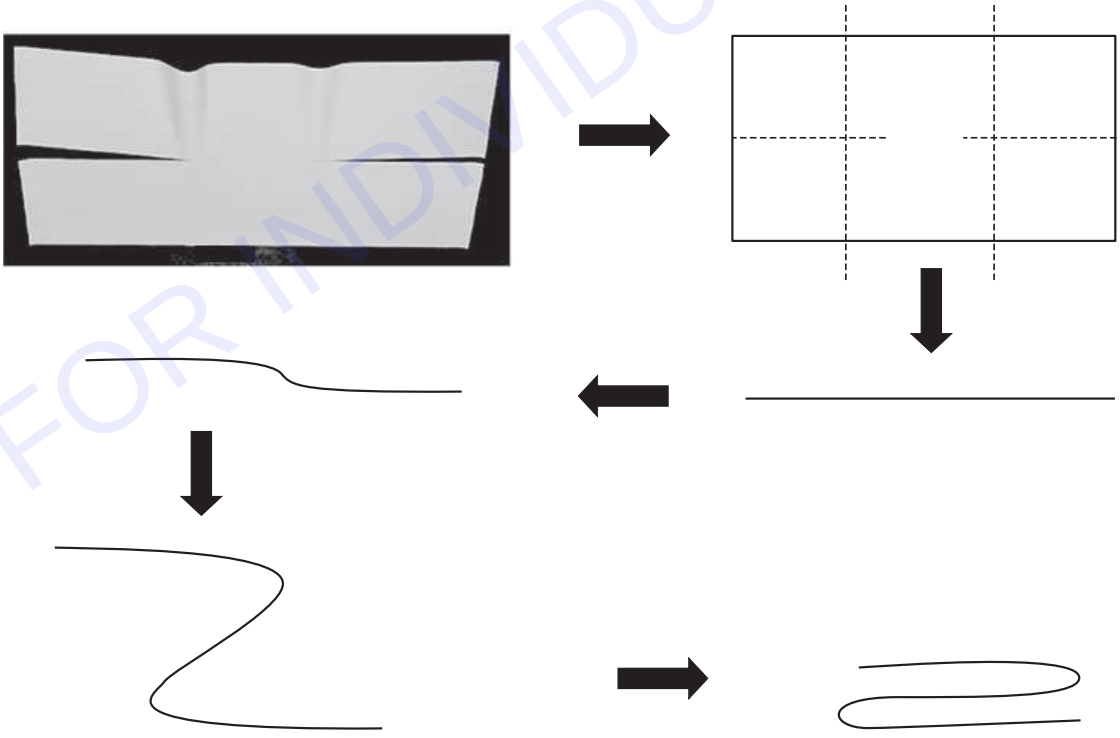




N **FIGURE 12.9.2.7 Diagram and Photograph for Panel E.**

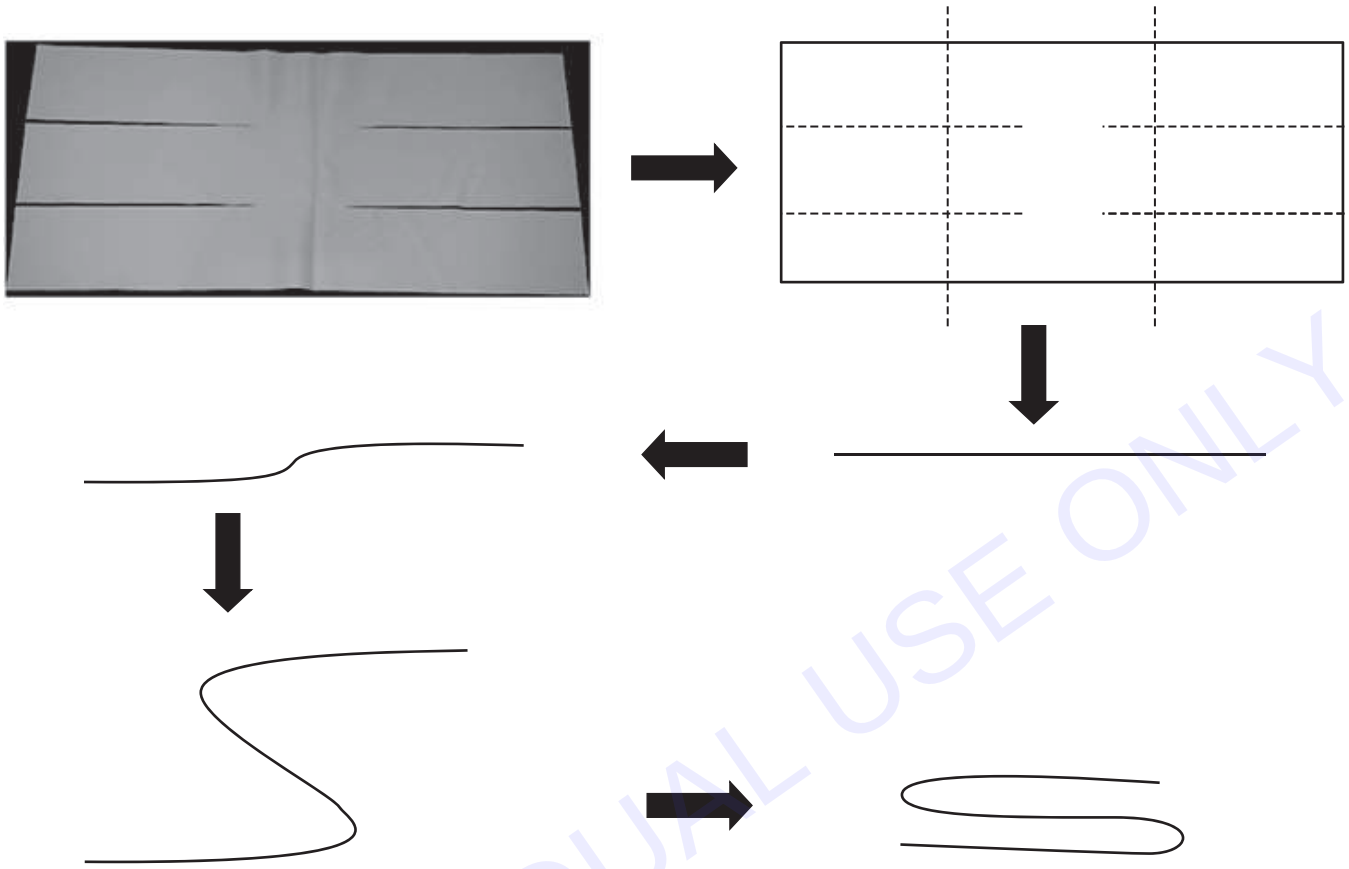


N **FIGURE 12.9.3.1 Steps for Folding and Placing Panel A into Wash Load.**



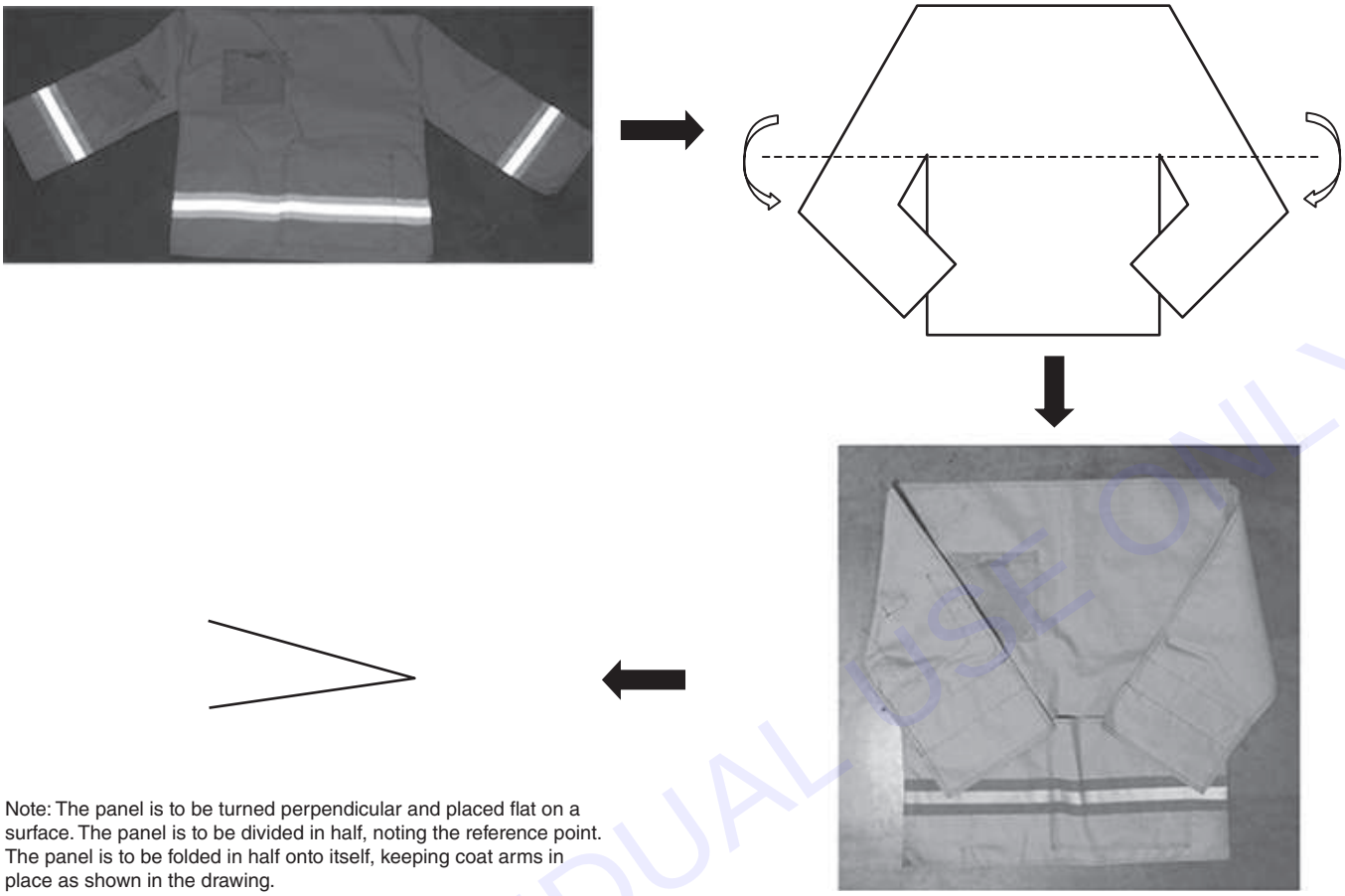
Note: Panel B is to be divided in thirds. Using these reference points, Panel B is to be grabbed at each line above and the left fold is to be pulled under the right fold until material is flat on itself.

N **FIGURE 12.9.3.2 Steps for Folding and Placing Panel B into Wash Load.**



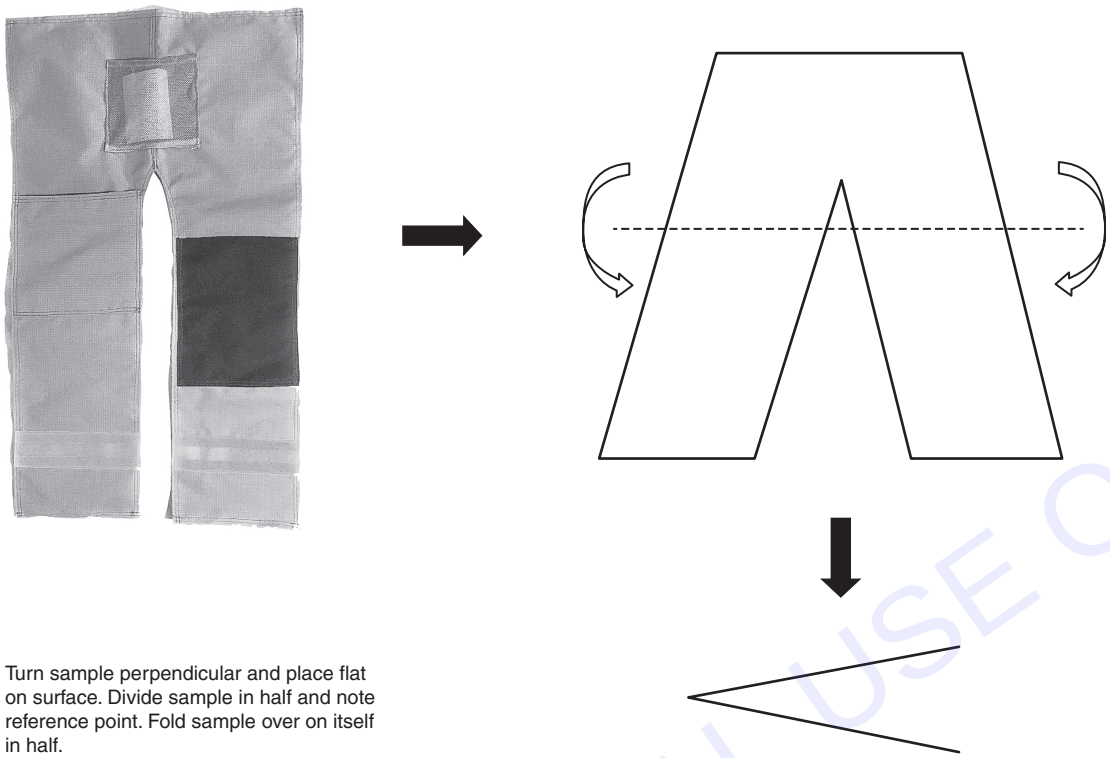
Note: The panel is to be divided in thirds. Using these reference points, Panel B is to be grabbed at each line above, and the right fold is to be pulled under the left fold until material is flat on itself.

N **FIGURE 12.9.3.3 Steps for Folding and Placing Panel C into Wash Load.**

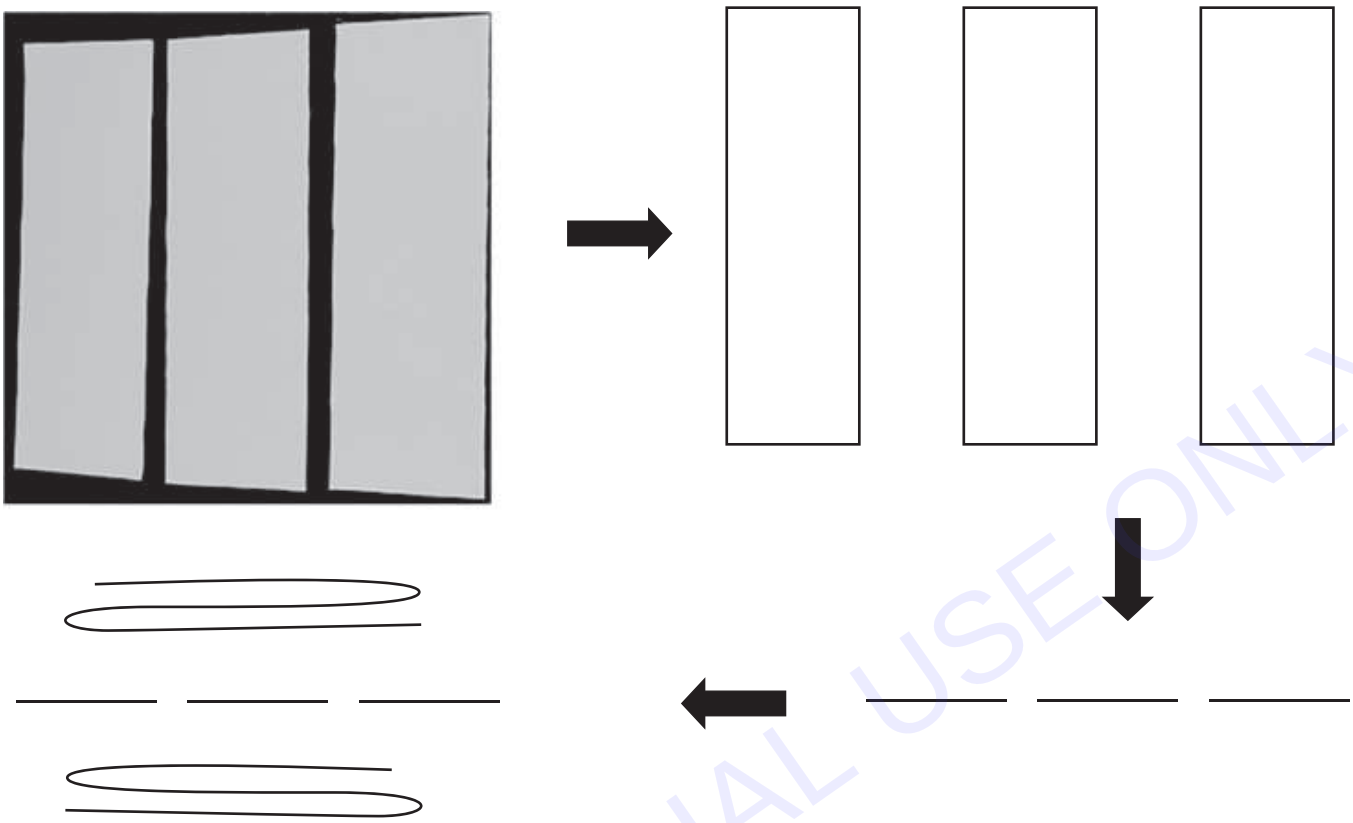


Note: The panel is to be turned perpendicular and placed flat on a surface. The panel is to be divided in half, noting the reference point. The panel is to be folded in half onto itself, keeping coat arms in place as shown in the drawing.

N **FIGURE 12.9.3.4 Steps for Folding and Placing Panel D into Wash Load.**

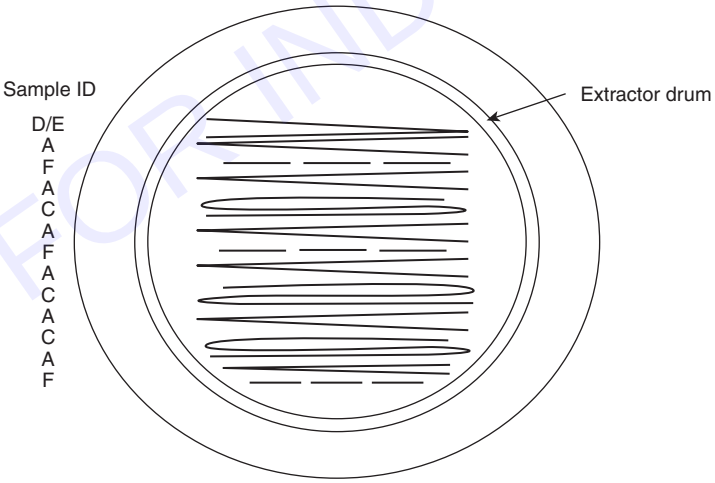


N **FIGURE 12.9.3.5 Steps for Folding and Placing Panel E into Wash Load.**



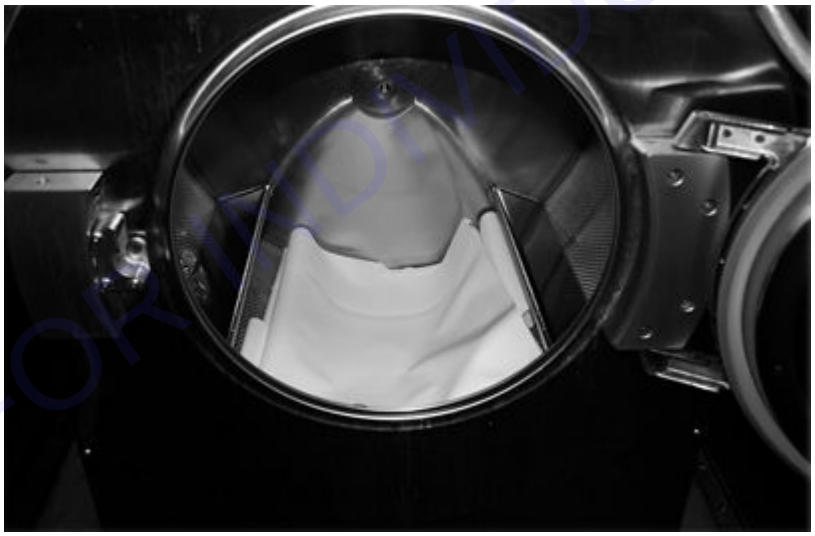
Note: The panels are to be laid flat and placed across the preceding ballast sample, oriented from front to back of the wash load.

N FIGURE 12.9.3.6 Steps for Folding and Placing Panel F into Wash Load.

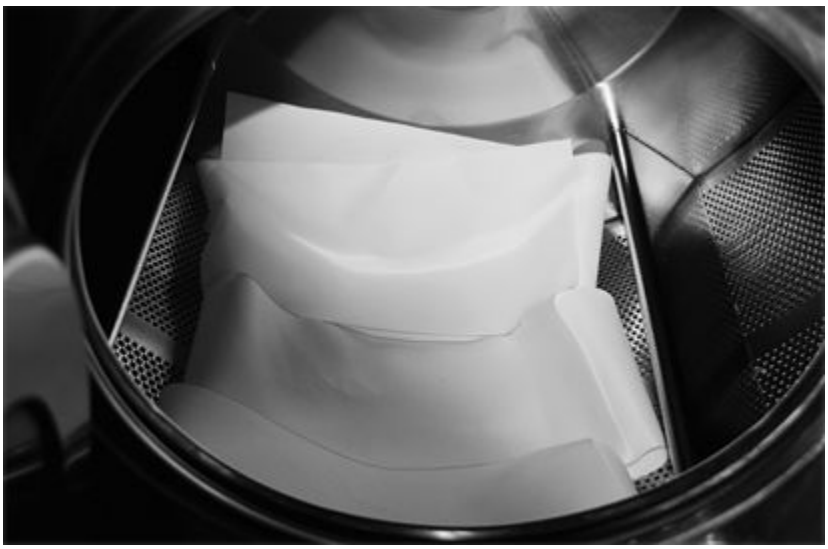


N FIGURE 12.9.3.7(a) Sequence for Placing Panels in Washer/Extractor Drum.

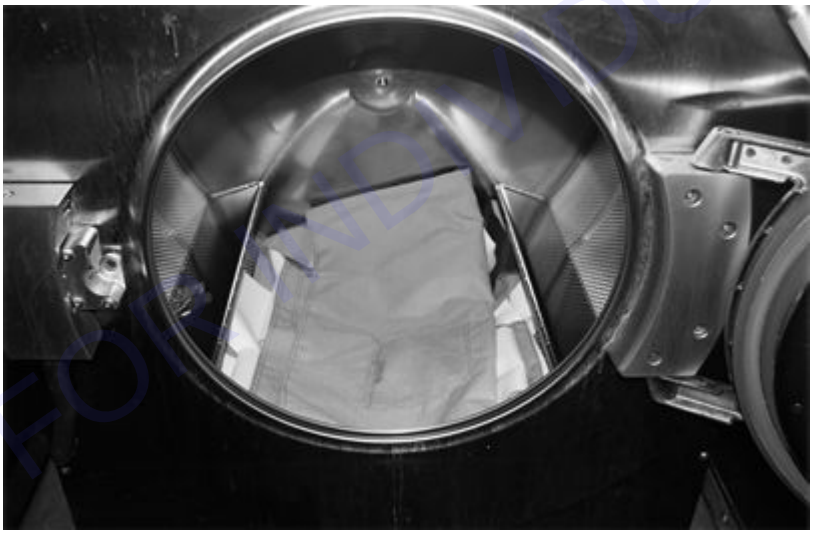
N **FIGURE 12.9.3.7(b) Placement of Panel F (3 Pieces) into Washer/Extractor Drum.**



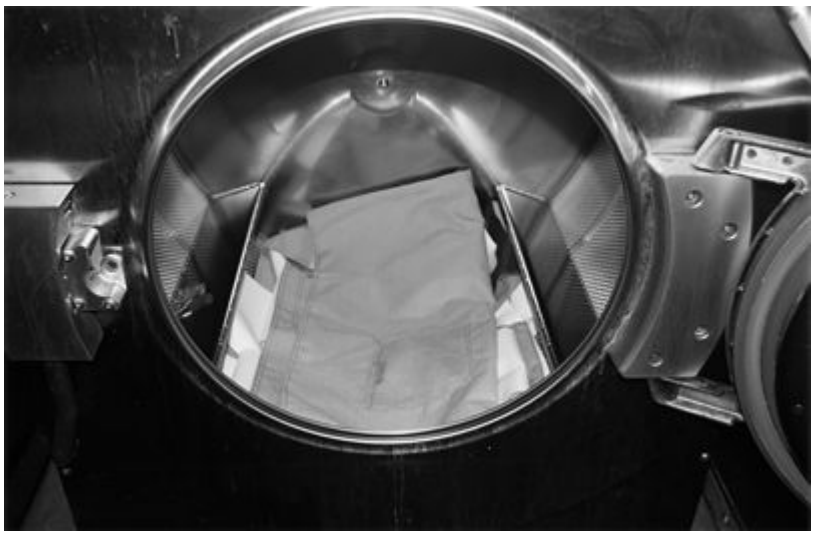
N **FIGURE 12.9.3.7(c) Placement of Panel C into Washer/Extractor Drum.**



N **FIGURE 12.9.3.7(d) Placement of Panel A into Washer/Extractor Drum.**



N **FIGURE 12.9.3.7(e) Placement of Panel D into Washer/Extractor Drum.**



N **FIGURE 12.9.3.7(f) Placement of Panel E into Washer/Extractor Drum.**

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

A.3.2.2 Authority Having Jurisdiction (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.

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N **A.3.3.5 Carcinogen/Carcinogenic.** Lists of carcinogens can be found in the following sources:

(1) U.S. National Toxicology Program (NTP): https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html#toc1
(2) International Agency for Research on Cancer (IARC): http://monographs.iarc.fr/ENG/Classification/
(3) National Institute for Occupational Safety and Health (NIOSH): https://www.cdc.gov/niosh/topics/cancer/npotocca.html
(4) American Conference of Governmental Industrial Hygienists (ACGIH): *2016 Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs)*

Each organization classifies specific substances or activities as being carcinogenic in different ways.

The products of combustion (smoke and fire gases) at a typical residential structural fire are a common source of carcinogens for fire fighters. As of 2007, IARC has classified occupational exposure as a fire fighter as a Class 2B carcinogen (possibly carcinogenic to humans).

A.3.3.8 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 (e.g., chlorine and ammonia) are identified as potential chemical terrorism agents because of their availability and the degree of injury they could inflict.

Biological terrorism agents are bacteria, viruses, or toxins derived from biological material. The CBRN ensemble protects against biological particles dispersed as aerosols and liquid-borne pathogens. Airborne biological terrorism agents could be dispersed in the form of liquid aerosols or solid aerosols (e.g., a powder of bacterial spores). Liquid-borne pathogens could be encountered during a terrorism incident as a result of deliberate disposal or from body fluids released by victims of other weapons (e.g., explosives, firearms).

CBRN ensembles protect from radiological particulates dispersed as aerosols. The protection is defined for blocking or filtering airborne particulate matter and liquid and solid 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.

N **A.3.3.12 Cleaning.** Cleaning is considered separate from the use of disinfectants and sanitizers; however, some cleaning processes might also effectively remove biological contamination. Removal of biological contamination is covered under disinfection and sanitization *(see Section 7.4)*.

A.3.3.12.1 Advanced Cleaning. Advanced cleaning usually requires that ensemble elements be temporarily taken out of service. Examples include hand washing and machine washing, depending on the type of protective element involved. It should be noted that advanced cleaning might not remove all contaminants.

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A.3.3.12.2 Specialized Cleaning. This level of cleaning involves specific procedures and specialized cleaning agents and processes primarily for the removal of hazardous materials such as bulk chemicals and other designated substances but excluding disinfection or sanitization of microbial contamination. Different approaches can be used for removing specific types of contamination. Specialized cleaning can also be an enhanced form of advanced cleaning.

