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NFPA 1992 Liquid Splash-Protective Suits for Hazardous Chemical Emergencies 1990 Edition

National Fire Protection Association 1 Batterymarch Park, Quincy, MA 02269-9101

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There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 1992

Standard on

Liquid Splash-Protective Suits for Hazardous Chemical Emergencies

1990 Edition

This edition of NFPA 1992, *Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies*, was prepared by the Technical Committee on Fire Service Protective Clothing and Equipment and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 13-15, 1989 in Seattle, WA. It was issued by the Standards Council on January 12, 1990, with an effective date of February 5, 1990 .

The 1990 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 1992

In 1985 the National Transportation Safety Board (NTSB) issued report I-004-5 on a hazardous material incident that occurred in Benicia, California. In that report, the NTSB recommended that standards be developed for protective clothing for protection from hazardous chemicals. The United States Department of Transportation (DOT) issued a position that requested private sector standards development undertake the project of writing the standards on hazardous chemical protective clothing and asked other governmental agencies to assist and participate in the private sector standards development system. DOT at this time also directly requested that the NFPA develop documents on hazardous chemical protective clothing. The Environmental Protection Agency (EPA), the United States Coast Guard (USCG), the Federal Emergency Management Agency (FEMA), and the Occupational Safety and Health Administration (OSHA) either adopted position statements modeled after the DOT position or endorsed the DOT position.

During 1985, the NFPA Standards Council approved a project for development of these standards and assigned the project to the Technical Committee on Fire Service Protective Clothing and Equipment. The Technical Committee on Fire Service Protective Clothing and Equipment established a standing Subcommittee on Hazardous Chemicals Protective Clothing and they began their work in Phoenix, Arizona in March, 1986. Representatives from the USCG, FEMA, and OSHA participated on the Subcommittee.

At the same time, ASTM was developing a document on a selection of chemicals for evaluating protective clothing materials that would serve as one of several ASTM testing criteria that would be referenced in the NFPA standards.

The Subcommittee met several times over a 2½-year period at different locations across the country and developed two standards, one for vapor-protective suits and one for liquid splash-protective suits.

NFPA 1991 addresses vapor-protective suits designed to protect emergency response personnel against exposure to specified chemicals in vapor and liquid splash environments during hazardous chemical emergencies. Chemical permeation resistance documentation is required for primary suit materials (garment, visor, gloves, and boots) against each chemical in the NFPA battery of chemicals and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. The NFPA battery of chemicals consists of 17 chemicals: those specified in ASTM F 1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Materials*, plus anhydrous ammonia and chlorine gas. These chemicals were selected because they are representative of the classes of chemicals that are encountered during hazardous chemical emergencies.

The standard includes performance requirements that were established to reflect simulated use conditions. A suit pressurization test is used to check the air-tight integrity of each protective suit. Also, an overall suit water penetration test is designed to ensure the suit provides full body protection against liquid splashes. Primary suit materials must resist permeation for one hour or more by each chemical in the NFPA battery. Manufacturers may certify protective suits for additional chemicals when the same permeation performance is met. Also included are penetration resistance testing of closures, and leak and cracking pressure tests for exhaust valves. These tests allow determination of adequate suit component performance in hazardous chemical environments.

Material testing for burst strength, tear strength, abrasion resistance, flammability resistance, cold temperature performance, and flexural fatigue are required so that materials used for vapor-protective suits will afford adequate protection in the environment where they will be used.

NFPA 1992 addresses liquid splash-protective suits designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments during hazardous chemical emergencies. Chemical penetration resistance documentation of garment material against an NFPA battery of test chemicals and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit is required. The NFPA battery of chemicals were selected from ASTM F 1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Material*. These do not include liquid chemicals with known or suspected carcinogenicity or skin toxicity because these garments deal with skin exposure and not inhalation. This criterion produces a different subset of ASTM F 1001 chemicals to be certified.

The standard includes performance requirements that were established to reflect simulated use conditions. An overall suit water penetration test is included to ensure the suit provides full body splash protection. Materials testing includes burst strength, tear resistance, flammability resistance testing, abrasion resistance, cold temperature performance, and flexural fatigue testing. These tests are required so that garment materials will provide adequate protection in the environment in which they will be used.

The Subcommittee presented their final draft reports to the Technical Committee in Monterey, California, in August, 1988. Final drafts of both NFPA 1991 and NFPA 1992 were entered into the Fall Meeting 1989 cycle and were voted on by the Association at the 1989 Fall Meeting in Seattle, Washington, on 15 November 1989.