N **A.3.3.13 Cleaning Facility.** This term is used within the standard to collectively refer to any facility that can be subject to verification for advanced cleaning, sanitization, or both.

N **A.3.3.15 Contamination.** Ensembles and ensemble elements can be exposed to products of combustion and other hazardous materials in several ways through contact with gases/vapors, liquids, or particulates. A fire in which the fire fighter wears SCBA and is exposed to fire smoke, other particulates, and fire gases represents a common source of contamination.

The extent and persistency of the contamination in the ensemble or ensemble element will vary with the type of contaminant, the length of the contamination period, and the means by which the ensemble or ensemble elements are contaminated. In general, contamination that is persistent represents the greatest concern since these forms of contaminants might remain in the clothing for extended periods of time and provide continued exposure to the fire fighter.

Examples of common contaminants found in fires include, but are not limited to, the following:

(1) Heavy inorganic metals (e.g., arsenic, antimony, cadmium, chromium, mercury)
(2) Semi-volatile organic compounds, including but not limited to, the following:
    (a) Polynuclear aromatic hydrocarbons (PAHs) (e.g., anthracene, chrysene, fluoranthene, naphthalene, pyrene)
    (b) Phthalate plasticizers [e.g., benzyl butyl phthalate (BPP), bis(2-ethylhexyl) phthalate (DEHP), dimethyl phthalate]
    (c) Polybrominated diphenyl ether flame retardants (PBDEs) [e.g., pentabromodiphenyl ether (BDE 99), hexabromodiphenyl ether (BDE 153)]
    (d) Polychlorinated biphenyls (PCBs) (e.g., 2,2,3,3,4,4,5,5-Octachlorobiphenyl)
    (e) Substituted phenols (e.g., 2-methylphenol and pentachlorophenol)
(3) Hazardous particulates (e.g., soot, asbestos, silica, lead dust)

In contrast, many volatile organic chemicals such as formaldehyde and benzene, while hazardous, easily evaporate unless bound in the materials used in the element. In addition, carbon particles that make up the majority of smoke actually absorb and hold many products of combustion, resulting in persistent contamination.

Certain materials, components, or portions of an ensemble element or ensemble might be more susceptible to contamination. For example, the textile fabric components of a protective helmet might be more easily contaminated than the hard surface of the helmet shell.

N **A.3.3.21 Decontamination.** Decontamination is specific to the removal or neutralization of contamination whereas cleaning can remove both soiling and contamination. Decontamination might also apply to certain types of specialized cleaning where particular procedures are used to remove or neutralize contaminants other than products of combustion that are found on protective ensembles or elements.

Decontamination might involve mechanical, chemical, thermal, or combined processes for removing or neutralizing contaminants. An example of a mechanical process is where brushing or wiping removes an exterior contaminant from the surface of the element. Chemical processes involve the use of detergents or other cleaning agents that react with or aid in the removal of contaminants from element materials. Heating is one type of a thermal process where higher temperatures could cause certain contaminants to evaporate out of the element materials. Laundering is a form of a combined process where the machine agitation, use of a detergent, and heated water all work together to remove contaminants from the element.

N **A.3.3.22 Disinfectant.** Disinfectants as an antimicrobial agent are considered a pesticide and thus subject to regulations established by the U.S. Environmental Protection Agency (EPA). All disinfectants must be registered with the EPA and meet specific labeling requirements. A listing of currently registered disinfectants can be found at www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants.

Disinfectants are required to be used as specified on the product label as determined by the EPA registration process.

Disinfectants can either be used on hard surfaces such as helmet shells and eye and face protection devices, or be used as a presoak treatment for fabrics and textiles. Appropriately labeled and registered disinfectants can also be used for disinfecting laundry. The specific requirements for demonstrating acceptable performance are found in the following EPA Office of Chemical Safety and Pollution Prevention (OCSPP) product performance test guidelines:

(1) OCSPP 810.2200, "Disinfectants for Use on Hard Surfaces — Efficacy Data Recommendations"
(2) OCSPP 810.2400, "Disinfectants and Sanitizers for Use on Fabrics and Textiles — Efficacy Data Recommendations"

Both of these documents provide for different classifications of disinfectants for their intended use. Classification types include limited (primarily for household use), general or broad spectrum (used in commercial areas), and hospital or

health care. Specific procedures and target microorganisms are utilized to demonstrate the effectiveness of the respective disinfectant. In general, a disinfectant must kill all target microorganisms.

See A.7.4.3 for more information on registered disinfectants.

A.3.3.23 Drag Rescue Device. The drag rescue device (DRD) is intended solely to assist in pulling or dragging an incapacitated fire fighter and is not intended for vertical rescue operations where the victim fire fighter would be raised or lowered.

A.3.3.29 Emergency Medical Operations. Patient care includes, but is not limited to, first aid, cardiopulmonary resuscitation, basic life support, and advanced life support.

A.3.3.32 Ensemble Elements. The proximity fire fighting protective ensemble includes, but is not limited to, garments, helmets, shrouds, gloves, and footwear. The structural fire fighting protective ensemble includes, but is not limited to, garments, helmets, hoods, gloves, and footwear.

A.3.3.36 Flame Resistance (Protective Clothing and Equipment). Flame resistance can be an inherent property of the textile material, or it can be imparted by specific treatment.

A.3.3.43 Goggles. To provide primary protection, goggles must be certified to ANSI/ASSE Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices*.

N **A.3.3.44 Gross Decontamination.** In this standard, the term *preliminary exposure reduction* is used in lieu of the more common industry term *gross decontamination* because it more accurately describes the activities specified by NFPA 1851 for initially addressing contaminated fire-fighting protective ensembles and ensemble elements. It is understood that while preliminary exposure reduction is likely to remove some contamination from the surface of the protective ensemble or ensemble elements, it does not guarantee full cleaning or decontamination for the removal of all contaminants. The use of the term *preliminary exposure reduction* reduces the possible inference that gross decontamination might be the only activity needed to render clothing safe for reuse and free from contamination. In hazardous materials operations, the types of protective clothing might be better designed to resist contamination and allow for easily cleaning given the clothing design and materials. This is not necessarily the case for structural or proximity fire-fighting protective clothing, particularly after exposure to products of combustion.

A.3.3.46 Hazardous Materials. Hazardous materials are any solid, particulate, liquid, gas, aerosol, or mixture thereof that can cause harm to the human body through respiration, ingestion, skin absorption, injection, or contact.

A.3.3.54 Interface Component(s). Interface components are evaluated and tested individually or are evaluated and tested as a part of the protective element.

A.3.3.64 Organization. Examples of organizations include, but are not limited to, fire departments, police and other law enforcement departments, rescue squads, EMS providers, and hazardous materials response teams.

N **A.3.3.66 Preliminary Exposure Reduction.** The primary purposes for preliminary exposure reduction actions are to reduce the exposure of the individual end users to soiling, products of combustion, and persistent contamination during doffing of ensembles and ensemble elements and to minimize the spread of that contamination to apparatus, vehicles, and the outside environment. Preliminary exposure reduction techniques for the outside of the ensemble and ensemble elements include brushing off dry debris with a soft bristle brush, rinsing off debris with a low-pressure, low-volume water hose, and spot cleaning for non-aluminized elements. Only a soft cloth or sponge should be used to remove debris on aluminized element surfaces.

These actions, conducted by an individual with assistance, are intended to begin the removal of soiling and contamination as soon as practically possible following the exposure of the individual on the fireground or at the emergency scene. The goal of preliminary exposure reduction is reducing contamination for the exposed ensemble or ensemble elements prior to leaving the scene. These techniques should be applied while the member is still wearing their SCBA and is still on air to prevent respiratory exposure from any off-gassing of contaminants or to dust from airborne debris. It is realized that circumstances might not allow for this immediate action due to limitation of resources (e.g., spare ensembles or ensemble elements), inclement weather, and other factors. Therefore, preliminary exposure reduction can take place some time or distance away from the specific exposure event.

In the hazardous materials industry, these actions are often referred to by the term *gross decontamination*, indicating the rinsing of the first responder or the actions to partially remove chemical residues or other hazardous substances after leaving the hot (contaminated) zone and before entering the cold (clean) zone during a hazardous materials incident. NFPA 1851 uses the term *preliminary exposure reduction* because the term *decontamination* suggests removal of contaminant. While there is an expectation that some of the surface contamination could be removed from protective ensembles or ensemble elements, gross decontamination or preliminary exposure reduction does not guarantee full cleaning or decontamination for all parts of the protective ensembles or ensemble elements.

N **A.3.3.67 Products of Combustion.** Normal products of combustion during fires include smoke (carbon particulates) and fire gases such as carbon dioxide, water, carbon monoxide, hydrogen chloride, nitric oxide, and a large number of other chemicals at different concentrations. The type and quantities of combustion products produced during a fire extensively vary with the type of fuels and fire conditions. The majority of fires are highly complex and entail a myriad of different materials that serve as fuels and create a large number of chemicals that are carcinogenic, are toxic, are corrosive, or create allergic reactions. Many products of combustion could include chemical substances that are persistent due to their low relative volatility or their adsorption onto soot or carbon particles created during combustion.

A.3.3.73 Proximity Fire Fighting Protective Ensemble. A proximity fire fighting protective ensemble includes, but is not limited to, garments, helmets, shrouds, gloves, and footwear.

A.3.3.81 Radiological Particulate Terrorism Agents. This standard addresses protective ensembles that provide only partial protection from certain radiation sources. By their nature, these ensembles provide protection from alpha particles; 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 particulates from direct skin contact.

N **A.3.3.83 Sanitizer.** Like disinfectants *(see A.3.3.22)*, sanitizers are considered a pesticide and thus subject to regulations established by the U.S. Environmental Protection Agency (EPA). All sanitizers must be registered with the EPA and meet specific labeling requirements. A listing of currently registered sanitizers can be found at https://www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants. Sanitizers are required to be used as specified on the product label as determined by the EPA registration process.

Sanitizers can either be used on hard surfaces such as helmet shells and eye and face protection devices, or be used as presoak treatments or laundry additives for fabrics and textiles. The specific requirements for demonstrating acceptable performance are found in the following EPA Office of Chemical Safety and Pollution Prevention (OCSPP) product performance test guidelines:

(1) OCSPP 810.2300, "Sanitizers for Use on Hard Surfaces — Efficacy Data Recommendations"
(2) OCSPP 810.2400, "Disinfectants and Sanitizers for Use on Fabrics and Textiles — Efficacy Data Recommendations"

Both of these documents provide for different classifications of disinfectants for their intended use. Classification types include sanitizers for food contact products and non–food contact products. Specific procedures and different target microorganisms are utilized to demonstrate the effectiveness of the respective sanitizer. In general, a sanitizer must reduce the number of microorganisms by 99.9 percent (a 3 $\log_{10}$ reduction).

See A.7.4.3 for more information on registered sanitizers.

A.3.3.84.1 Major A Seam. Outermost layer seam assemblies include outer shell seams. Rupture of the outer shell could reduce the protection of the garment by exposing inner layers such as the moisture barrier and the thermal barrier.

A.3.3.84.2 Major B Seam. Inner layer seam assemblies include moisture barrier and thermal barrier seams.

N **A.3.3.90 Soiling.** Soiling excludes contaminants that could adversely affect the wearer such as products of combustion and other hazardous materials, including toxic, corrosive, or sensitizing chemicals, potentially infectious body fluids, other infectious microorganisms, and CBRN terrorism agents. Since many fireground exposures with entry into a structure will involve exposure to combustion products that contain hazardous chemicals and other substances including carcinogens, any exposure to these conditions could result in contamination.

A.3.3.96 Structural Fire Fighting Protective Ensemble. A structural fire fighting protective ensemble includes, but is not limited to, garments, helmets, hoods, gloves, and footwear.

N **A.3.3.103 Structural Fire Fighting Particulate Blocking Hood.** These protective hoods have been designed to reduce the penetration of particulate contamination from reaching the end user. Hoods are required to meet NFPA 1971 and requirements for particulate blocking hoods.

A.3.3.112 Universal Precautions. Under circumstances in which differentiation between body fluids is difficult or impossible, all body fluids should be considered potentially infectious materials.

Δ **A.4.1.1** NFPA 1500 and NFPA 1581 also provide requirements and information on cleaning and decontamination.

Protective ensembles and ensemble elements are important tools that enable fire fighters to perform their jobs in a safe and effective manner. Organizations need to recognize that these items do not have an indefinite life span and that regular inspections are a necessary part of any protective equipment program.

Δ **A.4.2.2** The following sample outline for an SOP is provided as a guide to aid organizations in the development of their program SOPs. Organizations should consider addressing each point in the outline based on their types of protective clothing, operations, situation, needs, and so forth. The SOP should also include the responsibilities of the organization and of the individual members for each of the following points in the outline:

(1) Records, as follows:
    (a) Issued
    (b) Manufacturer information
    (c) Maintenance
    (d) Retirement
(2) Protecting the public and personnel from exposure to contaminated PPE, as follows:
    (a) Risk assessment
    (b) Contamination containment
    (c) Public access
    (d) Procedures, as follows:
        i. Public areas
        ii. Living areas
        iii. Food preparation and eating areas
        iv. Training areas
        v. Other
(3) Selection, as follows:
    (a) Risk assessment
    (b) Compliance with NFPA 1971
    (c) Element evaluation
(4) Inspection, as follows:
    (a) Routine inspection
    (b) Routine inspection procedure points
    (c) Advanced inspection
    (d) Advanced inspection procedure points
(5) Cleaning, as follows:
    (a) Preliminary exposure reduction
    (b) Preliminary exposure reduction procedure points
    (c) Advanced cleaning
    (d) Advanced cleaning procedure points
    (e) Drying procedures points
(6) Repair, as follows:
    (a) Basic repairs
    (b) Advanced repairs
    (c) Moisture barrier repairs
(7) Storage, as follows:
    (a) Unissued storage
    (b) Issued storage
(8) Retirement, disposition, and special incident procedures, as follows:
    (a) Condition
    (b) Age
    (c) Disposal method

Δ **A.4.2.3** Emergency response organizations are cautioned that accessories could degrade the protection or performance of the certified ensemble or ensemble element; interfere with

form, fit, or function of the certified ensemble or ensemble element; or become a hazard to the wearer.

Accessories are not part of the certified ensemble or ensemble element but could be attached to a certified ensemble or ensemble element by means not engineered, manufactured, or authorized by the certified ensemble or ensemble element manufacturer. If an accessory or its means of attachment causes the structural integrity of the certified ensemble or ensemble element to be compromised, the certified ensemble or ensemble element might not be compliant with the standard with which it was originally certified.

Additionally, if an accessory or the accessory's means of attachment is not designed and manufactured from suitable materials for the hazardous environments of emergency incidents, the failure of the accessory or the means of attachment could cause injury to the emergency responder.

Users are also cautioned that the means of attachment for an accessory that fails to safely and securely attach the accessory to a certified ensemble or ensemble element can allow the accessory to become inadvertently dislodged from the certified ensemble or ensemble element, possibly posing a risk to emergency response personnel in the vicinity.

Organizations should consider evaluating the ensemble with tests provided in NFPA 1971 in which the accessory could negatively impact the performance of the ensemble element, when in place. One test that is not part of NFPA 1971 but could be used to evaluate the performance of an externally placed accessory is ASTM F1930, *Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Flash Fire Simulations Using an Instrumented Manikin*. This test provides a simulation of a flash fire exposure using a static manikin. The effects of the flash fire on the accessory can be determined and compared to an ensemble that does not have the accessory in place. A minimum exposure time of 10 seconds is recommended for evaluating structural or proximity fire fighting ensembles. While this test provides a demonstration of ensemble/accessory performance under emergency conditions, it does not simulate all fire ground hazards, and other evaluations should be considered.

A.4.2.3.1 See A.4.2.3.

Δ **A.4.2.3.2** Organizations should consider evaluating the ensemble or ensemble element with tests provided in NFPA 1971 in which the accessory could negatively affect the performance of the ensemble or ensemble element, depending on how the element might be affected by the attachment of the accessory *(see Table A.4.2.3.2)*.

Another test that can be used to evaluate the performance of an externally placed accessory is ASTM F1930, *Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Fire Simulations Using an Instrumented Manikin*. This test simulates a flash fire exposure using a static manikin. The effects of the flash fire on an ensemble or ensemble element with the accessory can be determined and compared to the effects on an ensemble or ensemble element that does not have the accessory in place. A minimum exposure time of 10 seconds is recommended when evaluating structural or proximity fire-fighting ensembles. While this test demonstrates ensemble/accessory or ensemble element/accessory performance under emergency conditions, it does not simulate all fireground hazards, and other evaluations should be considered.

A.4.2.3.3 See A.4.2.3.2.

Δ **Table A.4.2.3.2 Evaluating Possible Negative Effects of Accessory Attachments on Ensembles or Ensemble Elements**

Ensemble and Ensemble Element Properties	Applicable Sections of NFPA 1971
Garments	
Flame resistance	8.2
Heat resistance	8.6
Whole-garment liquid integrity	8.48
Helmets	
Flame resistance	8.3
Heat resistance	8.6
Top-impact resistance	8.15
Impact resistance	8.16
Electrical insulation	8.30
Gloves	
Flame resistance	8.4
Heat resistance	8.6
Overall liquid integrity	8.32
Glove–hand function	8.37
Grip	8.38
Footwear	
Flame resistance	8.5
Heat resistance	8.6
Electrical insulation	8.31
Slip resistance	8.40
Overall liquid integrity	8.27.9
Hoods	
Flame resistance	8.2
Heat resistance	8.6
Liquid and particulate contamination protective ensembles	
Particle inward leakage	8.66
Whole ensemble liquid integrity	8.48

A.4.2.4 A manufacturer-trained organization receives training from an element manufacturer or a verified ISP in cleaning, inspection, and repair services for that organization's own elements. For garment elements, this entity has not received any formal verification from a third-party certification organization. If an organization has received training in cleaning, inspection, and repair of elements, it can be permitted to utilize another organization's equipment to conduct cleaning, inspection, or repair. For example, if organization A purchases a washer/extractor and neighboring organization B wishes to utilize this washer/extractor, it can be permitted to do so; however, organization B must use its trained personnel to conduct the laundering. If organization B wishes to use organization A's equipment and personnel to conduct the laundering, then organization A must be a verified organization *[see 4.2.4(2)]*.

A verified organization has demonstrated the ability to conduct cleaning, inspection, and repairs to a third-party certification organization in accordance with this standard and is not required to have the approval of the element manufacturer to perform these services. Verified organizations are permitted to conduct these services for other organizations.

A verified ISP has demonstrated the ability to conduct cleaning, inspection, and repairs to a third-party certification organization in accordance with this standard and is not required to have the approval of the element manufacturer to perform these services.

A manufacturer verified in cleaning has demonstrated the ability to conduct cleaning to a third-party verification organization in accordance with this standard. A verified cleaner has demonstrated the ability to conduct cleaning to a third-party certification organization in accordance with this standard.

Δ **A.4.2.4.2** Although approval from a manufacturer is not a requirement of this standard, it might be advantageous for the specific element manufacturer to be consulted when there is any question concerning the appropriate cleaning, inspection, or repair of a specific element. NFPA 1971 requires that every certified element contain the name and address of the element manufacturer so this information is readily available and each manufacturer will be able to offer the best possible practical knowledge of its product.

A.4.2.4.3 The end user should always request the list of repair categories for which the verified ISP is approved to perform.

N **A.4.2.4.3.1** Verified cleaners have received verification from a third-party verification organization to conduct garment element advanced cleaning services. Verified cleaners are not third-party verified to conduct advanced inspections or repairs.

N **A.4.2.4.5** This training is not required for every member of the organization. Organizations are allowed to determine the personnel who will receive this training. Typically, organizations require only the personnel who are involved in their PPE program to receive this training. In some cases organizations choose to also train selected personnel from each shift. Safety officers, training officers, and risk managers could also find this training beneficial.

For organizations that wish to perform basic garments repairs, additional hands-on training from the garment manufacturer or verified ISP is necessary. In addition, equipment and materials are needed to conduct basic garment repairs.

Organizations might be able to conduct some types of decontamination. Decontamination processes are dependent on the type of contaminate and could require specialized processes performed by a verified ISP. Additional information is provided in Chapter 7.

N **A.4.2.4.5.1** All ISPs, manufacturers, and verified cleaners performing advanced garment cleaning are required to successfully verify the effectiveness of cleaning for garment elements. If a department wants more in-depth information or specifics on how to perform garment cleaning, they should consult with an ISP or a manufacturer who has been third-party verified in cleaning.

N **A.4.2.4.5.2** Training should explain the activities that organizations are required to perform in order to comply with this standard, as well as provide information and options in regard to how organizations can accomplish them. This training does not negate the need for organizations to consult with manufacturers on specific instructions for performing inspections or basic repairs on proprietary products, individual ensemble elements, fabrics, or components with unique attributes or performance that require special consideration. For cleaning, it might be necessary to consult a manufacturer who has been verified in cleaning.

N **A.4.2.4.5.3** Written documentation of training should include:

(1) Organization name
(2) Personnel names
(3) Date trained
(4) Entity providing the training
(5) Edition of NFPA 1851 enforced at the time of the training
(6) Elements of NFPA 1851 for which the organization has been trained
(7) If applicable, indication that the organization received additional hands-on training necessary to conduct basic garment repairs

A.4.2.5 Retirement criteria should be based on a number of factors, including, but not limited to, the overall condition of the item, specific deterioration of materials or components beyond their repair economically, or the inability to adequately remove hazardous materials and other contaminants. Physical damage from use or improper cleaning are other factors that can affect when an item should be retired. The actual service life of ensembles and ensemble elements varies, depending on the amount of their use and the care they receive.

A.4.3.1 Records are an important part of an overall protective ensemble management program. Records can be used to provide information about the life cycle of protective ensembles and ensemble elements, to document cleaning and repair efforts, and to compare the effectiveness of elements that are made of different materials or by different manufacturers. These records can be compiled and maintained by the organization, a verified ISP, a verified cleaner, another third party selected by the organization, or any combination thereof.

A.4.3.2 Some departments utilize rental or loaner gear. Records should also be maintained on these ensembles and ensemble elements in order to maintain a history on the care and maintenance of the products. The fire department should require that the entity providing the gear provide the records of prior care and maintenance at the time of rental.

N **A.4.3.5** Organizations might place some elements in a rotating exchange program rather than assign them to a member. For example, some organizations keep an inventory of clean hoods they exchange after each contamination exposure. The member keeps a hood until it is contaminated and then exchanges it for a clean hood. The hood is never assigned to a specific member. Other elements might also be placed in a similar rotating exchange program.

A.4.4.2 It should be noted that the intent of this requirement is not to allow manufacturers to dictate which verified ISP an organization must use. The organization is allowed a choice in service providers for cleaning, inspection, and repairs. Also, this paragraph is not intended to imply that any of the requirements in this standard can be circumvented. The intent is to allow manufacturers to provide instructions that could differ from this standard, if necessary, due to a specific design feature, component, or material that requires special care or when an issue is not addressed by this standard. Any variations should be limited to the method of inspection, cleaning, or repair, not to the frequency.

A.4.5.2 Living areas include kitchen and dining areas, dayrooms, sleeping areas and dormitories, dedicated fitness

rooms, bath and shower areas, office areas, and meeting and conference rooms.

A.4.5.3 Extra caution should be practiced to avoid exposing children to soiled protective equipment because they usually are more interested in actually touching or handling the equipment than are adults. Children are also less likely to wash off any dirt or soot that they might pick up from handling ensembles or ensemble elements. Departments should consider dedicating PPE solely for use at public education events, to minimize public exposure to soils and contaminants.

Fire fighters often have a need to enter public facilities such as restaurants, grocery stores, and other businesses as part of their routine activities. PPE should not be worn during those times.

N **A.4.5.4** Public facilities include, but are not limited to, the home, home laundries, public laundries, commercial laundries, dry cleaners, stores, offices, private cars, and private homes. All efforts must be made to prevent exposing the public to soil and contaminants.

A.4.6.1 The purpose of this subsection is to require notification to the manufacturer and the certification organization of all health and safety concerns related to PPE identified through use or inspection. If a known or suspected failure of an ensemble element is identified, the element manufacturer and certification organization are the appropriate parties to be notified.

PPE health and safety concerns include, but are not limited to, the following:

(1) An occurrence resulting in loss of life or that which is likely to cause loss of life
(2) An injury resulting in permanent bodily damage, which can be instantaneous or cause a life-limiting disease or disorder eventually resulting in death
(3) An injury that requires hospitalization or medical or surgical treatment and that is not likely to result in a permanent disorder but is likely to necessitate loss of work for more than one day

A.4.6.2 The manufacturer and the certification organization information can be found on the product label.

A.5.1 The organization should consider establishing a committee to oversee the process of selecting ensembles or ensemble elements. The committee should consist of interested individuals representing a cross section of the organization (i.e., from both labor and management who collectively have several years of experience in fire fighting activities). The role of the committee should be to set and define goals and requirements and identify areas of responsibility for each member, plus provide recommendations to the authority making the final decisions.

Copies of specifications on the organization's current ensembles and ensemble elements should be distributed to the committee as a point of reference. The committee should consider if there are possible areas for improvement to the existing specifications. Examples of improvement criteria over existing specifications include heat stress, weight, design, style, interface with other components, durability, comfort, flexibility, safety, performance, price, customer service, delivery, compliance, reliability, and warranty.

Δ **A.5.1.1** In general, some hazards that can be encountered include, but are not limited to, physical, environmental, thermal, chemical, biological, electrical, radiation, operational, and ergonomic hazards. The organization should also consider the frequency and severity of the identified hazards when conducting the risk assessment.

The safety officer is the logical individual to perform this function since that is his or her role in the organization. The safety officer should consider national trends when performing this task. NFPA 1500 substantiates OSHA's regulations as follows:

(1) Section 4.3: Mandatory evaluation of safety and health programs
(2) Subsection 4.4.2: Mandatory compliance with state and federal laws
(3) Section 4.7: Safety officer's responsibilities also defined in NFPA 1521
(4) Section 7.1: Requirements for ensembles and ensemble elements

In the identification of hazards, the organization should consider those hazards that fire fighters are likely to encounter. A list of hazards is provided in Table A.5.1.1. In determining risk, the organization should consider the frequency or likelihood of exposure to the hazard along with its potential severity (consequence) if exposure occurs.

A.5.1.2(1) In performing the risk assessment, the organization should consider all of its responsibilities. In some departments there might be stations or units that require different types of ensembles.

Δ **A.5.1.2(6)** Examples of physical areas of operations include but are not limited to:

(1) One of the hazards faced by fire fighters is being struck by vehicular traffic. 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 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. Additional high-visibility requirements for fire fighters on or near roadways are regulated by the Federal Highway Administration's *Manual on Uniform Traffic Control Devices (MUTCD)*. It is the responsibility of the authority having jurisdiction (AHJ) to specify appropriate high-visibility apparel from the available garment options, if any, and based on a risk assessment, to establish policies for 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*, ANSI/ISEA 207, *American National Standard for High Visibility Public Safety Vests*).
(2) The use of personal flotation devices might need to be considered for operations near waterways.
(3) Fire fighters operating at elevation might need some form of fall protection, which might or might not be incorporated into their protective clothing.

Δ **A.5.1.2(7)** In determining the need for CBRN protection, the organization should determine homeland security priorities for its jurisdiction, including, but not limited to, whether the organization would be responding to a CBRN terrorism incident, the specific roles and missions to be undertaken in

response to a CBRN terrorism incident, the expected types of hazards that might be encountered for its members during a CBRN terrorism incident, and the capabilities of the organization to provide sufficient training and support for the use of CBRN protective ensembles (e.g., decontamination for safe doffing of ensemble elements). If it is determined that CBRN protection is needed, the organization should review the different classes of ensembles addressed in NFPA 1994 and the protective ensemble defined in NFPA 1991, together with its intended CBRN terrorism agent response or action plan, to determine the suitability of obtaining separate ensembles that comply with specific classes of ensembles for NFPA 1994 or ensembles meeting NFPA 1991.

Δ **A.5.1.3** These standards provide minimum requirements. In order to fully utilize this standard, organizations should be familiar with the performance requirements in NFPA 1971. Additional requirements can be necessary. Organizations should also solicit information from and exchange information with other organizations.

Δ **A.5.1.4** Certification of protective elements can be checked by examination of the product label for the mark of the certification organization. The organization should further check the certification of the specific protective element by contacting the certification organization and asking if the item is listed as being certified as compliant with NFPA 1971. Finally, the organization can check the legitimacy of the certification organization by asking for documentation that shows that the certification organization has been accredited to ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*.

Table A.5.1.1 List of Potential Fire Ground and Other Related Emergency Hazards

Physical Hazards	***Chemical Hazards***
Falling objects	Inhalation
Flying debris	Skin absorption or contact
Projectiles or ballistic objects	Chemical ingestion or injection
Abrasive or rough surfaces	Liquefied gas contact
Sharp edges	Chemical flashover
Pointed objects	Chemical explosions
Slippery surfaces	***Electrical Hazards***
Excessive vibration	High voltage
Environmental Hazards	Electrical arc flashover
High heat and humidity	Static charge buildup
Ambient cold	***Radiation Hazards***
Wetness	Ionizing radiation
High wind	Non-ionizing radiation
Insufficient or bright light	***Person–Position Hazards***
Excessive noise	Daytime visibility
Thermal Hazards	Nighttime visibility
High convective heat	Falling
Low radiant heat	Drowning
High radiant heat	***Person–Equipment Hazards***
Flame impingement	Material biocompatibility
Steam	Ease of contamination
Hot liquids	Thermal comfort
Molten metals	Range of motion
Hot solids	Hand function
Hot surfaces	Ankle and back support
Biological Hazards	Vision clarity
Bloodborne pathogens	Communications ease
Airborne pathogens	Fit (poor)
Biological toxins	Ease of donning and doffing
Biological allergens	

Δ **A.5.1.5** The majority of tests in NFPA 1971 provide quantitative results; however, some tests are established on the basis of pass or fail results and cannot be readily compared. Specific tests that offer comparative performance results include, but are not limited to, the following:

(1) Protective garment elements
   (a) Thermal protective performance of the material composite
   (b) Total heat loss of the material composite
   (c) Conductive and compressive heat resistance of reinforcements
   (d) Thermal shrinkage of the material layers (outer shell, moisture barrier, thermal barrier)
   (e) Flame resistance of material layers and other components (outer shell, moisture barrier, thermal barrier, other material layers and components)
   (f) Tear resistance of the material layers (outer shell, moisture barrier, thermal barrier)
   (g) Cleaning shrinkage of the material layers (outer shell, moisture barrier, thermal barrier)
   (h) Water absorption resistance of the outer shell
   (i) Tensile strength of the outer shell
   (j) Seam strength of outer shell, moisture barrier, and thermal barrier layers
   (k) Visibility properties of the trim
   (l) Radiant reflectance of the outer shell (for proximity fire fighting protective clothing)
(2) Protective helmet elements
   (a) Impact resistance (top and acceleration) after selected preconditions
   (b) Flame resistance
   (c) Heat resistance (level of sagging)
(3) Protective glove elements
   (a) Thermal protective performance of glove body and, if present, wristlet
   (b) Conductive heat resistance of glove body
   (c) Thermal shrinkage of glove and innermost material
   (d) Cut resistance of glove body
   (e) Puncture resistance of glove body
   (f) Burst strength of wristlet material
   (g) Dexterity of whole gloves
   (h) Grip of whole gloves
(4) Protective footwear elements
   (a) Flame resistance
   (b) Radiant heat resistance of upper
   (c) Conductive heat resistance of sole and upper
   (d) Puncture resistance of sole and upper
   (e) Cut resistance of upper
   (f) Abrasion resistance of sole
(5) Protective hood interface elements
   (a) Thermal protective performance of hood material
   (b) Flame resistance of hood material
   (c) Thermal shrinkage of hood material
   (d) Burst strength of hood material
   (e) Cleaning shrinkage of hood material
   (f) Particulate contamination blocking layer

Additional testing can also be specified for performance properties not addressed in NFPA 1971 based on the organization's hazard and risk assessment. When additional testing is specified, standard test methods should be used when available, and testing should be conducted at accredited, independent laboratories.

Organizations should consider the use of a request for information (RFI) or a request for proposal (RFP) format when soliciting quotations for structural or proximity fire fighting protective ensemble elements. The advantage of an RFI or an RFP proposal is that it allows manufacturers the option of providing all of the most current technologies for organization review (the offering is then not limited to the requirements of the specification). The organization can then choose among proposals for offered items finally accepted. Typically an RFI and an RFP have the following characteristics:

(1) Minimum requirements, such as NFPA product certification, required materials, or available options
(2) Inclusion of current specifications and a requirement that each manufacturer explain how its offering differs from the currently specified product
(3) Background on the offering firm's finances, capabilities, and references
(4) Field test procedures and results *(see 5.1.6)* of offered products

Using this approach, the organization can then employ a rating system that assigns values and weights to several factors, including, but not limited to, product design, manufacturer references, and field test results.

In this approach, a separately sealed cost proposal is opened only after the point ratings have been assigned to each offering. The organization can then apply separate criteria considering both technical merits and cost. This approach allows fire departments to compare prices and product acceptability.

Organizations should also consider integrated PPE programs that address various levels of care and maintenance as provided by or coordinated by the manufacturer of the fire fighter personal protective equipment. These programs can address many of the aspects of care and maintenance that are addressed in this standard, including, but not limited to, cleaning, inspection, and repairs, in addition to the offer of program guidance and reporting and documentation of procedures.

***N* A.5.1.5.1** Tradeoffs exist between the levels of thermal insulation provided by garment composite materials and the ability of those materials to trap heat that potentially leads to heat stress of the fire fighter. In NFPA 1971, thermal protective performance (TPP) testing measures the amount of heat transfer through the clothing composite (i.e., the combination of the primary garment clothing layers — the outer shell, the moisture barrier, and the thermal barrier) when exposed to a combination of convective heat and thermal radiation. The exposure level is intended to simulate the heat energy associated with a flashover. The test uses a calorimeter to measure the time-to-burn. The reported TPP rating is this time-to-burn multiplied by the exposure energy (2.0 cal/cm^2/sec). It is important to recognize that TPP testing simulates only one condition among an unlimited set of clothing exposure conditions. However, the TPP test is the primary measurement for qualifying garment composite material for thermal insulation. The minimum TPP value specified by NFPA 1971 for garment composites is 35.0 cal/cm^2/sec. Higher values of TPP indicate composites offering greater thermal insulation.

A total heat loss (THL) test is used to measure how well garments allow body heat to escape. The test assesses the loss of heat, both by the evaporation of sweat and the conduction of heat through the garment layers. As clothing is made more insulative to high heat exposures, there is a tradeoff with how well the heat build-up in the fire fighter's body (that can lead to heat stress) is alleviated. Differences in the weight and other characteristics of garment material composites including the type of moisture barrier will affect the transmission of sweat moisture, which carries much of the heat away from the body. If this heat is kept inside the ensemble, the fire fighter's core temperature can rise to dangerous levels if other efforts are not undertaken (i.e., limiting time on scene, rotating fire fighters, and providing rehabilitation at the scene). NFPA 1971 specifies that garment composites have a minimum THL of 205 W/m^2. Higher THL values indicate composites that provide greater heat loss. The validation and origin of this requirement is discussed in ASTM STP1386, *Field Evaluation of Protective Clothing Effects on Fire Fighter Physiology: Predictive Capability of Total Heat Loss Test.*

There are also limitations in the application of THL testing. Just as TPP testing only evaluates the base three-layer fabric system for thermal insulation, THL testing is a material test and does not evaluate the entire capability of the garment to dissipate heat. Areas of garments with additional layers such as trim, pockets, and reinforcements have less breathability. In contrast, these same areas of the garment have greater thermal insulation. The specifications of garment design must account for which areas of the garment need reinforcement and other materials and how these additional materials and reinforcements could contribute to stress.

Organizations should be aware that small differences in TPP and THL values might not represent significant differences that will translate into differences in field performance of garments. There is variation in the test results for both TPP and THL where values of ±3 cal/cm^2 in TPP and values of ±20 W/m^2 in THL might be due to variation in results produced by the materials rather than true differences in the garment composite materials.

In general, as garment material composite thickness increases, higher levels of thermal insulation (measured using TPP testing) are obtained. At the same time, thicker composites typically create more stress on the fire fighter. By also examining the results of THL testing, organizations can choose to optimize the selection of their composites by balancing composite THL values with TPP values, while still meeting the minimum performance for both areas of performance. For TPP testing, thermal barriers usually have the greatest impact, but like THL, the TPP value for a composite is based on the contribution from each layer.

Other measurements can be introduced to characterize garment material composite thermal insulation or heat stress effects. For example, the evaporative resistance test (referred to as Ret), which is also performed on the three base layers, offers a means for measuring the ability of the garment composite to allow the heat associated with sweat evaporation to pass through the material. Like THL, this test is associated with demonstrating the breathability of the garment material composite. In this test, different environmental conditions provide a different way of ranking composite performance,

although there are no established performance requirements for Ret within NFPA 1971. Specific research conducted by North Carolina State University using a physiological manikin and reported by the Fire Industry Education Resource Organization (F.I.E.R.O.) have shown that Ret provides discrimination of the composite materials' impact on wearer core temperature, skin temperature, and sweating rate with a higher correlation than THL over three different environmental conditions — hot, mild, and warm. This information means that Ret might provide a more reliable prediction and discrimination of the stress effects of different material composites on the protective clothing wearer as compared to THL. Unlike THL, the reported Ret measurement is a resistance having units of Pa m^2/W where lower values are associated with more breathable material composites.

Organizations should be aware that the measurements of garment material composite thermal insulation and heat stress effects are performed on the principal three-layer composite used in the construction of the garment and do not account for other layers that might be on the garment such as trim, pockets, outer shell reinforcements, and liner reinforcements. While necessary to meet the requirements of the standard and assist fire fighters in performing their duties, these additional layers increase overall thermal insulation and decrease breathability, resulting in potentially higher heat stress effects. Consequently, when deciding on the target levels of composite thermal insulation and breathability (i.e., total heat loss or evaporative resistance), organizations should take into account the garment design and how both thermal insulation and heat stress effects will be affected by both mandatory (e.g., trim, shoulder reinforcements, knee reinforcements) and optional (e.g., pockets) garment design features. Results for the investigation of these effects is provided in "The Cost of a Pocket: the Impact of Reinforcements on the TPP and THL."

N **A.5.1.6** Organizations are able to assess the effectiveness of ensemble interfaces, interface components and proper donning for reducing the penetration of particulate contamination by conducting a simple test. In this test, a fire fighter wears their ensemble consisting of protective garments, a helmet, gloves, footwear, a hood, and self-contained breathing apparatus (SCBA). A fluorescent agent–based solution is sprayed as an aerosol onto the exterior of the protective ensemble worn by the fire fighter, while the fire fighter carries out stationary exercises. When applied as a fine mist, the aerosol can approximate the small particles of smoke created in a structural fire. After carefully removing the ensemble, the underlying skin and clothing are examined under a black UV light to show any evidence of aerosol penetration. This information can then be used by the organization to judge how well interfaces are maintained between elements, the overall protective capabilities of specific interface components such as particulate blocking hoods, and the efficacy of donning methods.

For performing this test, the following supplies, equipment, and facilities are needed:

(1) A commercial fluorescent liquid solution that is typically applied in hand washing. A supply of 3.8 L (1 gal) will be sufficient to evaluate multiple ensembles.
(2) An ordinary paint spray with a variable control. An inexpensive electric-powered sprayer can be obtained for less than $100 from a home improvement supply store.
(3) A large black UV flashlight for viewing any fluorescent aerosol. Alternatively, a bank of long black UV fluorescent lights can be used in a darkened room.
(4) An area that can be darkened for examining the fire fighter test subject under black light. This area can be a closet or other room where the light can be fully blocked out.
(5) An area for spraying the liquid onto the fire fighter test subject.
(6) Optionally, the fire fighter test subject can wear black witness garments such as body wear underneath the ensemble to provide a uniform viewing surface. If this approach is used, synthetic material–based black body wear consisting of a full long-sleeved top and pants are useful. However, such garments must be totally free of lint as ascertained by being checked under a black light.

The basic procedures for conducting this test involve the following steps:

(1) Spray a very small portion of fluorescent solution (1 sec) onto either the black witness garment or the individual's skin to determine how it appears under the selected black light observation conditions. This will serve as a visual control for determining if penetration has occurred.
(2) The fluorescent solution should rinse off the individual's skin with thorough soap-and-water washing. It should also be readily removed from the black witness garments by conventional washing.
(3) If the fire fighter test subject wears the black witness garments, then the garments should be washed and free of lint.
(4) Put the fluorescent liquid in the sprayer reservoir and adjust the sprayer settings to deliver a light, circular spray pattern of liquid mist.
(5) Have the fire fighter test subject put on the complete ensemble to be evaluated.
(6) Spray the fluorescent liquid onto the fire fighter ensemble using a spray time of 5 to 10 seconds in each location. Ideally, have the test subject perform motions that are designed to challenge the interfaces, such as reaching above their head with their arms, bending over, and cross-body reaches.
(7) Following the spraying of fluorescent liquid, use extreme care removing the ensemble from the fire fighter test subject to prevent contaminant transfer to the interior and skin/clothing of the subject.
(8) After the ensemble is removed, check the surfaces on the black witness garments or test subject's skin under a black UV light in a darkened area to determine if there is any visual evidence of fluorescence that might have penetrated from the spraying process.
(9) Make notes or draw a diagram to show where underlying fluorescence has penetrated portions of the ensemble or the test subject's skin.

Based on this test method, information gained from the evaluation of different ensembles can show their relative effectiveness in preventing particulate penetration. However, it is important to note that this evaluation technique might not show all avenues of particulate penetration and can also provide results that might be difficult to interpret unless specific penetration pathways are identified. It is important to carry out these procedures with a high level of advance planning and scrutiny to ensure consistent and comparable results. For example, conducting the evaluation with the same test

subject(s) on the same day will allow more uniform testing when comparing different ensembles. Also, note that the donning process can impact the results of this procedure.

N **A.5.1.6.1** More than one type of eye and face protection component as provided with the helmet or separate eye and face protection devices might be needed to cover the full range of activities for which the organization conducts emergency response operations. For example, while the full facepiece of the self-contained breathing apparatus (SCBA) provides primary eye protection during structural fires including overhaul, organizations might rely on faceshields and goggles provided with helmets for eye and face protection when not wearing the SCBA facepiece. To fulfill this requirement, an organization might have to specify separate eye and face protection devices that are suitable for providing individual member protection during other types of emergency operations.

A.5.1.7 Organizations should contact manufacturers or vendors about field evaluation programs. Many provide sample items for tests. The following criteria should be used to conduct an effective field evaluation:

(1) Test participants should be selected based on a cross section of personnel, willingness to participate, objectivity, and level of operational activity.
(2) Participants should conduct field evaluations of each different product model being evaluated from each manufacturer for a particular ensemble element. Participants should be fitted for each product model being evaluated from each manufacturer. Evaluations should be conducted with the same participants to use and evaluate each ensemble.
(3) A product evaluation form should be developed for each element and interface area. The form should include a rating system for those characteristics considered important to the organization, facilitating a quantitative evaluation. Evaluation forms should include general performance criteria, a specific length of time for the field evaluation, and criteria addressing ease of movement, ability to work, and so forth. Size and fit issues should be addressed since they relate to comparative evaluation of ensembles and ensemble elements. Evaluation forms that provide only narrative responses should be avoided.
(4) The organization should solicit periodic reports from participants in the field evaluation. At least three evaluation reports should be completed and filled out independently.
(5) The organization should conclude the evaluation process in a timely manner and analyze the results.

Δ **A.5.1.8** Specifications translate the organization's needs into performance or design requirements that can be met by manufacturers of protective equipment. Specifications should clearly address every aspect of the department's needs and expectations in regard to both the performance and the delivery of the ensembles or ensemble elements.

Organizations should specify delivery time requirements and, if appropriate, penalty assessments for not meeting delivery dates. Warehousing requirements, if desired, should also be established in the procurement specification.

Organizations should be careful not to write specifications that are redundant or contradictory or that cannot be met by manufacturers of ensembles or ensemble elements. For example, the organization should be sure the thermal protection performance (TPP) specified can be achieved with the materials specified. A prebid meeting with participation by potential bidders or manufacturers is useful in eliminating inconsistencies and explaining requirements that might be unclear in the specifications.

Organizations should continuously review and document how their specifications and ensembles and ensemble elements meet their needs and applicable standards. There are many ways to improve the quantity and quality of information received from prospective bidders. Additionally, increased purchasing power potential can be gained by forming collective buys with other organizations for possible volume discounts.

Purchase specifications should indicate the organization's selection of choice for the following required NFPA 1971 ensemble element components:

(1) Garments
    (a) Outer shell material: fabric, weight, color
    (b) Thermal liner material
    (c) Moisture barrier material: base fabric, film, or coating
    (d) Trim: configuration, material, color
    (e) Closure system
    (f) Wristlets: material, design
(2) Hoods
    (a) Material
    (b) Face opening design
    (c) Particulate contamination blocking layer
(3) Gloves
    (a) Composite materials
    (b) Wristlet or gauntlet
    (c) Wristlet material
(4) Helmets
    (a) Material
    (b) Color
    (c) Retention system
    (d) Trim configuration
    (e) Trim color
    (f) Ear cover material
    (g) Ear cover dimension
    (h) Eye protection
(5) Boots: composite materials

Δ **A.5.1.8(2)** An organization should consider its needs for performance or features in excess of the minimum requirements of NFPA 1971, such as the following:

(1) Garment elements, as follows:
    (a) Any styling issues
    (b) Any specific range-of-motion requirements
    (c) Any sleeve retraction requirements
    (d) Any garment rise with overhead reach requirements
    (e) Any winter liner requirements
    (f) Any additional reinforcement needs (recognizing that multiple layering can modify protective performance in several areas, especially breathability)
    (g) Any specific additional thread requirements
    (h) Any specific additional requirements for stitch characteristics

(i) Any customized sizing requirements
(j) Any attachment requirements for liners and outer shells
(k) Any specific requirements for placement of visibility marking, visibility marking materials, and reflective lettering
(l) Any specific material choices
(m) Any requirements for weight reduction
(n) Any specific details of required suspender construction or suspender/garment interface
(o) Any requirements for spot or localized enhanced insulative performance
(p) Any requirements for field interchangeability or replacement of reinforcement pieces
(q) Any requirements for enhanced flexibility at movement-sensitive areas
(r) Any requirements for notification systems to indicate liner absence
(s) Any requirements for moisture barrier substrate or thermal fill accessibility to allow field inspection
(t) Any requirements for lumbar support systems
(u) Any customization requirements
(v) Any passport or accountability system requirements
(w) Any specialized or additional pocketing requirements
(x) Any flashlight clips required
(y) Any personal alert safety system (PASS) interface features required
(z) Any requirements for personal escape or rescue features
(aa) Any requirements for sizing adjustment
(bb) Any requirements for temperature-sensing features
(cc) Any requirements for interface area compatibilities

(2) Helmet elements, as follows:

(a) Any styling requirements
(b) Any customization requirements
(c) Any faceshield or goggles requirements
(d) Any reflective marking requirements
(e) Any customized sizing requirements
(f) Any specific material choices
(g) Any specific requirements for earflaps (e.g., design, materials, dimensions, attachment to shell specifics)
(h) Any specific requirements for suspension construction
(i) Any requirements for weight reduction

(3) Glove elements, as follows:

(a) Any specific material choices
(b) Any overall styling requirements
(c) Any details of cuff styling (wristlet or gauntlet)

(4) Boot elements, as follows:

(a) Any specific material choices
(b) Any overall styling requirements
(c) Any trouser interface requirements

(5) Hood interface elements, as follows:

(a) Any specific material choices
(b) Any styling requirements
(c) Any coverage requirements
(d) Any particulate-blocking layer

(6) All ensemble elements, as follows:

(a) Any additional certification requirements (e.g., Project FIRES, state OSHA, federal OSHA)
(b) Any requirements for interface with existing elements of the protective ensemble
(c) Any warranty requirements
(d) Any requirements for cleaning and repair support
(e) Any requirements for manufacturer or dealer references

(7) Liquid and particulate contaminant protection ensembles, as follows:

(a) Method of deploying the liquid and particulate contaminant protection
(b) Position of material systems of each element and ease of their inspection
(c) Manner in which ensemble interfaces are designed to limit liquid and particulate contaminant ingress
(d) Specialized donning or doffing procedures in the wearing of the ensemble
(e) Ensemble resistance to contamination and ease of ensemble doffing for safe exit of wearer from ensemble
(f) Specific types of SCBA for which ensemble is certified

A.5.1.8(3) Depending on the items being purchased and the size of the order, organizations should consider requiring product representatives to provide samples with their proposals. Manufacturers should also be required to provide complete user instructions and warranty information with each bid. Organizations should review the past record of each manufacturer concerning length of time for delivery, repair turnaround times, and similar customer service issues.

A.5.1.8(4) Organizations can obtain assistance in garment sizing from ASTM F1731, *Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing*. Helmets are adjustable and fit a wide range of sizes. If a helmet is not adjusted correctly, it might not stay on the user's head during periods of active wear. In addition to the sizing and depth adjustments, many models are available with quick adjusters to accommodate varying conditions for proper fitting (e.g., with or without SCBA facepiece).

A.5.1.8(5) Organizations should consider comparing a preproduction sample from the apparent winning submitter against the purchase specifications before awarding the bid.

A.6.1.3 It is not the intent of this standard to require the cleaning of ensembles and ensemble elements if the elements are not soiled. Organizations should establish guidelines for judging the extent of soiling that requires cleaning based on the organization's needs and experience. In applying such judgment, organizations should take into consideration the importance of keeping ensembles and ensemble elements clean. Soiled ensemble elements can pose a health risk to the wearer and the levels of protective performance.

A.6.2.2 Table A.6.2.2 provides a quick reference guide to routine inspection criteria.

Δ Table A.6.2.2 Routine Inspection Criteria

Criteria	Coats and Trousers	Hoods/ Shrouds	Helmets	Gloves	Footwear	DRD
Soiling	X	X	X	X	X	X
Contamination	X	X	X	X	X	X
Rips, tears, abrasions, and cuts	X	X	X	X	X	X
Damaged or missing hardware and closure systems	X					
Charring, burn holes, melting	X	X	X	X	X	X
Shrinkage	X	X	X	X	X	
Material discoloration and degradation	X	X	X	X	X	X
Visibility marking integrity attachment to garment: reflectivity damage	X		X	X	X	
Loss of face opening elasticity or adjustability		X				
Cracks, dents, abrasions			X	X		
Bubbling, soft spots, warping			X			
Damaged or missing components of suspension or retention systems			X			
Damaged or missing components of faceshield/goggle system, including discoloration and scratched lenses			X			
Inverted glove liner				X		
Exposed or deformed steel toe, steel midsole, or shank					X	
Loss of water resistance					X	
Closure system component damage and functionality					X	
Earflaps: rips, tears, or cuts; thermal damage such as charring, burn holes, or melting			X			
Correct assembly and size compatibility of shell, liner, and DRD	X					X
Delamination as evidenced by separation or peeling of outer shell (aluminized materials)	X	X	X	X	X	
Any damage to the particulate blocking layer (particulate-blocking hoods only)		X				

***N* A.6.2.2.2(6)** The following simple evaluation can be conducted in the field to assess the integrity of the particulate-blocking layer of hoods:

(1) Assess areas of the hood where a particulate-blocking layer is present using a bright flashlight or similar focused light to gauge the integrity of the particulate-blocking layer. The light source used should provide enough focused light to show changes in density of the hood materials when viewed. However, the light source should not produce excessive heat that would damage the hood materials and should be configured so as to prevent the bulbs from directly contacting the hood materials.
(2) Position the light source near the hood so that the light passes through the hood composite materials.
(3) Evaluate the hood by examining the amount of light coming through the hood composite. Brighter areas could be an indication of material degradation, migration, or shifting resulting in a thin or bare spot, which indicates the hood should be removed from service for additional evaluation or retirement. More obvious damage such as a hole or tear in the particulate-blocking layer might also be more observable than otherwise might be seen without the addition of a light source.

This test might not be suitable for all types of particulate-blocking hoods, especially hoods that use an ordinary moisture barrier as the particulate-blocking layer. Some hoods might be provided with an inspection opening to allow viewing of many portions of the particulate-blocking layer.

Section 12.1 also provides an evaluation method that can be adapted for conducting a light source–based evaluation of the hood using a simple fixture.

A.6.2.2.3(6) The inspection should ensure that the sides and edges of faceshields and goggles are maintained to preserve peripheral vision.

Δ **A.6.3.2.1** For any inspection program to be effective, ensembles and ensemble elements should be evaluated by trained individuals. The individuals evaluating the ensembles and ensemble elements should understand the limitations of each element and recognize the signs of failure. Utilizing trained individuals provides consistency on whether an item should be repaired or retired. The manufacturer and the organization, the verified ISP and the organization, or a verified organization should determine the level of training required to perform advanced inspections. Resources for training that should be considered, as a minimum, are the manufacturer(s) of the elements in use; the Fire and Emergency Manufacturers and Services Association (FEMSA) user guides; NFPA 1500; and professional cleaning and repair facilities.

A.6.3.3 If ensemble elements have been issued, they are not reserve and are intended to be subjected to the advanced inspection.

A.6.3.4 The following inspection grading scale is designed to assist fire department personnel in identifying and documenting the condition of ensembles and ensemble elements:

(1) *New or as-new condition.* Newly purchased items that are in like-new condition.
(2) *Good condition.* Items in good serviceable condition; might show wear, but replacement or repair is not necessary.
(3) *Maintenance needed.* Items in need of repair. The organization determines if an item is to be retired. Maintenance details are described in the "Comments" section of the inspection form.
(4) *Immediate replacement.* Unsafe items that should be removed from service.

A.6.3.5 Table A.6.3.5 provides a quick reference guide to advanced inspection criteria.

A.6.3.5.1 It is important to realize during the inspection of different layers of garment elements that some portions of the material might be more susceptible to damage than others. For example, one side of a multilayer laminate material or quilted material might show damage while the other side might not. Moreover, certain fibers in a single-layer material might be more susceptible to damage than other fibers. Each of these effects could be cause for repair or retirement of the garment element, depending on the extent of observed damage. When garments have an optional winter liner, the winter liner should be inspected during each advanced inspection.

A.6.3.5.1(3) All charred, burned, or discolored areas should be thoroughly checked for strength and integrity by aggressive flexing of the material and attempts to push a finger or thumb through the fabric. Any loss of strength or weakening of the materials to the degree that the material can be torn with manual pressure is a sign of deterioration, and the garment should be removed from service.

Δ **A.6.3.5.1(4)** While all materials and components in garment elements are susceptible to different types of damage from wear or abuse, the moisture barrier is one of the most difficult parts of the garment element to inspect and evaluate. That is because the film or coating side of most moisture barriers faces the interior of the liner and is hidden from easy examination. Even if a garment element is equipped with a means of opening the liner to view the film or coating side, it is difficult to conduct a visual evaluation of the moisture barrier film or coating. Even a physical examination of the moisture barrier film or coating side will not detect all types of damage or defects that can lead to loss of liquid penetration resistance for the garment element.

Moisture barrier coatings or films can become abraded, tear, or have pinholes from use. In severe cases, the degradation in some moisture barrier materials can take the form of separation, cracking, or flaking. Tapes used on moisture barrier seams, to ensure garment element integrity against liquid penetration, can crack, lift, or completely separate. Because only the most obvious damage is usually observable, the field evaluation procedures in Section 12.3 is necessary.

A simple evaluation that can be conducted in the field to assess the integrity of the moisture barrier is as follows:

(1) This test should be applied to areas of high wear such as, but not limited to, the broadest point of the shoulders, the back waist area of the coat, knees, crotch area, and seat area. Garment seams, discolored areas, or where potential damage to other layers has been detected should also be evaluated.
(2) Position the garment liner, removed from the shell, over a 5-gal bucket or similar container so that the thermal liner is pointed down, and the moisture barrier is oriented upward such that it will be in contact with the liquid exposure. When testing a seam, the seam should be positioned so that it divides the test area in two equal halves. The test liquid should consist of an alcohol–tap water mixture made by combining 1 part rubbing alcohol (70 percent isopropanol alcohol) with 6 parts tap water.
(3) Form a well in the liner area that is being evaluated so that it is lower than the surrounding liner. Pour 1 cup of the alcohol–tap water mixture onto the moisture barrier in the welled area of the liner. Allow the mixture to sit for 3 minutes and then visually inspect the thermal barrier side of the liner for any signs of liquid passing through the moisture barrier.
(4) If any liquid passes through, the garment should be removed from service and sent for an advanced inspection. After the evaluation, ensure that the liner is cleaned and allowed to completely dry to remove all traces of the alcohol–tap water mixture.

A.6.3.5.1(7) Material discoloration can indicate many types of possible damage, including, but not limited to, dye loss, heat degradation, UV damage, and chemical contamination.

A.6.3.5.1(9) Visibility markings can appear to the human eye to be undamaged when actually they have lost much of their ability to reflect. Retroreflective properties can be checked with the following simple flashlight test:

(1) Stand approximately 12 m (40 ft) from a sample of the trim being tested and a sample of new trim.
(2) Hold a bright, focused flashlight at eye level, either next to the temple or on the bridge of the nose, and aim the light beam at the samples.
(3) Compare the brightness of the reflected lights. If the reflected light from the trim being tested is substantially less than the light reflected from the new trim, the trim should be replaced.

This field evaluation test provides effective and timely results while allowing the evaluator to physically view the reflective trim as it is seen by the naked eye.

Δ Table A.6.3.5 Advanced Inspection Criteria

Criteria	Coats and Trousers	Hoods/ Shrouds	Helmets	Gloves	Footwear	DRD
Soiling	X	X	X	X	X	X
Contamination	X	X	X	X	X	X
Rips, tears, cuts, and abrasion	X	X	X	X	X	X
Damaged or missing hardware or closure system	X	X	X	X	X	
Charring, burn holes, melting	X	X	X	X	X	X
Shrinkage				X		
Material degradation (UV or chemical damage)	X	X	X	X	X	X
Material discoloration	X	X	X	X	X	X
Visibility marking integrity, attachment to garment, reflectivity damage	X		X	X	X	
Loss of face opening elasticity or adjustability		X				
Any damage to the particulate blocking layer (particulate blocking hoods only)		X				
Cracks, dents, abrasions			X		X	
Bubbling, soft spots, warping			X		X	
Damaged or missing components of the suspension and retention systems			X			
Earflaps: rips, tears or cuts, thermal damage (such as charring, burn holes, melting, or discoloration of any layer)			X			
Damaged or missing components of faceshield/goggle system, including discoloration and scratched lenses			X			
Inverted glove liner				X		
Exposed or deformed steel toe, steel midsole, or shank					X	
Loss of water resistance				X	X	
Evaluation of system fit and coat/trouser overlap	X					
Loss of seam integrity	X			X		X
Broken or missing stitches	X	X		X		X
Loss or shifting of liner material	X			X		
Loss of wristlet elasticity, stretching, runs, cuts, or holes	X			X		
Label integrity and legibility	X	X	X	X	X	X
Hook and loop functionality	X		X		X	X
Liner attachment system	X					X
Material elasticity, stretching out of shape		X				
Damage to the impact cap			X			
Loss of flexibility			X			
Punctures, cracking, or splitting		X			X	X
Excessive tread wear					X	
Condition of lining: tears, excessive wear, separation from outer layer					X	

(continues)

Δ **Table A.6.3.5** *Continued*

Criteria	Coats and Trousers	Hoods/ Shrouds	Helmets	Gloves	Footwear	DRD
Correct assembly and size compatibility of shell, liner, and DRD	X					X
Closure system functionality	X					
Accessories for compliance with 4.2.3	X		X			
Complete liner inspection (Section 6.4)	X					
Delamination as evidenced by separation or peeling of the outer shell (aluminized materials)	X	X	X	X	X	

While this simple test provides a practical evaluation of trim retroreflective performance, it does not evaluate trim fluorescence or mean that the trim will provide adequate fire fighter visibility. Trim can lose fluorescence (daytime visibility) and still remain retroreflective. Trim can also appear to be retroreflective and not have sufficient intensity for nighttime visibility at far distances. Only testing under laboratory conditions can provide an accurate determination of trim visibility properties.

Attention during inspection should be paid to sections that show evidence of damage, abrasion, excessive soiling, or stains/discoloration. With proper care, visibility markings on turnout gear can provide long service, often as long as the service life of the ensemble itself.

A.6.3.5.1(10) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

N **A.6.3.5.2(5)** Two different test methods are provided for inspection of the particulate-blocking layer in protective hood interface components. Each of these test methods has advantages and disadvantages, and either can be selected.

Section 12.1 provides a standardized means for evaluating damage to the particulate-blocking layer using a light evaluation method. This method is relatively simple and can be applied either by using a clear head form with an internal light source to evaluate the entire hood simultaneously or by using a pipe section with an internally positioned light source to evaluate selected portions of the hood. Nevertheless, this technique might not be effective for all types of particulate-blocking protective hoods. It might be difficult to identify damaged areas of hoods that have relatively thick or dense layers or are dark in color.

Section 12.2 provides an inspection technique based on the use of smoke directed towards the hood that is clamped onto a modified moisture barrier hydrostatic testing device. The hood is observed for the passage of smoke through the clamped hood inspection area. The test can be performed one of two ways: qualitatively, by simply observing any differences in the amount of smoke coming through the hood; or quantitatively, with the use of a light beam directed across the hood inspection area that measures the interruption of light caused by the passage of smoke. The latter test provides a measurement of light transmission from 0 percent (fully blocked by smoke) to 100 percent (no smoke). Ordinary two-layer knit hoods without particulate-blocking layers generally provide measurements of 20 to 40 percent light transmission. The quantitative method moderately correlates with NFPA 1971's particulate-blocking test used to qualify particulate-blocking protective hoods at the 1 micron particle size. It is important to point out that use of this test will require the hood to be cleaned twice. Hoods must be cleaned prior to the inspection, and they must also be cleaned after the inspection test is applied to remove any residual smoke-generating liquid deposited on the hood as a result of the exposure.

A.6.3.5.2(10) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

A.6.3.5.3(13) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

A.6.3.5.4(3) The watertight integrity of gloves can be evaluated by the following test. A test subject wears lightweight cotton gloves under the gloves being inspected. The test subject then immerses the gloves in water up to the wrist crease, repeatedly flexes his or her hands for 2 minutes, and then takes them out of the water. The test gloves are removed and the cotton gloves examined for signs of watermarks. Gloves showing signs of leakage should be removed from service.

A.6.3.5.4(8) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

A.6.3.5.5(6) Excessive tread wear significantly reduces traction and safe footing on many surfaces such as wet flooring and roads, roofs, ladder rungs, and apparatus steps and platforms. Inspection of tread wear should focus on the heel and the ball of foot areas since those two areas carry the majority of a fire fighter's body weight and are the most critical in maintaining adequate traction. The organization should consult with the manufacturer and set guidelines for a minimum tread depth that has to be present for footwear to remain in service.

A.6.3.5.5(10) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

A.6.3.5.7(5) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

A.6.3.7.1 Organizations should consult with the manufacturer of the ensemble with optional liquid and particulate contamination protection for any additional or specific advanced inspection requirements for this type of ensemble.

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A.6.4.5.1 The ability to inspect the interior sides of the liner for the moisture barrier and thermal barrier can be accommodated by the presence of an inspection opening designed by the manufacturer that is built into the protective element. The location and method for securing this opening will vary with the manufacturer's design. However, the intent of this feature is to permit the organization conducting the inspection to invert the liner so that the interior sides of the moisture barrier and thermal barrier can be readily inspected. If the protective element is not provided with an inspection opening, the organization conducting the complete liner inspection might be required to remove a portion of the seam in the lining to permit opening the lining and allow its inversion for inspecting the interior sides of the moisture barrier and thermal barrier. The procedures used for removing the lining seam should conform to those procedures specified by the manufacturer of the protective element and should account for practices that minimize the damage and allow for ease of reconstructing the liner seam to limit any decrement of protective element performance or integrity.

Δ **A.7.1** The importance of maintaining the cleanliness of ensembles and ensemble elements should not be underestimated. Studies have shown that soiled or contaminated ensembles and ensemble elements are a hazard to fire fighters because soils and contaminants can be flammable, toxic, or carcinogenic. Additionally, soils or contaminants can reduce the protective performance of the ensembles and ensemble elements. Clean ensembles and ensemble elements can last longer and offer emergency responders better protection. Ensembles and ensemble elements should be cleaned whenever they become soiled.

In everyday use, personal protective equipment (PPE) becomes dirty by absorbing sweat from the wearer and soils, soot, and so forth from the outside environment. Cleaning of ensembles and ensemble elements removes those substances. Ensembles and ensemble elements can also become contaminated with other substances, principally hazardous materials, particulates, and body fluids. The removal of these substances is most often referred to by the term *decontamination*. In structural and proximity fire fighting, both general cleaning and decontamination of ensembles and ensemble elements are often necessary.

Health risks of soiled or contaminated ensembles and ensemble elements. Soiled or contaminated ensembles and ensemble elements can expose fire fighters to toxins, carcinogens, and other harmful substances that enter the body through ingestion, inhalation, or skin absorption. Repeated small exposures to some contaminants can accumulate within the body over time and cause health problems.

Although great emphasis is placed on safety to avoid injury or inhalation hazards to personnel working on the fireground, many of the contaminants that lead to health risks are being carried away from the fire scene on PPE used by the fire fighter. Structural and proximity fires are increasingly being identified as sources for contamination by products of combustion that are known to include various toxic and carcinogenic chemicals.

Contaminants that a fire fighter could come into contact with can be trapped in the fibers of soiled ensembles and ensemble elements or absorbed into the materials themselves. Contact with the soiled ensembles and ensemble elements increases the risk of hazardous contaminants being introduced into the body through either skin absorption or from contaminants off-gassing into the immediate atmosphere breathed by fire fighters.

Ensembles and ensemble elements contaminated with body fluids present a potential risk of infectious diseases being transmitted to the person coming into contact with the contaminated ensembles or ensemble elements.

Other forms of contaminants include substances such as bulk chemicals, asbestos, and other hazardous substances encountered at the emergency scene.

Reduced performance hazards of contaminated ensembles and ensemble elements. When ensembles or ensemble elements become laden with particles and chemicals, other problems are faced in addition to being exposed to toxins, such as the following:

(1) Soiled ensembles and ensemble elements typically reflect less radiant heat. After materials are saturated with hydrocarbons, they will tend to absorb rather than reflect the radiant heat from the surrounding fire.
(2) Ensembles and ensemble elements heavily contaminated with hydrocarbons are more likely to conduct electricity, increasing the danger when entering a building or vehicle where wiring can still be live.
(3) Ensembles and ensemble elements impregnated with oil, grease, and hydrocarbon deposits from soot and smoke can ignite and cause severe burns and injuries, even if the materials are normally flame-resistant.

Even though the number of specialized hazardous materials response teams is growing, individual fire fighters can still encounter various chemicals in their normal fire-fighting activities. Exposures to oils, gasoline, and lubricants can occur around fire station vehicles. During responses, exposures to liquids ranging from pesticides to acids to chemical solvents can occur, knowingly or unknowingly. These contaminants, in addition to being hazardous, can also degrade ensembles and ensemble elements as follows:

(1) Fabrics and materials can become weakened and tear more easily.
(2) Thread or seam sealing tape can become loose.
(3) Water-repelling treatments can be removed.
(4) Visibility markings can lose reflective properties or markings, becoming less visible.
(5) Helmet shells, helmet faceshields, or goggles can pit or craze.
(6) Ensemble and ensemble elements hardware can become corroded.

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N **A.7.1.1.1** Verified ISPs are required to go through a third-party verification of their cleaning procedures for garments in order to determine the effectiveness of their cleaning processes. Since the technical committee did not want to deter organizations from cleaning, they purposely did not make this cleaning verification a requirement for organizations cleaning their own gear. However, this validation is the only real assurance that a garment is "clean" as per the parameters established by the standard. Organizations are encouraged to contact verification agencies to have their own cleaning processes go through the same verification; however, the recommended procedures provided in A.7.3.9(5) for garments have been examined in a verification process and are expected to meet the cleaning verification requirements that are applied to a verified ISP.

Although the training for cleaning is only required to be done initially for each new edition of the standard, organizations should work with their training provider to determine if the training needs to be performed more frequently. At a minimum, discussion with the trainer should occur when detergents, chemicals, equipment, processes, or employees managing the training program undergo changes in order to determine if additional training is required.

N A.7.1.1.3 In most cases, preliminary exposure reduction is a recommended first step for any handling, cleaning, disinfection, or sanitization of protective ensembles or ensemble elements. One exception is where the ensemble and ensemble elements have been exposed to CBRN terrorism agents where the action should be to remove and isolate the clothing as quickly as possible in order to prevent any further spread of contaminants. Certain other highly hazardous contaminants might also pose similar dangers, therefore the actions of the organization should be to have the ensemble and ensemble elements removed and isolated immediately and bagged for later assessment.

Specific procedures for preliminary exposure reduction are provided in Section 7.2. Procedures for preliminary exposure reduction include the isolation, bagging, and separate transport of ensembles and ensemble elements that are contaminated or soiled. In certain rare cases, there might be circumstances where certain steps within the specified preliminary exposure reduction procedures are not appropriate for the circumstances of the event and it is the organization's responsibility to provide this judgment (e.g., contamination with water-reactive substances or the creation of a hazardous particulate atmosphere from brushing off a highly toxic substance from the exterior of the clothing and equipment). Likewise, there might be circumstances where it is impractical to carry out preliminary exposure reduction on scene and delays might be incurred before the full set of procedures can be undertaken.

N A.7.1.1.6 In general, dry cleaning is not recommended for cleaning protective ensembles and ensemble elements. Some dry cleaning solvents, particularly perchloroethylene or similar chemicals, used in lieu of water can damage components of the ensembles and ensemble elements. In particular, reflective trim, moisture barrier seam tape materials, certain helmet materials, and leather gloves can be adversely affected by such solvents. The manufacturer should be consulted prior to performing dry cleaning to confirm that ensembles and ensemble elements will not be damaged. Caution should be exercised in considering any other type of dry cleaning process without fully understanding that the process will not damage the protective ensemble element or its components through one or multiple applications.

N A.7.1.2 The approaches used for deciding on the handling, cleaning, and disposition of protective ensembles and ensemble elements uses a decision tree involving the highest risk contaminants and soils first and then proceeding to lower risk contaminants and soils. The process is illustrated in Figure 7.1.1.2(a).

CBRN Exposure. The first decision involves any exposure to chemical, biological, radiological, or nuclear (CBRN) terrorism agents. The ensemble and ensemble elements are immediately condemned and removed from service, given the high risks associated with CBRN terrorism agents.

Hazardous Materials Incident Exposure. The second decision involves the use of fire-fighting protective ensembles and ensemble elements in a hazardous materials incident. It is recognized that fire fighters might sometimes wear their structural or proximity fire-fighting protective ensembles and ensemble elements in response to a hazardous material incident, even if other types of protective clothing might be considered more appropriate for the type of exposure. Hazardous materials incidents typically involve exposure to chemicals or other substances that pose toxic, corrosive, irritating, or sensitizing hazards to the wearer. This type of ensemble or ensemble element use might occur without any fire threat; this section provides for decisions involving exposure during a response to bulk chemicals that occur as the result of a fire-based incident.

For hazardous materials incident exposure, the prescribed action following preliminary exposure reduction, including isolating and bagging the gear, is to have the organization's hazardous materials team or other qualified experts knowledgeable in hazardous materials assess the exposure to determine if decontamination is needed and is possible. If decontamination is needed, some form of specialized cleaning is required. The recommended decontamination procedures should only be applied if it is understood that it will be effective in removing the hazardous materials contamination or reducing it to a safe level. Otherwise, the ensemble or ensemble elements should be disposed of as contaminated waste.

Contamination Exposure. The third decision involves any response where contamination of the protective ensemble or ensemble elements occurs. This decision is broken into a separate set of decisions provided in Figure 7.1.1.2(b) and described in A.7.1.3.

Soiling Exposure. If there is no contamination and the ensemble or ensemble element is simply soiled from ordinary dirt, sweat, or other nonhazardous materials, then it is still recommended for the ensemble and ensemble elements to go through preliminary exposure reduction, followed by advanced cleaning, and to be subject to at least a routine inspection.

N A.7.1.3 The application of the appropriate cleaning, disinfection, or sanitization procedure(s) is dependent on properly classifying the contamination types to which the ensemble or ensemble elements have been exposed. For this standard, there are four general classifications of contamination.

Bulk Chemicals. Exposure to chemicals can occur at any emergency scene, particularly where various types of oils, greases, and lubricants are used. Many residential structural fires include a variety of cleaning agents and other products contained in garages, kitchens, and other portions of a house where direct liquid exposure to the chemical in its bulk form can occur. Structural fires at commercial facilities, particularly those involved in manufacturing, can likewise include a variety of different chemical substances in containers that break open and result in exposure to fire fighters in gas/vapor, liquid, or solid form. Depending on the nature of the specific chemical and its respective hazards, contamination of the ensemble and ensemble elements can occur and remain as persistent contamination that advanced cleaning procedures might be able to remove. Specialized cleaning is often recommended for bulk chemical contamination and could require inquiries to the chemical supplier as well as the manufacturer of the respective protective ensemble or ensemble elements. Depending on the hazards associated with the specific chemicals, the extent of contamination, or the lack of available decontamination proce-

dures, organizations might conclude that the risk for reuse of the ensemble or ensemble elements outweighs any benefits of retaining the clothing even if it appears to be clean and free of contamination.

Asbestos and Other Designated Hazardous Substances. Certain types of common contaminants [e.g., asbestos, opioid drugs (fentanyl)] and parasites (e.g., bed bugs) can require specialized cleaning or treatments for their removal from ensembles and ensemble elements. These substances are called out separately from bulk chemical exposures because there is some history and experience for addressing ensembles and ensemble elements contaminated with them. In particular, asbestos warrants special attention because of the direct link between asbestos exposure and mesothelioma, and the elevated risk to fire fighters. Decontamination of ensembles and ensemble elements that have been exposed to fentanyl powders requires use of certain procedures that prevent exposure to fire fighters and others handling the element. Conventional washing of protective ensembles and ensemble elements that have been exposed to bed bugs also will fail to kill all eggs that remain in the clothing. Ensemble and ensemble element exposure to these substances requires special consideration and often entails specialized cleaning procedures or treatments for their removal. Depending on the risk associated with a specific contaminating substance, organizations might conclude that the risk for reuse of the ensemble or ensemble element outweighs any benefits to retaining the ensemble or ensemble element even if it appears to be clean and free of contamination.

Body Fluids and Other Microbial Contamination. Body fluids such as blood, vomit, and various secretions are often encountered in providing emergency patient care or rescue of victims at an emergency scene. These fluids must be treated as potentially infectious, therefore ensembles and ensemble elements contaminated with body fluids must be subject to sanitization or disinfection, where disinfection represents a greater efficiency in removing potentially infectious microorganisms. Other biological contaminants can include methicillin-resistant Staphylococcus aureus (MRSA) and Clostridium difficile (C. difficile) from medical victim contact and Escherichia coli (E. coli) from flood water contact. These contaminants require disinfection or sanitization of ensembles and ensemble elements to reduce the microbial threat where exposure has occurred. Disinfection or sanitization might precede advanced cleaning or be part of the advanced cleaning process since soils associated with many body fluids must also be removed. It is important to recognize that disinfection or sanitization generally only affects the viability of the microbial contamination and might not remove other associated soils such as dried blood, body fluids, or other liquids/solids in which the microbial contamination is found.

Products of Combustion. Generally, all fires where entry is made while wearing self-contained breathing apparatus (SCBA) will expose ensembles and ensemble elements to products of combustion. The smoke particles and fire gases easily penetrate and contaminate clothing. Depending on the length of exposure and degree to which fire fighters are exposed, the levels of contamination from products of combustion will vary but will always require advanced cleaning. Preliminary exposure reduction is undertaken to remove some forms of surface contamination as well as to minimize the transfer of exterior contaminants to the fire fighter or other surfaces such as apparatus seats and fire station work/living areas prior to advanced cleaning.

***N* A.7.1.3.5.1** It is recognized that it might not always be practical for organizations to carry out preliminary exposure reduction on-scene because of personnel constraints, lack of on-scene resources, availability of spare gear, the weather, and other operational factors. Nevertheless, it is important that organizations implement some form of preliminary exposure reduction procedure as soon as is practically possible, particularly following any event where ensembles or ensemble elements are contaminated.

Organizations should review and revise their policies and procedures to minimize opportunities for cross contamination of apparatus, personal vehicles, and fire stations.

***N* A.7.1.3.5.2** It is recognized that it might not always be possible for organizations to remove soiled or contaminated ensembles or ensemble elements from service immediately following an incident for advanced cleaning. This is not intended to change the fact that advanced cleaning should be applied whenever protective ensembles or ensemble elements are soiled and contaminated. It is important that organizations implement advanced cleaning as soon as possible following any event where ensembles or ensemble elements are soiled or contaminated.

Organizations should review and revise their policies and procedures to minimize the number of incidents where soiled or contaminated ensembles or ensemble elements remain in service. They should also review and revise their procedures to reduce the amount of time soiled or contaminated ensembles or ensemble elements remain in service, in those rare incidents, before receiving advanced cleaning. The goal is to eliminate the number of times and the amount of time contaminated ensembles and ensemble elements are left in service.

In many cases, this will fundamentally change the way fire departments manage their on-scene and post-scene operations. Organizations and fire fighters must understand that the longer soiled or contaminated PPE remains in service, the longer fire fighters are exposed to carcinogens and other health hazards. This exposure includes direct contact as well as off-gassing.

***N* A.7.2** Preliminary exposure reduction is not considered by itself to be a complete cleaning of ensembles or ensemble elements. Rather, it is intended to reduce the exposure of fire fighters to soils and contaminants that arise during structural or proximity fires or other emergency response events. Preliminary exposure reduction also aids in minimizing the transfer of soils and contaminants from the emergency scene to the apparatus, station, and personal vehicles. Other forms of cleaning, such as advanced or specialized cleaning, are required to provide full cleaning of the ensemble or ensemble elements.

***N* A.7.2.1.1** Preliminary exposure reduction is an essential first step in minimizing cross contamination preceding the cleaning of ensembles or ensemble elements as specified in 7.1.1.2 and as shown in Figure 7.1.1.2(a) and Figure 7.1.1.2(b).

A.7.2.1.2 Preliminary exposure reduction is an attempt to remove some exterior soiling and contamination from ensembles and ensemble elements that is performed by the end user to minimize transfer of soil and contaminants outside of the incident scene. Whenever possible, preliminary exposure

reduction should be conducted as personnel exit the emergency scene and before entering the rehabilitation area. While it is possible to conduct dry mitigation without the elements being taken out of service, wet mitigation might require protective elements to be removed because they are wetted. While the selected procedures for preliminary exposure reduction might not result in the elements being taken out of service, a determination by the organization might be made that the elements be isolated and bagged if determined to be contaminated and warrant more extensive cleaning.

Some organizations might consider having spare gear or other spare clothing, such as disposable clothing, available for members to wear until the members can shower and change into clean clothing.

It is recognized that it might not always be practical for organizations to carry out preliminary exposure reduction on-scene because of personnel constraints, lack of on-scene resources, availability of spare gear, the weather, and other operational factors. Nevertheless, it is important that organizations implement some form of preliminary exposure reduction procedure as soon as is practically possible, particularly following any event where ensembles or ensemble elements are contaminated.

Organizations should review and revise their policies and procedures to minimize opportunities for cross contamination of apparatus, personal vehicles, and fire stations.

A.7.2.2.1 Preliminary exposure reduction after the termination of an incident can remove substantial amounts of surface contaminants before they have a chance to set in and might limit the transfer of contaminants to apparatus, personal vehicles, and stations. Many of the contaminants that can cause damage to visibility markings and other materials and components of ensembles or ensemble elements also can be removed if preliminary exposure reduction is done as soon as possible after exposure. It is recognized that is not always practical for organizations to carry out preliminary exposure reduction on scene because of constraints in personnel, on-scene resources, availability of spare gear, weather, and other operational factors. Nevertheless, it is important that organizations implement some form of preliminary exposure reduction procedures as soon as practically possible, particularly following any event where ensembles or ensemble elements are contaminated.

Use of a portable decontamination shower unit that conforms to the requirements in ANSI/ISEA 113, *American National Standard for Fixed and Portable Decontamination Shower Units*, is one means for providing wet mitigation as part of preliminary exposure reduction.

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N **A.7.2.2.2** The purpose of remaining on air is to minimize the end user's exposure to products of combustion that might off-gas from the ensemble or ensemble elements following contaminant exposure during a structural fire and to help the end user avoid breathing in any particulates that might be dislodged from the ensemble or ensemble elements during dry mitigation.

N **A.7.2.2.4** The decision between dry and wet mitigation will depend on the resources available to the organization and the conditions at the emergency scene or other location. Work by the Illinois Fire Service Institute under an Assistance to Firefighters Research Grant from the U.S. Department of Homeland Security has shown that wet mitigation techniques are more effective in removing surface contamination as compared to dry mitigation techniques. Wet mitigation techniques remove a significant amount of products of combustion whereas dry mitigation techniques only remove a portion of such contamination. Techniques involving blowing air onto ensembles or ensemble elements, such as from a leaf blower, should be avoided because they are minimally effective and might only redistribute contamination at the emergency scene and create inhalation hazards for unprotected personnel (Fent, et. al.).

N **A.7.2.2.4.1** Dry mitigation techniques are best achieved with a soft bristle brush starting at the top of the end user's ensemble or ensemble element and working downward.

N **A.7.2.2.4.2** There are several means by which wet mitigation techniques can be carried out. One method is to use a reducer from the apparatus pump panel to supply a small hose line, such as a forestry hose or a garden hose with an adjustable nozzle, at low pressure and volume. Caution should be applied when using ordinary fire hoses and nozzles for this technique where the lowest possible flow rate is used. Most departments might have a "booster line" or "trash line" that is usually ¾ in. or 1 in. in diameter than can be applied at a low pressure less than 30 psi. Portable decontamination showers that conform to ANSI/ISEA 113, *American National Standard for Fixed and Portable Decontamination Shower Units*, can also be used and assist where weather, modesty, or other issues might occur.

The process of wet mitigation should start with spray at the top of the user's ensemble or ensemble element, rinsing downward. Where necessary, a soft bristle brush might be used to gently scrub the ensemble or ensemble elements. It is important that the spray be light, that it doesn't soak through the clothing, and that it can be applied over the entire fire fighter, as the primary purpose of this mitigation technique is to remove surface contamination. Wet mitigation techniques cannot remove interior layer soiling or contamination.

It is further recommended that a mild detergent be used as an aid in wet mitigation where the surfactant in the detergent is helpful for removing exterior soils. Where a mild detergent is used, it should be followed by gentle rinsing of the ensemble or ensemble elements.

Organizations performing wet mitigation techniques should take into consideration the runoff of any contaminated rinse water to minimize the spread of contamination to the environment.

N **A.7.2.2.5** It is recognized that it might not always be practical for organizations to carry out preliminary exposure reduction on-scene because of personnel constraints, lack of on-scene resources, availability of spare gear, the weather, and other operational factors. Nevertheless, it is important that organizations implement some form of preliminary exposure reduction procedure as soon as is practically possible, particularly following any event where ensembles or ensemble elements are contaminated.

Organizations should review and revise their policies and procedures to minimize opportunities for cross contamination of apparatus, personal vehicles, and fire stations.

The removal of ensembles or ensemble elements at the scene might require additional clothing to be present, particularly under inclement or cold weather conditions. Portable

facilities might be required for end users to change. Portable decontamination showers conforming to ANSI/ISEA 113, *American National Standard for Fixed and Portable Decontamination Shower Units*, can be set up at the scene in a relatively short period of time and require limited resources for provided in protection from weather and modesty to fire fighters. In addition, it is recommended that personnel use disposable wet wipes to clean portions of their face and skin when known to be directly exposed to contaminants, change into a clean station/work uniform, and take a shower as soon as possible.

For isolation of ensembles and ensemble elements, airtight protective containers or bags should be used to minimize cross contamination. Examples include disposable, heavy-duty polyethylene bags or sealable plastic cases, which are cleanable. If a plastic bag is used, it is recommended that the bag be clear to ensure that the contents of the bag can be readily identified. Relatively thick plastic bags, at least 2 mils in thickness, are recommended to resist punctures. Ensembles or ensemble elements should not be transported from the incident scene in the passenger areas of apparatus or personal vehicles. This reduces further exposure of personnel to contaminated ensembles and ensemble elements and also reduces cross contamination of apparatus or personal vehicles.

If the protective ensemble or ensemble elements are wet, the protective ensemble or ensemble elements must be removed as soon as possible following transport from the fire or other emergency scene since ensembles and ensemble elements that remain wet under closed conditions can result in the growth of damaging mold and mildew. It is further important that, following their transport, protective ensembles and ensemble elements be stored under conditions where they can dry until appropriate cleaning procedures can be conducted as specified in Chapter 7.

N **A.7.2.4** The manufacturer's guidelines for the proper cleaning of faceshields, flip-downs, or goggles should be followed. Most manufacturers list specific products that will clean these components without causing damage. For example, repeatedly using ammonia-based window cleaner will eventually cause fogging that will decrease visibility.

N **A.7.3.1.3** To perform advanced cleaning, the organization must be a manufacturer-trained organization. The training required to become a manufacturer-trained organization is specified in 4.2.4.5.

Δ **A.7.3.3** Advanced cleaning is a thorough cleaning of ensembles and ensemble elements accomplished by washing them with cleaning agents. Advanced cleaning is prescribed for ensembles and ensemble elements that are soiled or contaminated, including those that have been subject to ordinary wear without contamination, those that have been contaminated in structural or proximity fire fighting by products of combustion, or those that have been exposed to blood and body fluids. Where highly hazardous or other designated substances are involved, specialized cleaning might be needed.

Specialized cleaning differs from advanced cleaning in that an assessment of the contamination by an individual knowledgeable in the cleaning of fire-fighting protective ensembles and ensemble elements is needed for determining what type of cleaning, if any, is appropriate.

Advanced cleaning requires elements to be temporarily taken out of service. Advanced cleaning can be accomplished by hand washing in a utility sink or by machine washing, depending on the ensemble or ensemble element. Hand washing is not permitted for ensemble or ensemble elements, except for proximity fire-fighting garment outer shells and other radiant reflective components, because machine washing can cause damage to the aluminized surfaces of these materials.

Soiling and contamination are not always visible and can be difficult to observe on darkly colored materials. In addition, ensembles and ensemble elements can be contaminated with persistent fire gases and other hazardous substances, resulting in ensembles and ensemble elements that are unsafe for use. Ensembles and ensemble elements that have not been cleaned and appear to be unsoiled have been shown to contain numerous fire gas chemicals, including carcinogenic polynuclear aromatic compounds. Periodic cleaning is required to avoid use of ensembles and ensemble elements that could be contaminated without visible evidence of soiling.

It is the intent of this standard that ensembles and ensemble elements receive advanced cleaning whenever they are soiled or contaminated. This is in addition to the being subjected to advanced cleaning twice a year *(see 7.3.4 and A.7.3.4)*.

It is recognized that it might not always be practical for organizations to remove soiled or contaminated ensembles or ensemble elements from service immediately following an incident for advanced cleaning. This is not intended to change the fact that advanced cleaning should be applied whenever protective ensembles or ensemble elements are soiled and contaminated. It is important that organizations implement advanced cleaning as soon as is practically possible following any event where ensembles or ensemble elements are soiled or contaminated.

Organizations should review and revise their procedures to reduce the amount of time soiled or contaminated ensembles or ensemble elements remain in service, in those rare incidents, before receiving advanced cleaning. The goal is to eliminate the number of times and the amount of time contaminated ensembles and ensemble elements are left in service.

In many cases, this will fundamentally change the way fire departments manage their on-scene and post-scene operations. Organizations and fire fighters must understand that the longer soiled or contaminated PPE remains in service, the longer fire fighters are exposed to carcinogens and other health hazards. This exposure includes direct contact as well as off-gassing.

N **A.7.3.4** This requirement is not intended to change the fact that advanced cleaning should be applied whenever protective ensembles or ensemble elements are soiled and contaminated. Instead, it is intended to ensure that worn and used clothing is subjected to advanced cleaning at least every six months. One of those advanced cleanings should be in conjunction with an advanced inspection.

Δ **A.7.3.5** Machine cleaning using a front-loading washer/extractor is the most effective method for cleaning ensembles and ensemble elements such as structural fire-fighting coats, trousers, coveralls, and hoods. It is the most effective means of loosening and removing dirt, soot, and other debris. Front-loading washer/extractors are the appropriate machine type for protective ensembles and ensemble elements.

Front-loading washer/extractors have a door on the front of the machine through which garments are loaded. They clean by lifting garments out of the water and gently dropping them back into the water. These units provide better mechanical action because of the size and type of rotation, as well as the degree of extraction. They have various capacities and are designed to handle heavy loads of bulky items and also to save water and energy.

The capacity of a washer/extractor is important for several reasons, including the following:

(1) Washer/extractors that are overloaded do not clean effectively because there is not enough movement of the protective elements to provide for mechanical action.
(2) Washer/extractors that are underloaded do not clean effectively because the wash articles do not make sufficient contact with mechanical action.
(3) Large washer/extractors require more water and energy and also output a lot of water during the extraction discharge steps of the washing process.

A washer/extractor with a minimum load capacity of 13.6 kg (30 lb) and a minimum volumetric capacity of 0.11 m^3 (4.0 ft^3) is recommended. However, the capacity selection for the wash can be increased or decreased depending on the expected throughput of garments and the frequency of advanced cleaning. Further information on washer/extractor loading is provided in A.7.3.9(1).

It is very important for machine operators to ensure correct water temperatures and proper detergent selection and to adjust the g-forces of the spinning/extraction cycle. Careful adherence to manufacturers' recommendations of cleaning processes has a significant impact on cleaning thoroughness and maintenance of protection factors inherent in each element, as well as extending the life expectancy of elements.

When possible, organizations should provide a washer/extractor(s) for the sole purpose of cleaning protective ensembles and ensemble elements.

N **A.7.3.5(2)** Preliminary research suggests that excessive g-forces created by washing machine drums that spin at high revolutions per minute (RPMs) can damage protective garments. The type and severity of damage will depend on the g-forces created, exposure time, number of exposures, condition of the ensemble or ensemble element, and materials used to construct the ensemble or ensemble element. Thermal and moisture barriers are the most vulnerable. Thermal barriers can hold several times their weight in water; extraction at high RPMs creates high g-forces, resulting in the shifting of nonwoven insulating materials. Moisture barrier materials and seams are designed to impede the flow of water; extraction at high RPMs can severely damage moisture barriers and moisture barrier seams as water pushes against the barriers in an attempt to escape toward the outer perimeter of the drum. A vast majority of ISPs are monitoring extraction RPMs and have adjusted their commercial machines to create less than 100 G when cleaning all protective ensembles and ensemble elements. End users should make every effort to control and lower the RPMs of laundering machines used for protective ensemble and ensemble elements to preserve their integrity and increase their longevity.

N **A.7.3.6** Top-loading machines are similar to those used in most homes. Many use a center post agitator to whisk water through the fibers of garments. There are also high efficiency (HE) top-loading machines that do not have an agitator designed to clean multiple garments of minimum bulk. As a result of the center post agitation in machines that incorporate that feature, it is generally accepted that top-loading machines are more damaging to ensembles and ensemble elements than front-loading machines. Furthermore, many top-loading machines are unable to precisely control the temperatures for individual cycle steps, and HE top-loading machines generally lack sufficient rinsing capability for advanced cleaning of garments. Therefore, top-loading, agitating machines have the potential to reduce the longevity of garments due to mechanical damage and could be less effective in cleaning protective garments.

N **A.7.3.6.1** Some manufacturers might maintain lists of advanced cleaning processes, equipment, and detergents.

N **A.7.3.7.2** The pH for the product can be indicated on the product (detergent) container and should be the pH for the product in an undiluted form if it is a liquid. If the detergent is a powder, the pH will be reported at a specific concentration of the solid on a weight basis in water. If the pH is not listed on the product container, then the safety data sheet (SDS) should be requested from the product supplier. Most suppliers will normally provide the SDS for their respective products as part of the shipment, and it might also be possible to obtain a copy of the SDS online from the supplier's website.

The pH for the product is typically listed in Section 9 of the SDS for the product's physical and chemical properties.

The selection of the detergent should include a consideration of several factors in addition to the pH range. Foremost among these is demonstration by the supplier that the detergent is safe to use with fire fighter protective clothing. This demonstration consists of the following two parts:

(1) The effectiveness of the detergent in removing soils and other contaminants as indicated later in this section
(2) The impact of the detergent through multiple washings on the protective element as described in A.7.3.7.3

This information might be available from the supplier of the detergent, the manufacturer of the protective element, or the fabric suppliers. If there is uncertainty about a particular detergent or cleaning agent, the manufacturer of the protective element should be contacted.

Organizations should be cautious about detergent or chemical suppliers that offer several different chemicals for cleaning protective elements. Many chemical suppliers will provide the organization with an automated dispenser that can feed liquid chemicals into the washer/extractor at no cost, on the requirement that chemicals are purchased from that supplier. Certain types of chemicals, such as alkali builders and sours, should be avoided. Alkali builders are used to significantly increase the pH of the wash water for enhancing the cleaning performance of certain detergents. These chemicals typically have pH values that are greater than 10.5. When alkali builders are used, the pH is usually brought to a lower level using a "sour," an acid-based agent used to bring the wash water back to a neutral pH. Sour cleaning agents are added toward the end of the wash formulation and almost always have pH values much lower than 6.0. The combination of alkali builders and sours is most often used in institutional laundering facilities but is not appropriate for protective elements unless the manufacturer of the respective protective element has indicated that these types of products can be used safely.

In general, mild domestic laundry detergents can be used if applied with the instructions provided for the laundry in terms of the amount of detergent added for the wash water volume used in the suds (detergent addition step) for the specific washing machine or washer/extractor. A single detergent can be viable for washing both the shell and liners for structural firefighting protective garments; however, some suppliers might offer specialty detergents that have been formulated for either heavier duty cleaning of outer shells or gentler cleaning of linings. In addition, spot treatment agents are usually required for removal of specific heavy soiling and some common fireground contaminants.

N **A.7.3.7.3** Cleaning processing can have different effects on the performance properties of protective ensembles or ensemble elements, especially when repeated multiple times over the life cycle of the ensemble or ensemble element. The effects of the cleaning agent or cleaning process should be judged on the basis of tests performed on representative material samples following several cleaning cycles (washing and drying). The samples should be subjected to at least 25 cleaning cycles; however, organizations might want to demonstrate effects after as many as 40 cleaning cycles.

Ideally, ensembles and ensemble elements should be evaluated for each of the performance properties listed in NFPA 1971; however, key properties can be selected. Table A.7.3.7.3 provides a list of recommended key properties for the evaluation of the impact of cleaning procedures on garment elements. One approach for evaluating these properties is to construct large panels of the composites, with finished edges and including seams and other components of interest used in representative protective clothing, and subject these samples to the cleaning process multiple times. A panel size of 66 cm^2 (26 $in.^2$) has been found useful for this type of testing.

Other properties that are of interest to the organization can be evaluated, including, but not limited to, the following:

(1) Composite weight
(2) Composite thickness
(3) Composite total heat loss (breathability)
(4) Outer shell colorfastness to washing
(5) Outer shell colorfastness to light exposure
(6) Outer shell or thermal barrier abrasion resistance

The effects of cleaning properties are evaluated by comparing the measured property after washing with the same property measured for new material. It is important to review both the after-cleaning level and the change for the measured property. Properties should remain at or above the minimum performance requirements established in NFPA 1971. However, it should be recognized that some properties, such as composite total heat loss and individual layer tear resistance might be reduced and fall below initial NFPA 1971 minimum performance requirements during the service life of the garment. These criteria only pertain to ensembles and ensemble elements when new; therefore, experienced individuals within the organization should make a determination on whether diminished performance represents a safety hazard to the wearer.

It is also important to take note of large changes in clothing material properties, even if the results show compliant performance. For example, the tear strength of a material can be measured at a level of 11.4 kg (25 lb) before cleaning and then 10 kg (22 lb) after several cycles, whereas a different material could begin at 18.2 kg (40 lb) and drop to 11.4 kg (25 lb) after the same number of cleaning cycles. This particular case points out that one material might be more susceptible to damage during cleaning.

It is also possible for some measured properties to increase after multiple cleaning cycles. For example, thermal insulation as measured in the thermal protective performance test often improves after cleaning because the thickness (or loft) of the materials increases. Conversely, the total heat loss (THL) value of the same ensemble can decrease as a result of cleaning.

In evaluating the effects of cleaning agents or cleaning procedures on ensembles and ensemble elements, it is important to realize that applying multiple cleaning cycles does not simulate its use. Cleaning is but one factor in the wear of protective ensemble and ensemble elements. Cleaning, when properly applied, might also extend the life of the ensemble and ensemble element.

N **A.7.3.7.4** Organizations should be aware that cleaning of protective equipment is a complicated process and that there is no guarantee that the protective elements will be free from contamination after being subjected to an appropriate advanced or specialized cleaning procedure.

Testing for Cleaning Effectiveness. While the purpose of cleaning is to remove all contamination from an ensemble or ensemble element, cleaning processes are not always 100 percent effective in removing all contamination. The actual success of a cleaning process can be determined only by measuring the concentration of the contaminant(s) in the element before and after the selected process. The majority of tests that can be applied for measuring the concentration of contamination in the ensemble or ensemble element require destructive sampling of the ensemble or ensemble element that could render it unusable or nonrepairable. Furthermore, many test methods require only small portions of material for analysis; therefore, there is a lack of certainty that the swatches or pieces of material analyzed are representative of the entire ensemble or ensemble element. In addition, if destructive testing of one or more ensembles or ensemble elements is applied, then assumptions about other untested ensembles or ensemble elements have to be made, which might not be verifiable.

If testing is performed on a contaminated ensemble or ensemble element, it is also necessary to test unaffected elements in order to get a baseline on chemicals that might already be present in the clothing so that an adequate comparison of cleaned and uncleaned clothing can be made to determine the effectiveness of the cleaning process. When noncontaminated elements are selected for testing, they should be selected in such a fashion as to provide a similar age and level of use and prior cleaning for establishing an appropriate baseline. While an analysis of the rinse water or other extract from a cleaning process can provide some information, the sole evaluation of contamination levels in rinse water is not an appropriate measure of effectiveness. Claims for ensembles or ensemble elements being contaminant-free based on statements from any organization or facility or based on the use of specific cleaning products or processes should be viewed with caution unless detailed information demonstrating effectiveness in removing specific contaminants from relevant fire fighter ensembles or ensemble elements is provided.

N Table A.7.3.7.3 Recommended Test Methods in NFPA 1971 for Evaluating Effects of Advanced Cleaning Procedures on Garment Performance Properties

Performance Property	Test Method (in NFPA 1971)	Type of Sample(s)	Specimens Required*
Thermal protective performance (TPP)	Section 8.10	Composite	Three 150 mm (6 in.) squares
Flame resistance	Section 8.2	Outer shell, moisture barrier, thermal barrier	Five 75 mm × 305 mm (3 in. × 12 in.) rectangles (in each material direction)
Tear resistance	Section 8.12	Outer shell, moisture barrier, thermal barrier	Five 75 mm × 150 mm (3 in. × 6 in.) rectangles (in each material direction)
Breaking strength	Section 8.50	Outer shell	Five 100 mm × 200 mm (4 in. × 8 in.) rectangles (in each material direction)
Seam-breaking strength	Section 8.14	Major outer shell, moisture barrier, thermal barrier	Five 100 mm × 200 mm (4 in. × 8 in.) rectangles where seam bisects long dimension
Water absorption resistance	Section 8.25	Outer shell	Three 200 mm (8 in.) squares
Cleaning shrinkage resistance	Section 8.24	Outer shell, moisture barrier, thermal barrier	Five 375 mm (15 in.) squares
Liquid penetration resistance–Fuel H	Section 8.27	Moisture barrier seams	Three 75 mm (3 in.) squares
Viral penetration resistance	Section 8.28	Moisture barrier seams	Four 75 mm (3 in.) squares
Retroreflectivity and fluorescence	Section 8.45	Trim sections	Four 305 mm (12 in.) lengths

*Either specimens removed from garment element or representative prepared material samples.

General Procedures for Clothing Contamination Testing. Procedures used for measuring contamination levels should be specific for the contaminant(s), if known. Useful analytical procedures for measuring levels of a broad range of semivolatile organic chemicals in materials are found in the following sections provided in EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*: Method 3540C, "Soxhlet Extraction" and Method 8270D, "Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)."

These procedures involve extracting a small piece of fabric in a solvent such as methylene chloride and analyzing the extract solution using gas chromatography in conjunction with mass spectrometry. The gas chromatography separates chemical contaminants and quantifies their amount, while the mass spectrometry identifies the separate chemicals. It is important to note that these procedures only target certain classes of common chemical contaminants such as polynuclear aromatic hydrocarbons, phthalates, certain substituted phenols, and other low volatility organic compounds. Different extraction and analysis methods have to be used for other contamination substances such as brominated fire retardant chemicals and substituted dioxins.

Similar analytical procedures for measuring levels of inorganic chemicals (e.g., heavy metal contaminants like arsenic, chromium, and lead) in materials are found in the following sections provided in EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*: Method 3015A, "Microwave Assisted Acid Digestion of Aqueous Samples and Extracts," and Method 6010D, "Inductively Coupled Plasma-Atomic Emission Spectrometry." These procedures also involve analysis of a small material specimen. The specimen is digested in nitric acid and then treated with 50 percent hydrogen peroxide. The solution of the digested specimen is then diluted for analysis by atomic absorption or ion coupled plasma-atomic spectroscopy to identify and determine the amount of different inorganic substances.

Most tests for evaluating contamination levels of protective ensembles or ensemble elements will yield results that are reported in mass of contaminant per unit mass of the material, such as milligrams of contaminant per kilogram of material (mg/kg), which is equivalent to parts per million (ppm). In other cases, test results might be reported in the mass of contaminant per unit area of material, such as micrograms per square centimeter of material ($\mu g/cm^2$). These types of measurements provide a quantity of contamination that can be extrapolated to the entire item, knowing its overall weight or surface area; however, that extrapolation assumes that the contamination is uniformly spread over the entire ensemble or ensemble element. This is generally not a valid assumption since contamination varies across the ensemble or ensemble element.

Establishment of the Testing Approach. Because these procedures are sensitive for quantifying many forms of contamination, any testing for measuring contamination levels should involve control tests. Control tests are separate measurements used to determine background contamination that might be present in the material or in residue left from the cleaning agents or cleaning procedures. Failure to consider such chemicals can interfere with the accuracy of measurements for actual contaminants. In general, the following control tests are needed:

(1) A test of the same material being analyzed without the contaminant present (e.g., material taken from PPE with a similar history but unexposed to the contaminants)

(2) A test of the same material that is not contaminated after washing that has been subjected to the cleaning process (e.g., a test on a piece of new material that has been cleaned using the subject cleaning agent and procedures)

The levels of residual contaminants from these control tests should be subtracted from the after-cleaning samples. The residual contamination from the first control test should be subtracted from the before-cleaning samples. Decontamination effectiveness can be determined by calculating the proportion of contaminant removed using the following equation:

[A.7.3.7.4]

$$\text{Percent decontamination efficiency} = \frac{\text{Initial level of } C - \text{Final level of } C}{\text{Initial level of } C} \times 100$$

where:
C = contaminant

The decontamination effectiveness will vary with each contaminant because some contaminants can be removed more easily than others, given differences in the properties of the contaminant and the properties of the contaminated element materials. For example, chemicals such as hexane and benzene that evaporate easily will usually be removed easily compared with nonvolatile (nonevaporating) chemicals found in tars and oily chemicals.

Interpretation of Test Results. The remaining level of contaminant in a protective ensembles or ensemble element can be used to determine the potential risk to the wearer. However, there are no established safe levels of residual concentration levels for most contaminants. The decision to reuse a protective element based on known, measured levels of contamination should be undertaken by a trained professional familiar with the properties and hazards of the contaminant. Any uncertainty of the risk presented by residual contamination or of acceptable levels for continued use can be a cause for retirement and disposal of the protective item.

The procedures for measuring contamination levels in protective ensembles or ensemble elements are usually destructive in that they require that a specimen be taken from the item and subjected to extraction or digestion with a solvent. This requirement, in addition to the expense of the analytical testing, can make the decision to investigate contamination levels in protective ensembles or ensemble elements cost prohibitive.

Specimens of protective ensembles or ensemble elements taken for determination of contamination levels cannot be representative for all areas of the item being sampled. For example, a specimen taken from the pocket of a coat will not reflect the contamination level for the back of the coat or the bottom of trousers. In addition, sampling of one protective ensemble or ensemble element will not be representative of all ensembles or ensemble elements from a certain group that are or are suspected of being contaminated. Contamination levels for different protective ensembles or ensemble elements of the same type depend on the type of exposure, the condition of the protective element, and the care provided to the item.

Concerns over protective ensemble or ensemble element contamination can arise from a single incident involving a contamination event or can be an ongoing consideration as contaminants from routine situations accumulate in the ensemble(s) or ensemble element(s). Organizations can periodically sample ensembles and ensemble elements to determine the effectiveness of cleaning processes in removing harmful contaminants, but they should understand the limitations of the approach — specifically that sampling cannot be representative of all the protective ensembles and ensemble elements in use.

Further details about this information are provided in the report for the U.S. Fire Administration (USFA), "Research, Testing, and Analysis on the Decontamination of Fire Fighting Protective Clothing and Equipment." A synopsis of the USFA report is provided in ASTM STP1237, *Performance of Protective Clothing*.

Overall Considerations for Contamination Testing. While testing for determining contamination in exposed or cleaned protective elements can be useful, it must be carefully performed by qualified laboratories with the results interpreted by knowledgeable individuals to provide an accurate assessment of cleaning effectiveness and any hazards associated with the reuse of protective clothing. This testing is generally expensive, is destructive of the element being tested, and takes some to have performed. Any decision to perform testing on contaminated clothing should weigh the costs for replacing the clothing versus the cost of testing and destruction of clothing items through testing.

N **A.7.3.8** Universal precautions, normally applied for handling items potentially exposed to blood-borne pathogens, involve the assumption that all contamination is potentially harmful and that individuals handling the items need to wear appropriate PPE and apply appropriate hygiene to avoid accidental contact with contaminated ensembles or ensemble elements. Recommended PPE includes examination gloves, an apron and protective sleeves or coveralls, and a pair of safety glasses or goggles.

A.7.3.9(1) Proper load size is essential for effective cleaning. An overloaded washer prevents the wetted load from dropping during the washing process from an 11 o'clock to a 5 o'clock drop in a clockwise wash rotation. Overloading occurs when this drop of the wash load does not happen. In addition, full loads are best for washing as the agitation and cleaning are most efficient with full loads. Therefore, it is also important to avoid under-loading the washer/extractor.

The capacity of a washer/extractor is provided both in the weight of the load, usually reported in pounds, and the overall volume, usually reported in cubic feet, of the basket. As a rule of thumb, one cubic foot of washer/extractor basket allows a capacity of two garment shells or liners. For example, a 30 pound washer/extractor has a basket volume of 4.1 cubic feet. Thus, a washer/extractor with this capacity would fit four pieces. Similarly, a 60 pound washer/extractor with a 9.0 cubic foot basket would fit nine pieces. Where there is a fractional amount of cubic feet in the washer/extractor capability, it is recommended to round up to get a whole number of garment pieces.

A.7.3.9(2) It is recommended that heavily soiled structural fire-fighting garments be soaked according to the detergent manufacturer's instructions. The garment should be removed and the soak water should be drained. If necessary, a soft bristle brush should be used to gently scrub those portions of the garment outer shell that have the greatest soiling. Alternatively,

specific formulations for washer/extractors can include presoak steps at the beginning of the wash cycle.

Proximity garment outer shells should not be soaked, scrubbed, or brushed. Use a soft cloth or sponge when cleaning proximity garments.

A.7.3.9(4) At the time this edition was prepared, the technical committee recognized that, depending on the contaminant, the wash temperature maximum of 40°C (105°F) might not be the most effective temperature for cleaning those ensemble elements that can be subjected to higher wash temperatures in washer/extractors. However, even with this recognition, the technical committee was reluctant to increase the maximum wash temperature for advanced cleaning because it will occur more frequently than specialized cleaning or disinfection or sanitization and, to date, only limited testing has been done on the effects of multiple washings at 60°C (140°F) on garment ensembles and ensemble elements. Based on this work, there is a tradeoff between increasing the wash temperature for purposes of contaminant removal and the impact of the increased wash temperature for adversely affecting the performance properties of ensemble elements.

Effects of Increasing Wash Temperature for Removal of Contaminants. Fire fighter protective ensembles and ensemble elements might be contaminated with soot and chemicals such as polynuclear aromatic hydrocarbons (PAHs), phenols, phthalates, hydrocarbons, heavy metals, and other hazardous materials during fire responses, various chemical compounds from hazmat responses, and microorganisms during medical responses or biohazard responses. Appropriate removal of these contaminants is necessary both for protecting the health of the fire fighter and for ensuring that the gear performance is not compromised. To assess appropriate turnout cleaning parameters, specifically wash temperature, it is useful to consider the cleaning recommendations for garments used in agricultural and health care applications because such applications involve hazardous materials to which ensembles and ensemble elements might also be exposed: pesticides and infectious agents.

Extensive research has been performed to examine the effectiveness of different laundering procedures in removing pesticides. This information is relevant to fire fighter ensembles and ensemble elements because pesticide chemicals have a range of properties that are similar to fireground chemicals in terms of low volatility and often low water solubility. Research from several sources has shown that higher wash temperatures of up to 60°C (140°F) have greater efficacy at removing pesticide contamination, as reported in the following references:

(1) Thostenson, A., et al. "Laundering Pesticide-contaminated Work Clothes (PS1778)." North Dakota State University Extension Service, January 2016. www.ag.ndsu.edu/publications/crops/laundering-pesticide-contaminated-work-clothes/ps1778.pdf.
(2) Laughlin, J. "Decontaminating Pesticide Protective Clothing. *Reviews of Environmental Contamination and Toxicology* 130 (1993): 79–94. Springer, New York, NY. https://doi.org/10.1007/978-1-4613-9763-2_3.
(3) Easley, C. B., J. Laughlin, and R. Gold. "Laundering Pesticide Contaminated Clothing." Cornell University Cooperative Extension, Pesticide Safety Education Program (PSEP). psep.cce.cornell.edu/facts-slides-self/facts/genposaf-laund.aspx.

As a consequence of these findings, various organizations recommend the use of hot water at 60°C (140°F) as well as other laundering procedures for the optimum removal of pesticides from work clothing.

Similarly, a number of studies have addressed the efficacy of increased water temperatures in killing bacteria and other microorganism contaminants in hospital laundry. As a consequence of this research, the Centers for Disease Control (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC) have recommended the use of specific laundering practices that include even higher temperatures at 71°C (160°F) in combination with bleach. (Note: This practice is not appropriate for fire fighter protective ensembles and ensemble elements).

Clearly, high wash temperatures provide greater effectiveness in addressing many forms of contamination, but the use of higher temperatures must be weighed against its potential effects on the performance properties and continued service life of ensemble and ensemble elements.

Impact of Higher Wash Temperatures on Ensemble Element Materials and Components. To investigate the potential of applying higher wash temperatures, the technical committee conducted several laundering trials on unused materials, components, and full clothing both at 105°F (40°C) and at 140°F (60°C) to compare the overall impact of multiple launderings (60 cycles) at these temperatures. Multiple samples at several different facilities were subjected to conventional laundering procedures using both wash temperatures, with comprehensive inspections and assessment of certain performance properties after 20, 40, and 60 cycles of laundering. The preliminary findings of this work shows that components can be adversely affected by increased wash temperature and the increased cycles of laundering. Higher wash temperatures and multiple launderings created loss of certain performance properties for the actual material layers, and particular durability concerns were noted. At the time this work was conducted, it was not possible to fully conclude that safety issues would arise for protection of fire fighters; however, garment elements laundered multiple times and at the higher wash temperature would clearly require more frequent repair and replacement of components.

Specific Considerations for Frequent Advanced Cleaning, Sanitization, and Specialized Cleaning. Organizations are cautioned to be aware of the tradeoffs that exist for increased laundering at higher wash temperatures. Higher wash temperatures are likely to be more effective in removing many contaminants but will also likely reduce the service life of or increase the number of repairs to garment elements and other ensemble elements. Increased cleaning creates additional wear and tear on garments, but, if handled properly and coupled with frequent inspections, ensemble element service can be optimized for both effective cleaning and retention of performance properties.

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A.7.3.9(5) A formulation is a set of instructions or a program for how the washer/extractor injects specific wash chemicals, controls the water temperature and water level, and sets the specific times for each step. Different formulations should be used for outer shells versus liners given differences in soiling and contamination levels, as well as the types of materials and components involved in their construction. Suggested formulations are provided for garment outer shells in Table A.7.3.9(5)(a), while suggested formulations for garment liners and hoods is provided in Table A.7.3.9(5)(b). In each of these formula-

tions, load the washer/extractor to ¾ of the sight glass in the front of the machine.

An appropriate detergent should be dispensed once the drum is filled with water during the suds/detergent step. Consideration should be given to the levels of soiling and contaminants (light, medium, or heavy) in ensemble and ensemble elements for selecting the amount of detergent. Organizations should avoid using too much detergent. It is imperative that organizations check with the detergent supplier to ensure that the correct amounts of detergent are used according to the specific instructions for laundering fire-fighting protective garments. If automatic detergent dispensers are used, it is important to perform regular maintenance to ensure proper function and dispensing of the recommended amounts.

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N Table A.7.3.9(5)(a) Suggested Formulation for Garment Outer Shells

Operation	Time (min)	Temperature	Water Level
Prewash fill, flush	—	≤40°C (≤105°F)	High
Agitate	3	—	—
Drain	—	—	—
Fill	—	≤40°C (≤105°F)	Low–Med
Wash, add suds/ detergent	—	—	—
Agitate	12–15	—	—
Drain	—	—	—
Rinse, fill/agitate	5	Cold	High
Drain	—	—	—
Rinse, fill/agitate	5	Cold	High
Drain	—	—	—
Rinse, fill/agitate	5	Cold	High
Drain	—	—	—
Extract at 100 G	6	—	—

N Table A.7.3.9(5)(b) Suggested Washer/Extractor Formulation for Garment Sanitization

Operation	Time (min)	Temperature	Water level
Prewash fill, flush	—	≤40°C (≤105°F)	High
Agitate	3	—	—
Drain	—	—	—
Fill	—	≤40°C (≤105°F)	Low–Med
Wash, add detergent	—	—	—
Agitate	9–12	—	—
Drain	—	—	—
Rinse, fill/agitate	5	Cold	High
Drain	—	—	—
Rinse, fill/agitate	5	Cold	High
Drain	—	—	—
Rinse, fill/agitate	5	Cold	High
Drain	—	—	—
Extract at 100 G	5	—	—

Note: Wash formulations assume a full load for the washer size.

N A.7.3.10 Deciding how to dry ensembles and ensemble elements after cleaning should be done with the following factors in mind:

(1) Time constraints
(2) Effect of the drying method on the ensembles and ensemble elements

Drying is what takes up the majority of time to get ensembles and ensemble elements back in service. Nevertheless, the recommended and preferred method of drying is air or forced ventilation or drying in a drying cabinet as opposed to machine-drying by tumbling action. In some cases, it might be appropriate for machine-drying by tumble action of a garment liner while the garment outer shell is air dried or dried in a drying cabinet.

N A.7.3.10.1(1) Air drying is the most appropriate method for drying ensembles and ensemble elements. It causes no mechanical damage and little or no shrinkage. The most efficient method of air drying involves forced air ventilation. This method can be achieved by simply using fans to recirculate air in the room with the ensembles and ensemble elements. The basic drying room should include floor drains, a method to exchange the air to the outside environment, and drying racks for hanging ensembles and ensemble elements to provide maximum air exposure. Overall drying time will depend on the efficiency of the drying room and the ambient conditions. Heating the room or the inlet air up to 38°C (100°F) can further improve the efficiency of the drying process. Drying ensembles and ensemble elements in ambient air, as opposed to drying rooms, takes a considerable length of time, depending on the ambient environmental conditions.

N A.7.3.10.1(1)(a) The use of racks to provide maximum air exposure of the ensembles and ensemble elements will decrease the overall drying time.

N A.7.3.10.1(1)(b) Exposure to direct and indirect sunlight will cause degradation of fibers in protective garments, resulting in loss of fabric strength. Similar effects have been observed for extended exposures to fluorescent or ultraviolet (UV) light.

N A.7.3.10.1(2) A suitable alternative to air drying involves the use of a drying cabinet. Drying cabinets, available from different machine manufacturers, are contained cabinets where garments, gloves, and footwear can be suspended with the introduction of heated air over a specified period of time. This type of drying approach enables greater control of the air temperatures and, if properly used, can result in improved efficiency of garment drying and lower utility costs.

N A.7.3.10.2 Machine drying of ensembles and ensemble elements is generally not recommended. Dryers can reach high basket temperatures during operation, potentially damaging ensembles or ensemble elements. Machine drying also includes mechanical action that can cause damage. Nevertheless, a tumble dryer with a moisture-sensing feature can dry a saturated load with higher than 40°C (105°F) heat; when it reaches a percent dryness level, the heat can then be reduced or stopped.

N A.7.3.10.2(3) "No heat" is the preferred method of machine drying because it effectively accomplishes forced air ventilation.

N A.7.3.10.2(4) Excessive temperatures can cause damage to ensembles and ensemble elements, excessive garment shrinkage, and potentially premature failure and retirement of

protective equipment. Temperatures can rise as the garments in the basket dry out.

N **A.7.3.10.2(5)** Removal of garments before they are completely dry prevents exposure to excessive heat and reduces the potential for premature retirement of ensembles and ensemble elements. Ensembles and ensemble elements should be air dried to complete the drying process. Mechanical dryers can be used on a "no heat" setting.

N **A.7.3.10.2(6)** Ensembles and ensemble elements should be completely dry before reuse to avoid the potential for steam burns caused by moisture remaining in the layers of the ensemble or ensemble element under some exposure conditions.

N **A.7.3.11.2** Ensembles and ensemble elements should be cleaned only with like items, including, but not limited to, outer shells with outer shells, liners with liners, hoods with hoods, gloves with gloves, and footwear with footwear. In general, accessory items should only be cleaned with accessory items [e.g., life safety harnesses should be removed (whenever possible) from coats and/or pants prior to cleaning, and cleaned separately]. An exception is that drag rescue devices (DRDs), when properly contained in mesh bags, can be appropriately cleaned with garment outer shells. It is highly recommended that garment liner systems be removed and cleaned separately, if possible, to avoid contamination with the debris found in the shell. Because the moisture barrier will limit the flow of water through the outer shell fabric, removing the liner will result in better cleaning. Separating the liner from the outer shell will also reduce drying time. The liner should also be turned inside out to help protect the moisture barrier layer during both laundering and drying. *[See A.7.3.9(5).]*

N **A.7.3.12.1** The manufacturer's instructions for the specific helmet should be consulted to determine if there are other detachable components such as the impact cap, suspension, faceshield, or other items that are best removed from the helmet shell and cleaned separate.

N **A.7.3.12.2** Detachable items can include helmet covers, liners, suspension sweat bands or covers, ear covers, certain types of faceshield/goggle components, identification shields, and various accessories.

N **A.7.3.12.4** Advanced cleaning includes washing both the inside and outside surfaces of the helmet carefully, using a soft brush to reach between components and into difficult-to-access spaces, and separately washing the eye/face protection with a soft cloth. Proximity items should not be brushed. Only a soft cloth or sponge should be used to wash proximity items that utilize aluminized fabric. It is usually not necessary to completely submerge a helmet for cleaning unless it is being inspected for damage or repairs are being performed in conjunction with the cleaning.

N **A.7.3.12.4(2)** See A.7.3.7.2 for a discussion on the limits for selecting detergents based on their range in pH.

Δ **A.7.3.13.1** The thermal protective capability of leather gloves is seriously degraded when gloves are washed in any machine that develops excessive g-forces to extract water from the materials. Studies indicate that the outer leather shell material becomes compressed and does not fully recover once dry. This loss of thickness directly relates to a loss of thermal protection as well as a loss of dexterity, both important factors of fire fighter PPE safety.

N **A.7.3.13.2(2)** See A.7.3.7.2 for a discussion on the limits for selecting detergents based on their range in pH.

N **A.7.3.13.2(4)** If gloves are heavily soiled, the gloves should be submerged in a way where the dirty wash water does not contaminate the interior of the gloves. This can be accomplished by wearing the glove while it is being washed. If the exterior only is submerged, the interior of the gloves should be separately washed with clean water and detergent followed by rinsing.

N **A.7.3.13.2(7)** Gloves are most effectively dried when they are placed on a rack or otherwise hung to allow water to drain from the interior. Gloves might also be placed in a drying cabinet. Forced air dryers are also available for gloves where the glove is mounted on a plastic pipe that blows air into the glove interior.

A.7.3.14.1 Unless specifically approved by the manufacturer, footwear should not be machine washed. Damage to both the footwear and the machine can result. Alternative commercial machine technologies as well as specific procedures for different footwear materials and construction are available but should be used only after consultation with and approval from the footwear manufacturer.

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N **A.7.3.14.2(2)** See A.7.3.7.2 for a discussion on the limits for selecting detergents based on their range in pH.

N **A.7.3.14.2(3)** Where the use of a soft bristle brush is difficult for cleaning the full interior of the footwear, it is recommended that the footwear be filled with a mixture of water and detergent and allowed to stand for at least 15 minutes before the mixture is poured out of the footwear and followed by rinsing.

N **A.7.3.14.2(6)** The interior of footwear can be particularly difficult to dry. Turning the boot upside down can allow the boot to drain easily and dry more quickly. However, given the volume of water that can come out of footwear, pooling of water from the drainage can create a slip hazard in the drying area. An alternative approach to drying footwear is to use plastic tubes or similar equipment for blowing air into the footwear interior.

N **A.7.4.2** Applicable regulations in 29 CFR 1910.1030, "Bloodborne Pathogens," include observing universal precautions, instituting engineering and workplace controls, using appropriate PPE for personnel involved in the disinfection or sanitization and biological decontamination of PPE, and ensuring that the decontamination area is in a clean and sanitary condition. Universal precautions are applied to prevent contact with blood or other potentially infectious materials where all body fluids are considered potentially infectious materials. Engineering and workplace controls include the provision of handwashing facilities and the prohibition of food and beverages in areas where handling of contaminated PPE and decontamination occur. They also include bagging and appropriately identifying body fluid–contaminated clothing using either a biohazard symbol or red bag to indicate potentially infectious materials. PPE includes the use of gloves, aprons, full torso coveralls or smocks, arm covers, and eye/face protection. At a minimum, persons involved in cleaning contaminated ensembles and ensemble elements should wear cleaning gloves, an apron and protectives sleeves or a coverall, and a pair of goggles or a faceshield that conforms to NFPA 1999. In addition, cleaning of contaminated ensembles and ensemble elements should take place in a designated area with sinks and

counters made of materials, such as stainless steel, that can be adequately decontaminated following an element-cleaning procedure.

NFPA 1581 should be consulted for additional guidance.

N **A.7.4.3** The contamination of protective ensembles or ensemble elements with body fluids or other potentially infectious materials, such as contaminated flood water, requires specific procedures for eliminating the health threats associated with microbial contamination. At a minimum, protective ensembles and ensemble elements should be subject to sanitization, where the levels of microbial contamination are reduced to acceptable levels, or disinfection, where all viable microbial contamination has been eliminated. In general, sanitization is most often applied to porous surface such as the fabrics and textiles associated with garments, helmets textile components, gloves, footwear, and hoods, whereas disinfection is applied to hard surfaces such as helmet shells.

In many cases, disinfection or sanitization is initially applied to the ensemble or ensemble element to inactivate the microbial contamination and is then followed up by advanced cleaning to further remove the soils associated with the contamination (e.g., blood and body fluid solid residue). Any sanitizer or disinfectant that is used on the ensemble or ensemble element should be registered with the EPA, which has approval processes for different types of sanitizers and disinfectants. The EPA has established guidelines for demonstrating the efficacy of both disinfectants and sanitizers. These procedures are established in the following publications:

(1) OCSPP 810.2200, "Disinfectants for Use on Environmental Surfaces — Guide for Efficacy Testing"
(2) OCSPP 810.2300, "Sanitizers for Use on Hard Surfaces — Efficacy Data Recommendations"
(3) OCSPP 810.2400, "Disinfectants and Sanitizers for Use on Fabrics and Textiles — Efficacy Data Recommendations"

A listing of currently registered disinfectants and sanitizers can be found at https://www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants.

However, in order to identify an appropriate sanitizer or disinfectant on the EPA's directory, the EPA registration number, manufacturer name, or product name is needed. Many disinfectant and sanitizer products are rebranded and have a distributor number that appears after the primary manufacturer registration number. This listing also identifies specific disinfectants or sanitizers for effectiveness against specific types of infectious diseases. A recommended starting point is "List H. EPA's Registered Products Effective Against Methicillin Resistant *Staphylococcus aureus* (MRSA) and Vancomycin Resistant *Enterococcus faecalis* or faecium (VRE)." Not all recommended listed disinfectants or sanitizers are suitable for protective ensembles or ensemble elements. Examine the product's safety data sheet (SDS) for chemicals that might be harmful to the protective ensemble or ensemble element, particularly those with container pH outside the prescribed acceptable range of 6 to 10.5 specified in 7.3.7.2, or check with a verified ISP or the manufacturer of the ensemble or ensemble element for further advice. See 7.4.3.2 for additional information.

Where these product types are used, it is essential that instructions provided by the supplier be followed since the efficacy of their disinfection or sanitization is based on specific ratios of agent to water, residence time, and other application factors that were used to demonstrate the effectiveness of the product as a disinfectant or sanitizer. Use of too little product or under the wrong conditions might cause the product to be ineffective in achieving sanitization or disinfection. Unless specifically indicated as a laundry additive, many disinfectants and sanitizers are not to be used as part of the wash chemicals.

In some cases, certain laundering procedures or supplemental additives such as ozone could be effective in providing sanitization of clothing. If used with garments, the textile components of helmets, or hoods, however, these procedures/additives must be qualified as effective by meeting the requirements in 11.3.7.5 where specific testing is conducted to demonstrate sanitization efficacy.

Since disinfection and sanitization only affects microbial contamination, it must be followed up with advanced cleaning to remove any soils associated with the body fluid or other infectious material.

N **A.7.4.3.2** A listing of currently registered disinfectants and sanitizers can be found at https://www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants.

N **A.7.4.3.3** The same approach described in A.7.3.7.3 can be used to assess the impact of the respective disinfection or sanitization agents or process on ensembles or ensemble elements.

N **A.7.4.3.5** The determination of effectiveness for a specific sanitizer or disinfectant can be accomplished by using products that are registered with the EPA as a sanitizer or disinfectant appropriate for the type and materials of the ensemble or ensemble element and using the sanitizer or disinfectant as specifically directed by the product labeling and directions. Procedures are also provided in Chapter 12 for assessing the effectiveness of sanitizers on textile-based fabrics.

N **A.7.4.3.6** The application of spot sanitization and cleaning requires judgment since not all blood and body fluid contamination is clearly visible. This judgment should take into account how the exposure occurred so that a determination can be made whether spot sanitization and cleaning will fully remove the contamination. It is important to point out that some forms of biological contamination such as methicillin-resistant *Staphylococcus aureus* (MRSA) or other population and health care infections are not likely to be visible.

N **A.7.4.4.1** Sanitization represents inactivation of microorganisms to a safe level. For textile-based products, sanitization is generally considered achievable, whereas disinfection involving the inactivation of all microorganisms might not be possible.

Three different approaches can be used for the sanitization of garments: use of a soak tank, use of a washer-extractor, or use of ozone in an advanced cleaning process.

Use of Soak Tank. A tank or other vessel that is large enough to hold the number of sets of garments can be used for sanitization. In this approach, the vessel is filled with water and an EPA-registered sanitizer is added at the concentration specified by the supplier. The entire garment is placed in the sanitizer/water solution with all portions of the garment immersed. The garment is left in the tank or vessel for a period of time indicated by the sanitizer instructions, but typically periods of time ranging from 1 hour or more can be used. Extended soak times in excess of the sanitizer instructions are recommended since garments include multiple layers, pockets, and other features the sanitizer solution might not easily reach. Longer

soak times should also be used when clothing is heavily contaminated. Following the end of the soak period, the garment should be subjected to advanced cleaning as described in A.7.3.9(5).

Use of a Washer/Extractor. Another recommended procedure for sanitization of protective garments involves using an EPA-registered sanitizer as part of the cleaning formulation. In this approach, an EPA-register sanitizer or other product that has been demonstrated to be effective in sanitizing garments is used as a laundry additive. The garments are placed in an extractor with a special programmed formulation into which the sanitizer is added. The specific steps for this formulation are shown in Table A.7.4.4.1.

One of the steps allows for the injection of the sanitizer at a concentration recommended on the sanitizer product label, which is typically 1 ounce per gallon of water added. This step should subject the garment to the sanitizer for at least 10 minutes, followed by extraction (drain and spin) and a rinse cycle at moderate temperature. Following this procedure, the garments should be subjected to normal advanced cleaning as recommended in A.7.3.9(5).

Use of Ozone in an Advanced Cleaning Process. The use of ozone injected into washing machines for the sanitization of linens has been demonstrated as effective in reducing microbial contamination. Special ozone-generating equipment is available that can be installed for adding appropriate amounts of ozone to the wash water in washer/extractors at specific steps in the cleaning process. The specific steps where ozone is added, the amount of ozone, and the overall configuration of the equipment to provide this capability depend on the ozone-generating equipment, the washer/extractors involved, and the specific procedures in place at the facility where sanitization operations are carried out. Where these processes are used, the specific system should be verified for biological decontamination effectiveness as specified in 11.3.7.4.

Other approaches for sanitization of garments can be performed that involve novel sanitizers or processes; however, before these approaches are used, biological decontamination effectiveness as specified in 11.3.7.4 should be demonstrated since there can be substantial differences between processes used for ordinary linens and garments as compared to fire fighter protective clothing.

N **A.7.4.4.3** It is not recommended that garment shells and liners be separated prior to sanitization in order to minimize the handling of the contaminated garment. Instead, the entire garment should be subject to the sanitization process first to address the microbial contamination and then separated for advanced cleaning. An exception to this approach would occur if the organization is relying on advanced cleaning to provide sanitization of the garments or if a laundry additive–based sanitizer is used as part of the advanced cleaning process. Regardless, practices for sanitization of garments should include minimum handling to avoid cross contamination.

N **Table A.7.4.4.1 Suggested Washer/Extractor Procedures for Garment Sanitization**

Step	Action
1	Fill to a maximum of 35°C (95°F) on low
2	Inject disinfectant
3	Wash/soak for 10 minutes*
4	Drain for 1 minute
5	Extract on low for 4 minutes

*Perform advanced cleaning after disinfecting soak.

N **A.7.4.5.1** Examples of helmet components include ear covers, suspension covers, and goggles. Helmet textile components can be sanitized using similar procedures as applied to garments. See A.7.4.4.1 for more information.

N **A.7.4.5.3** See A.7.4.3 for the selection of an appropriate disinfectant for the hard surfaces of a helmet. It is important to select a disinfectant that does not contain constituents that could damage the helmet surfaces.

N **A.7.4.6.1** If gloves have been exposed to blood and potentially infectious materials, gloves can be set in a soak tank that uses sanitizer at the supplier's recommended dilution for the supplier's recommended contact time. Following this step, it is important that gloves be thoroughly rinsed and then subjected to advanced cleaning.

While potentially suitable for exterior-based contamination, the use of spray-applied sanitizers or disinfectants should be viewed with caution because their effectiveness will be affected by the ability of the solution to fully penetrate all biologically contaminated areas of the gloves.

Consideration should be given for the disposal of gloves that have been extensively contaminated by blood, body fluids, or other potentially infectious materials, especially when the contamination extends to the interior of the gloves.

At the time this standard was prepared, there were no cleaning verification procedures that had been prepared specifically for gloves.

N **A.7.4.7.1** A similar approach to the sanitization procedure for gloves described in A.7.4.6.1 can be applied to footwear. If the biological contamination is expected to have only affected the exterior layer or surface of the footwear, the footwear can be placed in the soak tank such that only the exterior contacts the sanitizer solution by placing weights in the boot and controlling the soak solution to a level just below the top line of the footwear. As with gloves, following the sanitization of footwear in the soak tank, the footwear should be thoroughly rinsed and then subjected to advanced cleaning.

At the time this standard was prepared, there were no cleaning verification procedures that had been prepared specifically for footwear.

N **A.7.4.8.1** Hoods can be sanitized using similar procedures as those applied to garments. See A.7.4.4.1 for more information.

N **A.7.5.2** Specialized cleaning is reserved for those forms of contamination that cannot be removed by advanced cleaning and for clothing contaminated with soils associated with body fluids or other infectious materials. *(See Section 7.4 and associated annex material.)* Since there are a myriad of different potential contaminants, organizations should consider using specialized cleaning where there are concerns for highly dangerous or unusual forms of contamination. Examples of situations where specialized cleaning can be applied include, but are not limited to, the following:

(1) Bulk chemicals (e.g., varnish, household cleaning supplies, other liquids or solids that could be encountered in their ordinary form via ruptured or broken

containers on the fireground) found at the fire scene that either come directly in contact with ensembles or ensemble elements or are exposed to ensembles or ensemble elements due to their decomposition in a fire

(2) The identification of asbestos or other hazardous particulates that are either known before or after the fire event

(3) The provision of emergency medical care to individuals or at facilities where known elevated levels of hazardous particulates, such as fentanyl or other opioid drug residues, are present

(4) Response environments where textile products are contaminated with bedbugs or other infectious organisms

N A.7.5.3 Where certain types of contaminants are frequently encountered that warrant specialized cleaning, organizations should determine their capabilities and limitations with respect to cleaning both soiled and contaminated ensembles and ensemble elements that have been contaminated with specific substances outside of their normal capabilities for applying advanced cleaning. While it is possible that some forms of advanced cleaning might effectively remove these substances, the organization should obtain independent information indicating the efficacy of any applied specialized cleaning procedures.

The following are examples of specialized cleaning for three specific forms of contamination: asbestos, fentanyl and other synthetic opioid drugs, and bed bugs.

Asbestos. Given its established link to mesothelioma asbestosis, clothing known to be contaminated with asbestos fibers presents an elevated risk, and complete decontamination might not be possible. While the application of additional presoaking and rinse cycles in conjunction with advanced cleaning might remove the large majority of respirable asbestos fibers, some uncertainty still exists for the condition of the clothing following cleaning. In general, it is recommended that organizations work with ISPs capable of removing asbestos contamination if cleaning has been determined to be a viable option. It is further recommended that testing as described in A.7.5.3.3 be performed with any specialized cleaning of asbestos-contaminated protective ensembles or ensemble elements.

Fentanyl and Other Synthetic Opioid Drugs. Where ensemble or ensemble element exposure to fentanyl and/or other synthetic opioids has occurred, extreme care must be taken to ensure that any powder residue is not aerosolized into the breathing zone of the individual wearing the ensemble or ensemble element. It is highly recommended that individuals involved in the handling and cleaning of ensembles and ensemble elements contaminated with synthetic opioid drugs wear at least air-purifying respirators outfitted with P-100 particulate filters, given the severe effects from respirations of these drugs at very low concentrations. Highly absorbent wipes are recommended for the removal of any exterior deposited powder followed by rinsing with soap and water. Use of alcohol-based wipes for removal of contamination from exposed skin is not recommended because these types of products could increase the absorption of the drug into the wearer's skin. Detergents or other cleaning agents with a pH near neutral (7.0) should be used to wash products contaminated with these types of substances. Additional information related to the hazards and exposure control of fentanyl and other synthetic opioid drugs is available as follows:

(1) Interagency Board for Equipment Standardization and Interoperability (interagencyboard.org/content/first-responder-ppe-and-decontamination-recommendations-fentanyl-august-2017)

(2) Center for Disease Control and Prevention (CDC) (www.cdc.gov/niosh/topics/fentanyl/risk.html)

(3) CDC's 2018 interim report, "Evaluation of Potential Occupational Exposures to Opioid Drugs During an Emergency Medical Services Response"

Bed Bugs. Bed bugs are a frequent type of contamination for protective ensembles and ensemble elements, generally resulting from exposure to areas or items infested with bed bugs. Conventional laundry procedures are ineffective in removing bed bugs. More importantly, conventional laundry processes are insufficient to kill any eggs that might have been laid in the clothing item, which can cause the further spread of bed bugs. Two different approaches based on temperature extremes can be used to decontaminate ensembles and ensemble elements exposed to bed bugs. Using a wash temperature of 60°C (140°F) and a drying temperature above 40°C (105°F) for a minimum of 30 minutes has been determined to be effective in killing bed bug adults, nymphs, and eggs. Drying could be accomplished with a drying cabinet as long as the requisite temperature can be maintained over the minimum 30-minute period. If the clothing is wet, longer periods of drying might be necessary to ensure that the clothing reaches the temperature of 40°C (105°F) for an extended period of time. Alternatively, extremely cold temperatures of –21°C (–5°F) or below for at least 8 hours can be used for killing bed bug adults, nymphs, and their eggs, although longer freezing times are recommended because the mass of clothing can take a relatively long time to reach the appropriate temperature. Documentation for the effectiveness of these test conditions is provided in Naylor and Boase, "Practical solutions for treating laundry infested with Cimex lectularius (Hemiptera: Cimicidae)."

N A.7.5.4.4 It might not be possible for a specific cleaning procedure to fully remove all contaminants. In some cases, testing of contaminated clothing might show residual levels of contamination still being present after cleaning. In these cases, the organization should contact individuals with expertise on exposures and hazards associated with the specific contaminants to determine if there are levels of residual contamination that are acceptable for continued safe use of the ensemble or ensemble element.

There are certain persistent contaminants found in clothing regardless of whether the ensemble or ensemble element has been exposed in a fire. For example, certain phthalates are common contaminants in clothing as the result of contact with plastics. These plasticizer chemicals are found through many ordinary items worn or used by individuals. There are also other ordinary environmental contaminants that can show up on protective ensembles and ensemble elements.

In addition, it is important than any testing determine baseline levels of certain chemicals or other substances that could be intrinsically part of the ensemble or ensemble element. Typically, certain heavy metals can be found in dyes and other constituents of heavy metals and are not actually due to contamination on the fireground or with the use of the ensemble or ensemble elements.

Regardless of any evidence gathered or testing performed to assist in determining whether to apply specialized cleaning, it is

highly recommended that organizations maintain records of this information.

N **A.7.5.4.5** See 7.3.7.4 for more information. If ensembles or ensemble elements are exposed to specific hazardous contaminants and advanced or specialized cleaning is performed for the removal of this contamination, testing of selected cleaned ensembles or ensemble elements might provide a basis for determining the effectiveness of the cleaning process and the ability of the ensembles or ensemble elements to be reused.

For example, the following nondestructive testing procedure conducted in a qualified laboratory can be used to determine residual asbestos fibers in protective garments that have been identified as being exposed to asbestos, based on either on-scene monitoring or post-incident findings:

(1) Seal each protective element in a separate plastic bag.
(2) Identify a NVLAP-accredited asbestos analysis laboratory and send the bagged elements to that laboratory using the laboratory's chain of custody and sample provision procedures.
(3) At the selected laboratory, have each element separately removed in a sterile room.
(4) Have the entire exterior surface of each element vacuumed using a specialized sampling pump that withdraws air at a rate of 2 L/min through a transmission electron microscopy (TEM) cassette (25 mm, 0.45 micron, MCE filter); multiple cassettes might be needed for each element, depending on its overall surface area and the amount of lint and other surface contaminants present.
(5) Following vacuuming, seal the element back in the bag.
(6) Analyze each cassette filter sample to identify and quantify asbestos fibers using TEM according to ASTM D5755, *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading*.
(7) Have the laboratory provide a report for the specific identification and quantification of asbestos fibers present on each element sample. Results should be reported as structures (fibers) per square centimeter of element surface area.

It must be noted that the above procedures, while attempting to provide full sampling of the element and provide consistency with industry practices for quantifying asbestos levels on contaminated surfaces, might not fully capture all asbestos even when careful sampling of the entire item is applied. In addition, where one element or a small group of elements are sampled and analyzed to represent an entire population of elements, care must be exercised in assuming that the limited sampling and analysis results apply to the entire set of affected elements. Furthermore, while some background levels of asbestos might occur naturally, there is no established acceptable level of asbestos fibers for protective ensembles or ensemble elements. If clothing was initially shown to be contaminated with asbestos and subsequent testing reveals that asbestos has not been found, some uncertainty still exists for potential continued exposure to asbestos.

A.8.1.4 Although repairs can bring ensembles or ensemble elements back to a serviceable level of performance, repaired ensembles or ensemble elements might not provide the same levels of protection and performance as new ensembles or ensemble elements.

A.8.2.4 Although some hardware can be replaced in the field, it should be noted that field application might not be as permanent or as strong as when the hardware is replaced at the factory, by a verified organization, or by a verified ISP.

A.8.4.1 For elements that are being repaired by a verified ISP, the questions in this section should be asked to determine if the verified ISP is knowledgeable enough to ensure that the repaired elements are safe and serviceable. It is important that the organization request information for the verified ISP so that the organization can make an informed decision about how their gear is being maintained and by whom. The following questions should provide assistance in making that decision, but they should not be considered to be all-inclusive, and the organization might have other questions they would like to ask as well.

(1) Can the ensemble or ensemble element be repaired (i.e., is the damage too severe), or does the age and/or overall condition of the garment make a repair too costly or prohibitive to safety?
(2) Does the verified ISP have a certificate it can provide for review?
(3) The certificate and/or the certification organization's listing should be read carefully. What materials does the listing identify that the verified ISP is verified to repair? Some verifications are limited to outer shells and, therefore, the verified ISP cannot repair moisture barriers. Other verified ISPs elect to become verified to work only on specific moisture barrier fabrics, not all. It is important to confirm that a verified ISP has been verified to work on the specific type of moisture barrier found in a garment.
(4) Does the verified ISP have liability insurance for repair or replacement of lost or stolen ensembles or ensemble elements?
(5) Does the verified ISP have a quality assurance program? If so, the verified ISP should make that program available upon request.
(6) Does the verified ISP take appropriate steps to prevent cross-contamination between any and all items being repaired?
(7) Does the verified ISP have training to do the required repair?
(8) Can the verified ISP supply documentation to confirm the repair was completed?
(9) Does the verified ISP have current calibration data for the gauges used on the hydrostatic testing apparatus?
(10) Does the verified ISP follow the guidelines of the moisture barrier manufacturer for repair of moisture barriers?

(11) At what point does it make the decision to replace a moisture barrier rather than repair it? Does age enter into that decision?
(12) If a moisture barrier has been repaired previously (e.g., patches on the fabric, re-seam-sealing small areas of the seam), and additional punctures or taping issues are found, at what point does it stop repairing and make the decision to replace the moisture barrier? Does age enter into that decision?
(13) Has the verified ISP attended seminars provided by moisture barrier manufacturers for proper testing and repair?
(14) Does the verified ISP have documentation that it can provide warranty repairs for the moisture barrier manufacturer's products? Most of the major moisture barrier manufacturers provide warranties on their products, but the ISP must be registered with the moisture barrier manufacturer in order to perform these repairs.
(15) Does the verified ISP warranty its work, and if so, for how long?
(16) What is the normal turnaround time for repairs?

A.8.4.3 Due to the complexity and specialized equipment needed to conduct moisture barrier repairs, it is mandated that the garment be returned to the manufacturer or to a verified ISP. The equipment needed to conduct these repairs is typically not found in the field but in specialized repair facilities or manufacturing facilities. Moisture barrier materials are found in collars, collar closure systems, and other assemblies, including, but not limited to, storm flaps and sleeve wells.

A.8.4.4 While some loss of quilting threads on thermal liners is the normal result of wear, excessively large areas where quilt stitching is broken or missing can indicate the need to replace the liner.

A.8.4.5 Organizations can acquire a replacement complete liner assembly (thermal barrier and moisture barrier) from the original garment manufacturer and install that replacement liner assembly in the original outer shell. The exception to this is sewn-in liner assemblies. Liner assemblies that are sewn into the outer shell should be replaced in accordance with 8.4.5.

A.8.4.8 Stress areas are generally considered to be the corners of pockets and flaps, the base of the fly, the top and bottom of the storm flap, and any place where the stitching begins or ends.

A.8.4.10 Depending on the method of construction, broken zippers can be replaced in the field, providing they can be replaced without causing a breach of any moisture barrier material and without affecting the garment integrity.

A.8.4.11 Depending on the method of construction, hooks and loops can be replaced in the field, providing they can be replaced without causing a breach to any moisture barrier material and without affecting the garment integrity.

A.8.4.12 Reinforcing materials are those fabrics, including, but not limited to, suede leather and outer shell fabrics, that are used to reinforce specific areas of an element, for example, a knee or elbow on a garment.

A.8.5.2 The manufacturer's literature supplied with the helmet should be consulted for disassembly instructions. If the manufacturer's instructions cannot be located, the manufacturer should be contacted for a new set of inspection and maintenance instructions. Accessories to structural fire fighting helmets should include only those items that are provided by or recommended by the manufacturer. Because aftermarket accessories affect the weight and balance of the helmet, they should not be utilized unless they have the approval of the manufacturer. Pre-existing holes should never be enlarged to accommodate aftermarket accessories.

A.9.1 Proper storage of ensembles and ensemble elements extends their life, maintains their performance, and reduces potential health risks. Improper storage can result in damage to the ensemble or ensemble element and can compromise the fire fighter's safety. Certain conditions can result in deterioration of performance of the ensemble or element or create potential health hazards.

A.9.1.1 Ultraviolet (UV) light, especially from sunlight, is a known cause of protective ensemble degradation. Storage in both direct and indirect sunlight causes degradation of fibers in protective garments, resulting in fabric strength loss, and can cause accelerated aging of other equipment. In addition, other UV light sources, such as fluorescent light, can cause similar degradation. Therefore, ensembles and ensemble elements should be stored to minimize exposure to all sources of UV light. LED light sources produce minimal amounts of UV light, and therefore, could be a good alternative to other light sources.

A.9.1.2 Storage of wet or moist ensembles and ensemble elements promotes the growth of mildew and bacteria, which can lead to skin irritation, rashes, or more serious medical conditions. Mildew and bacteria growth can also affect the strength of some materials.

Δ **A.9.1.4** Storage in extreme temperatures for extended periods can accelerate deterioration of ensembles and ensemble elements. A cold performance parameter of −32°C (−25°F) is used in NFPA 1971. Temperatures above 82°C (180°F) can cause some adhesives to lose their integrity.

A.9.1.6 Contaminated and soiled ensembles and ensemble elements can present a health risk to individuals who come into contact with them, and need to be segregated. The potential for spread of contamination is particularly high when newly contaminated or soiled ensembles and ensemble elements are transported inside the passenger compartments of vehicles or stored in living quarters. It is recognized that it is not always possible to segregate contaminated or soiled elements. Therefore, airtight protective containers or bags should be used to minimize cross contamination. Examples include disposable polyethylene bags or sealable plastic cases, which are cleanable. If a plastic bag is used, it is recommended that the bag be clear to ensure that the contents of the bag can be readily identified.It is further suggested that plastic bags, if used, be at least 2 mils thick to resist punctures.

If the protective ensemble or ensemble elements are wet, the protective ensemble or ensemble elements should be removed as soon as possible following transport from the fire or other emergency scene since ensembles and ensemble elements that remain wet under closed conditions can result in the growth of damaging mold or mildew. It is further important that protective ensembles and ensemble elements be subjected to appropriate cleaning procedures *(see Chapter 7)* or stored under conditions where the ensembles or ensemble elements can dry following their transport. To prevent the spread of disease or infections through cross contamination, soiled elements should not be cleaned with other items of clothing or laundry.

A.9.1.7 Storage in contact with hydraulic fluids, solvents, hydrocarbons, hydrocarbon vapors, or other contaminants can cause material degradation, transfer toxins to individuals, and reduce self-extinguishing properties of ensembles and ensemble elements.

Δ **A.10.1.1** Retirement criteria should be based on a number of factors, including, but not limited to, the following:

(1) Overall condition of the item
(2) Specific deterioration of materials or components beyond their economic repair
(3) Ability to adequately remove hazardous materials and other contaminants
(4) Age of structural or proximity ensemble or ensemble elements
(5) Excessive soil buildup that could impact performance of the ensemble or ensemble element

Physical damage from use, detrimental effects from improper cleaning procedures, and fabric failure of an ensemble and ensemble elements that can make repairs impossible are other factors that can affect when an item should be retired.

Where ensembles and ensemble elements are worn, damaged, or contaminated, organizations should determine if it would be more appropriate for them to be repaired, decontaminated, or replaced. One general guideline is if the cost of the repair or decontamination is greater than 50 percent of the replacement cost of the ensemble or ensemble elements, replacement should be considered. A typical guideline that can be used involves the use of a matrix that takes into account the current age of the gear and the cost of the repair versus the replacement cost of the item. *(See A.10.1.4.)*

Experience suggests that ensembles and ensemble elements that are approaching 10 years since the date of their manufacture have a high likelihood of performance deficiencies in multiple areas that can often be detected only by destructive testing. Additionally, experience suggests that the reflective outer shell of proximity elements that are approaching 5 years since the date of their manufacture have a high likelihood of performance failures that can be detected only by destructive testing. Such performance failures could compromise fire fighter safety.

It is important to understand that the actual service life of ensembles and ensemble elements varies depending on the amount of their use and the care they receive. Factors such as the size of the department, area covered, types of exposures, and aggressiveness of the individual fire fighter are all considerations in how long any ensemble element will last. It is possible that a protective element could be exposed to circumstances that totally destroy it the first time it is utilized. Since the purpose of fire fighters' protective elements is to protect the wearer, if the element has saved a life or prevented serious injury, even just once, it has done its job. In many cases, an ensemble or ensemble element will need to be retired sooner than 10 years (or 5 years for the proximity reflective outer shell component).

An additional consideration that can influence the decision to repair or replace an ensemble or ensemble element centers on the advances in technology that occur through each revision of NFPA 1971. These technological advances might be deemed important enough by an organization to influence its criteria for replacement of ensembles or ensemble elements.

For every revision of this standard since the inclusion of the 10-year protective element retirement requirement, the technical committee has conducted a detailed assessment of its impact based on technical changes in NFPA 1971 and the availability of new technology for nondestructive evaluation of continued protective element service.

For both the 2014 and 2019 revisions, the technical committee spent considerable time on the issue of mandatory retirement. In each case, the technical committee reaffirmed its position based on the following factors:

(1) Since NFPA standards are revised every 5 years, 10 years represents two revision cycles that incorporate significant performance enhancements in ensembles and ensemble elements to warrant retirement of personal protective equipment (PPE) 10 years from the date of manufacture. Significant changes in the technology used in fibers, fabrics, components, and overall designs of fire fighter protective ensembles and ensemble elements along with the test methods for their evaluation have advanced considerably over this period of time. For example, many materials that were used in protective garments to meet the 2007 edition of NFPA 1971 are no longer available. Some of these differences in clothing technology can mean that fire fighters operating on the same fireground wearing clothing certified to different editions of NFPA 1971 can have protective ensembles and elements that provide different levels of protection. These differences increase with each new edition of NFPA 1971.
(2) In the absence of scientifically validated test methods that would support modifying or eliminating the current mandatory retirement of 10 years, the technical committee reaffirmed the existing 10-year requirement for all PPE. Around the time the 2014 edition of this standard was released, research was carried out and documented in "A Post-use Evaluation of Turnout Gear Using NFPA 1971 Standard on Protective Ensembles for Structural Fire Fighting and NFPA 1851 on Selection, Care and Maintenance." The research examined over 250 garments, including 108 garments that had been retired, and found support for the 10-year retirement requirement on the basis of comprehensive inspections and testing of samples from gear for selected performance properties. The technical committee remains aware of ongoing research efforts to investigate the service life of fire fighter protective ensembles and ensemble elements.
(3) In the absence of a nondestructive test or evaluation method that can conclusively and reliably determine that PPE remains compliant with the performance requirements in place at the time of manufacture, the technical committee continues to support the existing retirement criteria. Nearly all performance properties either require samples that must be cut from protective ensembles or ensemble elements or are destructive in the manner of testing. Through the date of the current revision, no single or combination of nondestructive test methods has been identified that permits confidence in fully assessing protective ensemble or ensemble element service life.
(4) Increasing concern for fire fighter exposure to carcinogens and their retention in clothing, sometimes in spite of the frequent application of advanced cleaning, has provided an additional reason for maintaining the existing retirement criteria. Older ensembles and ensemble elements tend to absorb and retain low volatility carcino-

gens and other hazardous materials compared with new protective ensembles and ensemble elements. As with performance testing, the technology for nondestructive evaluations of contamination levels that can readily determine retention of persistent contaminants does not yet exist.

Organizations should include members who have received training in the inspection of ensembles and ensemble elements, who understand the limitations of each ensemble and ensemble element, and who recognize the signs of failure in the decision-making process as to the integrity of an ensemble or ensemble element. Organizations are further encouraged to ensure that inventories of protective ensembles and ensemble elements are effectively managed so that their full utility can be realized. Efficient rotation of clothing and use of spare ensembles and ensemble elements where available can help maximize their service life. Repurposing clean, expired ensembles or ensemble elements for use as training gear, exercise gear, public education gear, and demonstration gear are good alternatives for extending the non–fire use of retired gear.

A.10.1.2 After discussion of the concept of mandatory retirement for protective elements, the consensus of the technical committee, led by the fire service segment, is that the life of a turnout suit is generally less than 10 years. Regardless of when the element was originally produced, it is imperative that the protective elements be routinely inspected to ensure that they are clean, well maintained, and still safe. Just knowing the age of the elements cannot do that. In the 2014 and 2019 revision cycles, the technical committee, led by the fire service, again reaffirmed this position.

A.10.1.3.1 Specific to proximity elements, the consensus of the technical committee is that the life of a proximity outer shell is considerably less than that of a structural shell and that the life span is entirely dependent on the type and amount of field use to which each separate element has been exposed. Given the characteristics of the aluminized outer materials necessary to obtain the required radiant and reflective properties, this type of fabric is especially susceptible to abrasion, which can result in a loss of the protective qualities in a very short time. Regardless of when the element was originally produced, it is imperative that the protective elements be routinely inspected to ensure that they are clean, well maintained, and still safe. Just knowing the age of the elements cannot do that. It should be noted that most manufacturers of proximity fire fighting protective garments can make a replacement outer shell for a liner system that is less than 10 years old from the date of manufacture. If a replacement outer shell is not obtainable, the entire garment might need to be retired.

A.10.1.4 Organizations can use various methods to determine whether it is cost effective to repair or replace structural ensembles or ensemble elements and proximity ensembles or ensemble elements. One commonly used method involves the use of a matrix that compares factors such as the age of the gear, the cost of the repair, and the replacement cost or the original cost of the ensemble. Table A.10.1.4 is an example of such a matrix.

Δ **A.10.1.5** All structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements are required by NFPA 1971 to be certified by an independent, third-party certification organization. For an ensemble or ensemble element to meet the requirements of NFPA 1971, the item should carry a statement on the product label stating compliance and the label, symbol, or other identifying mark of that certifying organization.

Table A.10.1.4 Sample Calculator for Turnout Gear Repair Limits

Year of Service	Year-of-Service End Date	Amount of Original Cost ($1000) Allowed for Repair	Amount Allowed per Set
1st	01/11/05	70%	$700
2nd	01/11/04	50%	$500
3rd	01/11/03	40%	$400
4th	01/11/02	25%	$250
5th	01/11/01	20%	$200
6th	01/11/00	15%	$150
7th	01/11/99	10%	$100
8th	01/11/98	5%	$50
9th	01/11/97	5%	$50
10th	01/11/96	0%	$0

Third-party certification is an important means of ensuring the quality of ensembles and ensemble elements. To be certain than an item is properly certified, labeled, and listed, NFPA strongly recommends that prospective purchasers require appropriate evidence of certification for the specific product and model from the manufacturer before purchase. 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 required for third-party certification by NFPA 1971 and is a service performed by the certification organization.

Details about certification and product labeling can be found in Chapters 4 and 5 of NFPA 1971. Also, the definitions of *certification/certified* in Section 3.3 of NFPA 1971, and *labeled* and *listed* in Section 3.2 of this standard should be reviewed.

From time to time, NFPA receives complaints that certain items of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements might be carrying labels falsely identifying them as compliant with an NFPA standard. NFPA advises those purchasing structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements to be aware that any structural fire fighting ensemble or ensemble element or proximity fire fighting ensemble or ensemble element that does not bear the appropriate compliance statement and the mark of an independent, third-party certification organization is not compliant with NFPA 1971, even if the product label states that the ensemble or ensemble element is compliant.

When an organization is in doubt as to the authenticity of a certification claim, the certification organization or the consumer protection agency of the state/provincial government should be contacted directly.

A.10.1.8 Changes in the type of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements used by a fire department can result in the retirement of elements that have not yet reached the end of their service life. Items of no further use to the

organization in frontline service might be of use for training or donation to other organizations.

A.10.3.1 When developing these procedures, the organization should coordinate with other agencies such as the medical examiner, law enforcement, or other experts to determine what actions are appropriate. Organizations can find additional guidance related to the processing of structural ensembles and ensemble elements and proximity ensembles and ensemble elements that are directly related to serious fire fighter injuries and fire fighter fatalities in the International Association of Fire Fighters manual, *Line of Duty Notification, Assistance, and Investigation Policy*, available at www.iaff.org/safe/lodd.html, and the International Association of Fire Chiefs guide for investigating a line-of-duty death, "LODD Response Plan," available at www.iafc.org.

N **A.11.1.1.1** Organizations should look at the listed capabilities indicated by the certification organization for verified ISPs to determine which moisture barriers can be repaired prior to requesting repair work on their garments. The ISP's or organization's certificate or the certification organization's website should also be reviewed.

Δ **A.11.1.3.1** It should be noted that the 2008 edition of NFPA 1851 included two categories of independent service providers (ISPs): verified and non-verified. In the 2014 edition of the standard, the technical committee eliminated the non-verified ISP completely. This was based on the technical committee's position that any service provider offering advanced inspection, advanced cleaning, sanitization, basic repair, advanced repair, and training must be third-party verified in order to do so. Thus, the term *ISP* can be used only by companies verified by an independent third-party agency in accordance with the requirements of this standard. In the 2020 edition, the technical committee maintained the categories of verified ISP and verified organization; the category of verified cleaner was also added to allow for more access to entities that clean and sanitize garments but don't offer other services covered by this standard, like inspection and repair.

A.11.2.1 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.11.2.5 The contractual provisions covering verification programs should contain clauses advising the verified organization or verified ISP that, if requirements change, the process should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently verified repairs. Without such clauses, certification organizations would not be able to move quickly to protect their names, marks, or reputations. A verification program would be deficient without these contractual provisions and the administrative means to back them up.

A.11.2.7 Investigative procedures are important elements of an effective and meaningful verification program. A preliminary review should be carried out on processes submitted to the agency before any major testing is undertaken.

A.11.2.12 Such inspections should include witnessing of advanced cleaning, advanced inspections, and advanced repairs and review of the quality management system.

• *N* **A.11.2.16** The certification organization should establish procedures for when complaints are submitted. These procedures should 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.

For the purposes of defining noncompliant cleaning or repairs of ensemble elements, a valid report should include any specific approach to cleaning or repair that is not authorized by the manufacturer of the ensemble element and that does not meet the one or more of the respective applicable requirements for cleaning in accordance with Chapter 7 or for repairs in accordance with Chapter 8.

Where a report of potentially noncompliant cleaning or repairs is provided, the certification organization should make an assessment of the severity of the noncompliance and its consequences to the safety and health of users. This assessment should involve the certification organization consulting with the manufacturer of the affected ensemble element(s).

Where a complaint of potentially noncompliant cleaning or repairs is provided, the certification organization should determine the scope of the services as applied to ensemble element(s) in terms of the period of time for which the noncompliant cleaning or repairs had occurred, if possible.

The certification organization should conduct the investigation with input from the verified ISP or verified organization providing the cleaning or repairs. Where findings conclude that the verified ISP's or verified organization's specific cleaning or repairs are noncompliant with this standard and the certification organization's appeal procedures referenced in 11.2.14 have been followed, the certification organization should take one or more of the following corrective actions:

(1) Require the verified ISP or verified organization to institute changes in its procedures to bring its cleaning or repairs into compliance with this standard
(2) Require the verified ISP or verified organization to notify those parties or individuals affected by the noncompliant cleaning or repairs
(3) Require the verified ISP or verified organization to perform compliant cleaning or repairs on the affected ensemble elements when such recleaning of ensemble elements or performance of additional repairs is necessary to protect the users
(4) Remove the verified ISP or verified organization from its verification program if it refuses to comply with the certification organization's corrective action indicated as part of its investigation

The certification organization should provide the findings of the investigation to the appropriate parties.

Where a change to this standard is necessary as a result of the investigation, the certification organization should submit either a Public Input for a proposed change to the next revision of this standard or a proposed Temporary Interim Amendment (TIA) to the current edition of this standard.

N **A.11.3.6.2** The engineering analysis should consider the type of detergent used, the wash and rinse temperatures, water levels applied, and time for each specific step of the wash or sanitization formulation and procedures. For example, if a presoak is only used for some formulations in cleaning or sanitizing garment outer shells, then it should not be used as part of the verification of the advanced cleaning or sanitization procedures.

N **A.11.3.7** The requirements in this section are imposed to verify that certain facilities that perform advanced cleaning and sanitization of fire fighter protective garments can provide minimum levels of contaminant removal. Facilities subject to this verification by the certification organization include ISPs, cleaners, manufacturers that provide cleaning services, and verified organizations.

Verification of advanced cleaning includes evaluating the facility's ability to separately remove both heavy metal contamination and semivolatile organic compound contamination using procedures established in Chapter 12. Minimum levels of contamination removal for these substances are based on cleaning efficiency, which is measured by comparing levels of specific contaminants in contaminated surrogate clothing samples subject to advanced cleaning to similar samples that have not been cleaned. These minimum levels were established by a comprehensive study conducted by the Fire Protection Research Foundation and reflect practical and achievable contamination removal levels based on current cleaning approaches available to the fire service.

Verification of sanitization is applied to those facilities that sanitize fire fighter protective garments. Sanitization is applied to biological contaminations such as microorganisms from blood, body fluids, and contaminated water. Procedures for verifying sanitization of fire fighter protective garments are established in Chapter 12. Effectiveness for sanitization is judged on a log reduction (powers of 10) where the minimum log reduction represents a 99.9 percent reduction in the number of viable microorganisms. This level of reduction is consistent with EPA regulations for sanitizer registration.

N **A.12.1.1** While this technique can be effectively used for quick inspection of a particulate-blocking protective hood interface component, hoods that use dark materials or utilize multiple thick layers in their construction can be difficult to inspect for identifying damage. If this technique does not readily identify small holes and tears in the type of hood being tested, it is recommended that the smoke evaluation method specified in Section 12.2 be used for inspection of particulate-blocking hoods.

N **A.12.1.3.1** A clear head form can be found online and at various fashion or clothing display supply stores. Ideally, the head form should be completely clear and have average human features. It is advantageous to use an SCBA facepiece on the head form and block off the area underneath the SCBA visor to minimize light coming out of the face opening. A regular incandescent light bulb of 60 W or greater can be used as the light source. Alternatively, a light-emitting diode (LED) light can also be used and might provide greater light intensity. The head form and light source can be mounted on a board or platform to provide ease of use.

The equipment used in Section 12.2 can also be used where the transparent cylindrical reservoir is replaced with an opaque cylindrical reservoir, the smoke generator is not connected to the sample clamping device, and a small multi-LED light source is used inside the cylindrical reservoir.

N **A.12.1.3.2** A simple fixture meeting this requirement is a 100 mm (4 in.) diameter solid color Schedule 40 or Schedule 80 PVC pipe section that is approximately 150 mm (6 in.) long and mounted on top of a board or other platform. A socket can be used to mount the pipe vertically on the board. A socket or other open pipe fixture end can be installed on the top of the pipe section cut edge to provide a smoother surface for mounting the hood. A small multi-LED can be placed at the base inside the pipe section as the light source. A simple elastic band can be used to hold the hood in position at each inspection site.

N **A.12.1.6** Research performed by the North Carolina State University has shown that this test can readily discriminate the presence of 1 mm or larger diameter holes in natural-colored hoods; however, the ability of the test to identify holes in black-colored hoods is lessened to holes that are 7 mm or larger in diameter. The utility of this test should be demonstrated before relying on this technique to detect damage in particulate-blocking hoods.

N **A.12.2.1.2** This test method involves clamping a portion of the particulate-blocking hood onto a fixture and flowing a simulant smoke underneath the portion of the hood being tested under specific conditions of exposure.

In the qualitative test approach, the test operator examines the exposed area of the tested hood for any signs of visual penetration of smoke. A comparison is made with a new hood to determine if there are any differences in the amount of smoke penetration observed.

In the quantitative test approach, a light transmission meter is used to measure the density of smoke across the exposed surface of the test hood and provides the percentage of light transmission. A measurement of 100 percent indicates the amount of smoke coming from the hood does not affect the light beam, whereas any measurement less than 100 percent indicates that some smoke is passing through the area of the hood being tested. As with the qualitative test, acceptable performance is determined by a comparison between light transmission measurements with a new hood and light transmission measurements with a used hood.

N **A.12.2.3** An example test apparatus, quantitative smoke inspection method (QSIM), conforming to the requirements in 12.2.3 is shown in Figure A.12.2.3(a) and Figure A.12.2.3(b).

N **A.12.2.3.2** A hydrostatic testing device used for conducting water penetration evaluation of garment moisture barriers and moisture barrier seams can be adapted for achieving these characteristics.

N **A.12.2.3.3** Several commercial smoke generators can be used to meet these requirements. Smoke generators can use either aqueous-based smoke-generating liquids (e.g., glycerin) or mineral oil. A determination should be made for the safety of the smoke-generating liquid. If there are any concerns for residue left by the smoke-generating liquid, then the tested hood should be subjected to an advanced cleaning.

N **A.12.2.3.5** A representative light transmission meter is a window tint meter used for automotive windshields that is self-contained with both a movable LED light source and a photo-resister with a digital display and RS232 port for data acquisition.

N **A.12.2.4.2(13)** The cleaning procedures used should be appropriate for removing any residue left on the hood interface component as the result of contact with the test smoke. The post-inspection test cleaning procedures do not necessarily have to be those complying with 7.3.16, but should be demonstrated to remove the smoke-generated residue.

N **FIGURE A.12.2.3(a) Complete QSIM Testing Apparatus.**

N **FIGURE A.12.2.3(b) QSIM During Testing with No Test Fabric in Place.**

N **A.12.2.4.3(1)** Suitable standard reference materials are the CHEMEX® bonded filters as prefolded squares. When evaluated using the quantitative approach in 12.2.4.3 in one, two, three, and four layers of the standard reference material filter paper, the following results should be obtained:

(1) One layer light transmittance: 36.9 percent ± 10.0 percent
(2) Two layer light transmittance: 68.6 percent ± 10.0 percent
(3) Three layer light transmittance: 82.6 percent ± 5.0 percent
(4) Four layer light transmittance: 91.7 percent ± 5.0 percent

N **A.12.2.6.2** Organizations and ISPs conducting the inspection of particulate-blocking hoods should establish the baseline performance of new, unused hoods and apply statistics for determining if lower light transmission values suggest possible defects in used hoods.

A.12.3.3.1 An evaluation apparatus meeting these requirements is specified in AATCC 127, *Water Resistance: Hydrostatic Pressure Test*. The method of pressurization can be automatic or manual.

N **A.12.4.1** This test method is used for verifying the efficacy of advanced cleaning in removing contaminants generally associated with products of combustion. For the purposes of this testing, a single outer shell material is used where samples of the outer shell material are contaminated with specific chemicals under controlled conditions and then subjected to a single cycle of advanced cleaning at the cleaning facility. The results of the test are used to determine cleaning efficiencies for two different groups of chemical contaminants: selected semivolatile organic chemicals and selected heavy metals. While this test method is used to assess the effectiveness of advanced cleaning in removing contaminants, it cannot be inferred to represent the effectiveness of advanced cleaning procedures to remove all contaminants in all types of materials under all circumstances.

N **A.12.4.2** The paragraphs in 12.4.2 provide an overall description of procedures for measuring cleaning efficiency for advanced cleaning processes in removing chemical contaminants from protective garment outer shell materials. Section 12.4 provides the overarching set of procedures for these measurements covering both semivolatile organic compound (SVOC) and heavy metal inorganic contaminants. Specific procedures for the preparation of SOVC-contaminated specimens, the extraction of SVOC contaminants from both contaminated and noncontaminated specimens, and the analysis of those specimens for specific contaminants are provided in Section 12.6. Similarly, specific procedures for the preparation of heavy metal inorganic compound contaminated specimens, the extraction of heavy metal contaminants from both contaminated and noncontaminated specimens, and the analysis of those specimens for specific contaminants are provided in Section 12.7. Section 12.9 is referenced for the preparation of surrogate garments, the preparation of ballast material panels, and the creation of the wash load.

N **A.12.4.4.4.1** A total of 10 specimens are prepared and used for two types of contaminant (semivolatile organic compounds and heavy metals). Of the six contaminated specimens, two specimens are inserted into the pockets of a surrogate coat, two specimens are inserted into the pockets of a surrogate pant, one specimen travels with the other specimens to the cleaning facility where the verification is conducted, and the last specimen is retained by the certification organization or its designa-

ted laboratory. Of the four noncontaminated (control) specimens, one specimen is inserted into the pocket of a surrogate coat, one specimen is inserted into the pocket of a surrogate pant, one specimen travels with the other specimens to the cleaning facility, and the last specimen is retained by the certification organization or its designated laboratory.

The number of specimens can be reduced to five contaminated specimens and three noncontaminated specimens if the certification organization can demonstrate that the transportation of the specimens to the receiving facility does not affect the specimen's condition or the contaminant concentrations. This reduction in sample numbers would occur if the travel specimens are not prepared and sent to the cleaning facility. The removed sixth contaminated specimen and removed fourth noncontaminated specimen are intended to be controls to indicate the transportation of the specimens is not affected by their transport to the cleaning facility.

N **A.12.5.1** This test method is used for verifying the efficacy of sanitization to inactivate microbiological contaminants associated with biological contaminants such as body fluids or contaminated water. For the purposes of this testing, a single outer shell material is used where samples of the outer shell material are contaminated with specific types of bacteria under controlled conditions and then subjected to a single cycle of sanitization at the cleaning facility. The results of the test method are used to determine log reductions for two different bacteria: *Klebsiella pneumoniae* and *Staphylococcus aureus*. While this test method is used to assess the effectiveness of sanitization in inactivating or killing these biological contaminants, it cannot be inferred to represent the effectiveness of sanitization procedures to inactivate all forms of microbial contamination in all types of materials under all circumstances.

N **A.12.5.2** The paragraphs in 12.5.2 provide an overall description of procedures for measuring log reduction for sanitization processes in removing biological contaminants from protective garment outer shell materials. Section 12.5 provides the overarching set of procedures for these measurements covering two different types of vegetative bacteria: *Klebsiella pneumoniae* and *Staphylococcus aureus*. Specific procedures for the preparation of bacteria-contaminated specimens, the extraction of bacteria contaminants from both contaminated and noncontaminated specimens, and the analysis of those specimens for specific contaminants are provided in Section 12.8. Section 12.9 is referenced for the preparation of surrogate garments, the preparation of ballast material panels, and the creation of the cleaning load.

N **A.12.5.2.6** Log reduction is a shorthand for indicating the percentage reduction of microorganisms. For example, a $\log_{10}$ 3 reduction is the removal of a 99.9 percent reduction of microorganisms. In this referenced method, the log reduction is based on comparing the reduction of the microorganisms between surrogate fabrics subjected to a sanitization process and the same fabrics subjected to a water wash only. The procedures used in this standard are based on ASTM E2274, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants*, which is one of the test methods specified by the U.S. Environmental Protection Agency (EPA) for determining the efficacy of sanitizers.

N **A.12.5.4.4.1** A total of 10 specimens are prepared and used for types of bacteria. Of the six contaminated specimens, two specimens are inserted into the pockets of a surrogate coat, two specimens are inserted into the pockets of a surrogate pant, one specimen travels with the other specimens to the cleaning facility where the verification is conducted, and the last specimen is retained by the certification organization or its designated laboratory. Of the four noncontaminated (control) specimens, one specimen is inserted into the pocket of a surrogate coat, one specimen is inserted into the pocket of a surrogate pant, one specimen travels with the other specimens to the cleaning facility, and the last specimen is retained by the certification organization or its designated laboratory.

The number of specimens can be reduced to five contaminated specimens and three noncontaminated specimens if the certification organization can demonstrate that the transportation of the specimens to the receiving facility does not affect the specimen's condition or the biocontamination levels. This reduction in sample numbers would occur if the travel specimens are not prepared and sent to the cleaning facility. The removed sixth contaminated specimen and removed fourth noncontaminated specimen are intended to be controls to indicate the transportation of the specimens is not affected by their transport to the cleaning facility.

N **A.12.6.4.1** This type of apparatus can either be fabricated or purchased. Multiple port evaporators/concentrators can be purchased or fabricated. A photograph of a fabricated miniature evaporator designed to hold oil tubes is shown in Figure A.12.6.4.1.

N **A.12.6.4.8** EPA Method 3540C, "Soxhlet Extraction," can be adapted for use with textile sample matrices for performing this type of extraction for semivolatile organic compound contaminants.

N **A.12.6.5.6** EPA Method 8270E, "Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)," can be adapted for use with textile sample matrices for performing this type of analysis for semivolatile organic compound contaminants.

N **A.12.7.2.3** A metal wire test tube rack can be used for this purpose.

N **FIGURE A.12.6.4.1 Photograph of a Miniature Evaporation Apparatus.**

N **A.12.7.2.4.3** Given the hydrophobic nature of original finish on the specimens, extreme care must be exercised that no liquid runs off the specimen during the application of the metals standard solution.

N **A.12.7.3.1.5** EPA Method 3050B, "Acid Digestion of Sediments, Sludges, and Soils," can be adapted for use with textile sample matrices for performing this type of extraction for heavy metal contaminants.

N **A.12.7.3.2.9** EPA Method 3050B, "Acid Digestion of Sediments, Sludges, and Soils," can be adapted for use with textile sample matrices for performing this type of extraction for heavy metal contaminants.

N **A.12.7.4.1.3** EPA Method 6010D, "Inductively Coupled Plasma," can be adapted for use with textile sample matrices for performing this type of analysis for heavy metal contaminants.

N **A.12.8.1.2** In the preparation, extraction, and analysis of bacterial contaminated specimens, references are made to ASTM E2274, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants*, which are intended to provide procedures for carrying out verification of sanitization procedures in inactivating or neutralizing specific bacterial contamination. Due to the generalized nature of the ASTM E2274 procedures, particularly as applied to evaluating sanitizers under ideal exposure conditions, the following guidance is offered to provide specific recommended procedures for meeting the requirements in Section 12.8.

Preparation of media, specimens, and inoculation of specimens as follows:

(1) Grow a culture of the needed bacteria per accepted ATCC culture methods.
(2) Prepare 6 plates of appropriate agar media for each of the bacteria used in 100 mm (4 in.) slippable petri dishes for the contaminated swatches and 1 more plate per bacterium for the noncontaminated swatches.
(3) Perform a serial dilution of the culture and plate 200 μL of the -4, -5, and -6 to determine the concentration.
(4) Use the initial bacterial concentration to determine the concentration in the inoculation amount.
(5) Sterilize all specimens to be used in testing with a suitable sterilization technique.
(6) Label all petri dishes.
(7) Use aseptic techniques when placing all specimens in their corresponding petri dishes.
(8) Negative control (lab and travel control) dishes should be performed first and must be covered with parafilm and placed directly into the refrigerator at 4°C (39°F).
(9) Contaminate specimens with each bacterium separately to reduce cross-contamination possibilities.

Once all the contaminated specimens have been inoculated, carefully place the petri dish into the incubator set to the same growth temperature for that bacteria.

Allow the specimens to remain in the incubator until completely dry (continually check as over drying can cause low recovery results in positive controls).

Once the specimens are dry, apply parafilm on all petri dishes except the contaminated laboratory control for each bacterium and place in the refrigerator.

Ship out the necessary specimens on ice for laundering.

Contaminated Lab Control Analysis as follows:

(1) Place 10 mL of broth (same as growth medium used in culturing each bacterium) into three appropriate containers with lids.
(2) Label the 3 containers with bacterium name then "(+)", "(+) 10x", and "(+) 100x" respectively.
(3) Place the dry contaminated lab control into the container marked (+) and vortex or shake (depending on the size of the container) for 1 minute.
(4) Once the time is up, aliquot 1 mL of the (+) into the (+) 10x and 0.1 mL of the (+) into the (+) 100x and vortex or shake for 1 minute.
(5) Label the 6 agar media plates that were prepared for each bacterium with the bacteria name then "–3" with "(+) 10x" and "3" with "(+) 100x".
(6) Spread plate 0.2 mL on each of the respective plates for the 10x and 100x samples and allow to dry before incubating the samples.
(7) Determine the colony forming units (CFUs) and record individual results for all plates.

Noncontaminated Lab Control Analysis as follows:

(1) Place 10 mL of broth (same as growth medium used in culturing each bacterium) into an appropriate container with a lid.
(2) Label the container with "(-)".
(3) Place the swatch into the broth container and vortex or shake for 1 minute.
(4) Label 1 agar plate per bacterium with "(-)".
(5) Spread plate 0.2 mL from the (-) labeled container and allow to dry before incubating.

Test Specimen Analysis as follows:

(1) Process each bacterium separately to reduce contamination possibilities.
(2) Prepare agar media plates for each bacterium so that each test specimen gets 3 plates (47 mm petri dishes).
(3) Prepare 3 containers with 10 mL of appropriate broth for each bacterium for each test specimen.
(4) Label the containers and agar plates with specimen code then "1", "10", and "100" respectively.
(5) Aseptically place the test specimen into the container with the 1 and vortex or shake for 1 minute.
(6) Add 1 mL of the solution made in (5) to the container labeled 10, then add 0.1 mL of the solution made in (5) to the container labeled 100, and vortex or shake both dilutions for 1 minute.
(7) Once all test specimens have been processed and their dilutions been made, use a vacuum filtration system to filter all the test specimens and their dilutions onto filters.
(8) Plate these filters on the corresponding prepared 47 mm agar media plates and incubate.
(9) Determine the colony forming units (CFUs) and record individual results for all plates.

Travel Noncontaminated Specimen Analysis as follows:

(1) Process noncontaminated specimens that travel to the sanitization facility location in same way as the noncontaminated lab controls.

Travel Contaminated Specimen Analysis as follows:

(1) Process contaminated specimens that travel to the sanitization facility location in the same way as the contaminated laboratory controls.

Sterilizer Check Specimens as follows:

(1) Process sterilizer check specimens in the same way as the noncontaminated laboratory controls once these swatches are subjected to the same sterilizing cycle that was used for the garments and individual specimens.

N **A.12.8.2.7** See A.12.8.1.2.

N **A.12.8.3.4** See A.12.8.1.2.

N **A.12.9.3.8** Specific examples of samples (panels) are given below for set size washer/extractors in Table A.12.9.3.8(a) through Table A.12.9.3.8(c). These tables are intended to provide examples for how Panel D and Panel E are alternated and distributed with the respective wash loads. The specific panel weight can vary based on cutting practices and use over time.

Examples of recommended sequences for the individual panels for a 40 lb, a 60 lb, and a 100 lb washer/extractor load at 80 percent capacity are provided in Table A.12.9.3.8(d).

N **Table A.12.9.3.8(a) Number and Type of Panels for 40 lb Washer/Extractor Load at 80 Percent Capacity**

		Individual Weight		Total Weight	
Panel	Number	g	lb	kg	lb
A	28	172	0.38	5.08	11.20
B	9	354	0.78	3.27	7.20
C	9	354	0.78	3.27	7.20
D	3	354	0.78	1.06	2.34
E	3	354	0.78	1.06	2.34
F (3 pieces)	15	181	0.40	0.91	2.00
Total load weight	—	—	—	14.65	32.28

N **Table A.12.9.3.8(b) Number and Type of Panels for 60 lb Washer/Extractor Load at 80 Percent Capacity**

		Individual Weight		Total Weight	
Panel	Number	g	lb	kg	lb
A	42	172	0.38	7.62	16.80
B	12	354	0.78	4.35	9.60
C	16	354	0.78	5.66	12.50
D	3	354	0.78	1.06	2.34
E	3	354	0.78	1.06	2.34
F (3 pieces)	27	181	0.40	1.63	3.60
Total load weight	—	—	—	21.38	47.18

N **Table A.12.9.3.8(c) Number and Type of Panels for 100 lb Washer/Extractor Load at 80 Percent Capacity**

		Individual Weight		Total Weight	
Panel	Number	g	lb	kg	lb
A	70	172	0.38	12.07	26.60
B	20	354	0.78	7.08	15.60
C	32	354	0.78	11.03	24.32
D	3	354	0.78	1.06	2.34
E	3	308	0.68	1.06	2.34
F (3 pieces)	13	181	0.40	2.36	5.20
Total load weight	—	—	—	34.66	76.40

N **Table A.12.9.3.8(d) Recommended Sequencing for Individual Panels**

	Extractor Load		
Step Sequence	40 lb	60 lb	100 lb
1	D	D	D
2	A	A	A
3	C	F	C
4	A	A	A
5	F	C	F
6	A	A	A
7	B	F	B
8	A	A	A
9	C	B	C
10	A	A	A
11	E	C	C
12	A	A	A
13	B	F	B
14	A	A	A
15	C	E	C
16	A	A	A
17	F	B	F
18	A	A	A
19	B	C	B
20	A	A	A
21	C	F	C
22	A	A	A
23	D	C	E
24	A	A	A
25	B	B	B
26	A	A	A
27	C	C	C
28	A	A	A
29	E	F	C
30	A	A	A
31	B	D	B
32	A	A	A
33	C	B	C
34	A	A	A
35	F	C	F
36	A	A	A
37	B	F	B
38	A	A	A
39	C	C	C
40	A	A	A

(continues)

N Table A.12.9.3.8(d) *Continued*

	Extractor Load		
Step Sequence	40 lb	60 lb	100 lb
41	D	B	D
42	A	A	A
43	B	C	B
44	A	A	A
45	C	E	C
46	A	A	A
47	E	C	C
48	A	A	A
49	B	B	B
50	A	A	A
51	C	C	C
52	A	A	A
53	F	F	F
54	A	A	A
55	B	C	B
56	A	A	A
57	F	B	F
58	A	A	A
59	C	C	C
60	—	A	B
61	—	D	A
62	—	A	C
63	—	C	A
64	—	A	F
65	—	B	A
66	—	A	B
67	—	C	A
68	—	A	C
69	—	F	A
70	—	A	C
71	—	C	A
72	—	A	E
73	—	B	A
74	—	A	C
75	—	E	A
76	—	A	F
77	—	C	A
78	—	A	B
79	—	F	A
80	—	A	C
81	—	B	A
82	—	A	C
83	—	C	A
84	—	A	B
85	—	F	A
86	—	A	C
87	—	B	A
88	—	C	C
89	—	B	A
90	—	—	B
91	—	—	A
92	—	—	C
93	—	—	A
94	—	—	F
95	—	—	A
96	—	—	D

(continues)

N Table A.12.9.3.8(d) *Continued*

	Extractor Load		
Step Sequence	40 lb	60 lb	100 lb
97	—	—	A
98	—	—	C
99	—	—	A
100	—	—	C
101	—	—	A
102	—	—	B
103	—	—	A
104	—	—	C
105	—	—	A
106	—	—	C
107	—	—	A
108	—	—	B
109	—	—	A
110	—	—	C
111	—	—	A
112	—	—	F
113	—	—	A
114	—	—	B
115	—	—	A
116	—	—	F
117	—	—	A
118	—	—	C
119	—	—	A
120	—	—	E
121	—	—	A
122	—	—	C
123	—	—	A
124	—	—	F
125	—	—	A
126	—	—	B
127	—	—	A
128	—	—	F
129	—	—	A
130	—	—	C
131	—	—	A
132	—	—	B
133	—	—	A
134	—	—	C
135	—	—	A
136	—	—	F
137	—	—	A
138	—	—	B
139	—	—	A
140	—	—	F
141	—	—	A
142	—	—	D

N A.12.9.3.9 The efficacy of the wash load can be checked by running a test load and examining the condition of the panels washing the wash process. A successful test load occurs when all panels open during the wash process. For certain low depth wash drums, larger panels might have to be removed from the sequencing in order to achieve a successful load.

Annex B Informational References

Δ **B.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.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

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

NFPA 1521, *Standard for Fire Department Safety Officer Professional Qualifications*, 2015 edition.

NFPA 1581, *Standard on Fire Department Infection Control Program*, 2015 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2018 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents*, 2016 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incidents*, 2018 edition.

NFPA 1999, *Standard on Protective Clothing and Ensembles for Emergency Medical Operations*, 2018 edition.

B.1.2 Other Publications.

B.1.2.1 AATCC Publications. American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709-2215.

AATCC 127,*Water Resistance: Hydrostatic Pressure Test*, 2018.

N **B.1.2.2 ACGIH Publications.** American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.

2016 Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs).

B.1.2.3 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/ASSE Z87.1, *American National Standard for Occupational and Educational Personal Eye and Face Protection Devices*, 2015.

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

ANSI/ISEA 113, *American National Standard for Fixed and Portable Decontamination Shower Units*, 2013.

ANSI/ISEA 207, *American National Standard for High-Visibility Public Safety Vests*, 2011.

Δ **B.1.2.4 ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D5755, *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading*, 2014.

ASTM E2274, *Standard Test Method for Evaluation of Laundry Sanitizers and Disinfectants*, 2016.

ASTM F1731, *Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing*, 1999, reapproved 2013.

ASTM F1930, *Standard Test Method for Evaluation of Flame-Resistant Clothing for Protection Against Fire Simulations Using an Instrumented Manikin*, 2018.

ASTM STP1237, *Performance of Protective Clothing*, 5th volume, 1996.

ASTM STP1386, *Field Evaluation of Protective Clothing Effects on Fire Fighter Physiology: Predictive Capability of Total Heat Loss Test*, 2000.

Δ **B.1.2.5 EPA Publications.** Environmental Protection Agency, William Jefferson Clinton East Building, 1200 Pennsylvania Avenue, NW, Washington, DC 20460.

EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. The specific methods cited can be downloaded at https://www.epa.gov/hw-sw846

Method 3015A, "Microwave Assisted Acid Digestion of Aqueous Samples and Extracts," February 2007.

Method 3050B, "Acid Digestion of Sediments, Sludges, and Soils," December 1996.

Method 3540C, "Soxhlet Extraction," December 1996.

Method 6010D, "Inductively Coupled Plasma," July 2018.

Method 8270E, "Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)," 2007.

OCSPP 810.2200, "Disinfectants for Use on Environmental Surfaces — Guide for Efficacy Testing," *EPA Series 810 — Product Performance Test Guidelines*, September 2012.

OCSPP 810.2300, "Sanitizers for Use on Hard Surfaces — Efficacy Data Recommendations," *EPA Series 810 — Product Performance Test Guidelines*, September 2012.

OCSPP 810.2400, "Disinfectants and Sanitizers for Use on Fabrics and Textiles — Efficacy Date Recommendations," *EPA Series 810 — Product Performance Test Guidelines*, March 2013.

Δ **B.1.2.6 IAFC Publications.** International Association of Fire Chiefs, 4025 Fair Ridge Drive, Suite 300, Fairfax, VA 22033-2868.

"LODD Response Plan," www.iafc.org/topics-and-tools/resources/resource/line-of-duty-death-resources

Δ **B.1.2.7 IAFF Publications.** International Association of Fire Fighters, 1750 New York Avenue, NW, Suite 300, Washington, DC 20006-5395.

Line of Duty Notification, Assistance, and Investigation Policy,http://client.prod.iaff.org/#contentid=369.

Δ **B.1.2.8 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, reconfirmed 2014.

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

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B.1.2.9 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

FHA *Manual on Uniform Traffic Control Devices*, 2012.

Title 29, Code of Federal Regulations, Part 1910.1030, "Bloodborne Pathogens."

N **B.1.2.10 USFA Publications.** U.S. Fire Administration, 16825 South Seton Avenue, Emmitsburg, MD 21727.

"Research, Testing and Analysis on the Decontamination of Fire Fighting Protective Clothing and Equipment." (A synopsis of this report is provided in ASTM STP1237, *Performance of Protective Clothing*.)

N **B.1.2.11 Other Publications.**

Easley, C. B., J. Laughlin, and R. Gold. "Laundering Pesticide Contaminated Clothing." Cornell University Cooperative Extension, Pesticide Safety Education Program (PSEP). psep.cce.cornell.edu/facts-slides-self/facts/gen-posaf-laund.aspx.

Kent, K. W., et al. "Contamination of firefighter personal protective equipment and skin and the effectiveness of decontamination procedures," *Journal of Occupational and Environmental Hygiene* 14(9): 801–814, June 2017.

Laughlin, J. "Decontaminating Pesticide Protective Clothing." *Reviews of Environmental Contamination and Toxicology* 130 (1993): 79–94. Springer, New York, NY. https://doi.org/10.1007/978-1-4613-9763-2_3.

McQuerry, M., A. Hummel, R. Barker, and S. Deaton. "The Cost of a Pocket: How Additional Reinforcements Impact THL & TPP." *Fire Engineering* 168, no. 12 (2015): 78–79.

McQuerry, M., S. Klausing, D. Cotterill, and E. Easter. "A Post-use Evaluation of Turnout Gear Using NFPA 1971 Standard on Protective Ensembles for Structural Fire Fighting and NFPA 1851 on Selection, Care and Maintenance." *Fire Technology* 51, no. 5 (2015): 1149–1166.

Naylor, R. A., and C. J. Boase. "Practical solutions for treating laundry infested with Cimex lectularius (Hemiptera: Cimicidae)." *Journal of Economic Entomology* 103(1): 136–139, February 2010.

Report #HP170626, "A Report to FIERO on Total Heat Loss and Evaporative Resistance Measurements of Eight Firefighter Composites." Textile Protection and Comfort Center (T-PACC), College of Textiles, North Carolina State University, June 2017.

Report #PSM170626, "A Report to FIERO on Phase II Testing: Predicted Physiological Responses from Eight Firefighting Suits Tested in Three Environmental Conditions." Textile Protection and Comfort Center (T-PACC), College of Textiles, North Carolina State University, June 2017.

Thostenson, A., et al. "Laundering Pesticide-contaminated Work Clothes (PS1778)." North Dakota State University Extension Service, January 2016. www.ag.ndsu.edu/publications/crops/laundering-pesticide-contaminated-work-clothes/ps1778.pdf.

Δ **B.2 Informational References.** The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

NIOSH Publication No. 2005-149, *NIOSH Pocket Guide to Chemical Hazards*, September 2005.

Title 29, Code of Federal Regulations, Part 1910.120, "Hazardous Waste Operations and Emergency Response," August 22, 1994.

B.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.

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Submit a Public Comment

Once the First Draft Report becomes available there is a Public Comment period. 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 follow the same steps as previously explained for the submission of Public Input.

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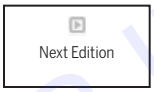

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Information on the NFPA Standards Development Process

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/regs."

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) 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.

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