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NFPA 1992

Standard on

Liquid Splash-Protective Suits for Hazardous Chemical Emergencies

1990 Edition

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

Information on referenced publications can be found in Chapter 6.

Chapter 1 Administration

1-1 Scope.

1-1.1* This standard specifies minimum documentation, design criteria, performance criteria, and test methods for liquid splash-protective suits designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments during hazardous chemical emergencies.

1-1.2* This standard does not apply to protective clothing for any fire fighting applications, and does not provide criteria for protection from radiological, biological, or cryogenic agents, or from immersion in liquid chemicals, or against flammable, explosive, or chemical vapor atmospheres.

1-1.3* This standard is not intended to be utilized as a detailed manufacturing or purchase specification, but can be referenced in purchase specifications as minimum requirements.

1-2 Purpose.

1-2.1 The purpose of this standard is to provide minimum requirements for liquid splash-protective suits used in hazardous chemical emergencies.

1-2.2 It is not the purpose of this standard to provide criteria for protection from vapors given off by liquids. Vapor protection requirements are specified in NFPA 1991, *Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies*.

1-2.3 Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all situations to which fire fighting personnel may be exposed.

1-3 Definitions.

Approved.* Acceptable to the "authority having jurisdiction."

Authority Having Jurisdiction.* The "authority having jurisdiction" is the organization, office, or individual responsible for "approving" equipment, an installation or a procedure.

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

Boot or Bootie Assembly. The segment of the chemical-protective suit designed to protect the wearer's feet, combined with the interface between the garment and type of foot protection.

Bootie. A sock-like extension of the suit leg designed to protect the wearer's feet when worn in conjunction with an outer boot.

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

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

Chemical-Protective Clothing Material. Any material or combination of materials used in an item of clothing for the purpose of isolating parts of the wearer's body from chemical or physical hazards.

Chemical-Protective Suit. A single or multi-piece garment constructed of chemical-protective clothing materials designed and configured to protect the wearer's torso, head, arms, legs, hands, and feet. It shall be permitted to cover the wearer's head, hands, and feet with attached or detachable hoods, gloves, and boots. It shall be permitted to completely enclose the wearer by itself or in combination with the wearer's respiratory equipment, hood, gloves, and boots.

Compliant. Meeting or exceeding all applicable requirements of this standard.

Cracking Pressure. The pressure at which the suit exhaust valve just begins to crack open, releasing exhaust air to the outside suit environment.

Cryogenic Agents. Low temperature materials that are capable of causing acute or long-term freeze burn damage to the human body.

Emergency Response Personnel. Personnel assigned to organizations that have the responsibility for responding to different types of emergency situations.

Exhaust Valve. One-way vent valves designed to release exhaust air from the inside of the chemical-protective suit to the outside environment.

External Fittings. Any component externally located on, and part of, the liquid splash-protective suit that is not part of the garment material, visor material, boot assembly, glove assembly, or closure assembly.

External Gaskets. Any gasket externally located on, and part of, the liquid splash-protective suit that is not part of the garment material, visor material, boot assembly, glove assembly, or closure assembly.

Flammable or Explosive Atmospheres. Atmospheres containing chemical vapors or gases at concentrations that will burn or explode if ignited.

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

Garment Label. A label affixed to the garment by the manufacturer containing general information, warnings, care, maintenance, or similar data. This garment label is not a certification organization label or identifying mark.

Garment Material. The chemical-protective clothing material used in constructing the major portion of the chemical-protective suit.

Glove Assembly. The segment of the chemical-protective suit designed to protect the wearer's hands, combined with the interface between the garment and type of hand protection.

Hazardous Chemical Emergencies. Incidents involving the release or potential release of hazardous chemicals into the environment, which can cause loss of life, personnel injury, or damage to property and the environment.

Hazardous Chemical. Any solid, liquid, gas, or mixture thereof that can potentially cause harm to the human body through respiration, ingestion, skin absorption, or contact.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization 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.

Liquid Splash-Protective Suit. A chemical-protective suit that meets all requirements of this standard NFPA 1992, *Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies*, and that protects against chemical liquid splashes, and not against chemical vapors or gases.

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

Primary Suit Materials. Chemical-protective suit materials limited to the garment material, visor or faceshield material, glove material, and boot or bootie material. This includes, in addition to the above materials, the wearer's respiratory equipment when worn outside the liquid splash-protective suit and includes all exposed respiratory equipment materials designed to protect the wearer's breathing air and air path.

Radiological Agents. Radiation associated with x-rays, alpha, beta, and gamma emissions from radioactive isotopes, or other materials in excess of normal radiation background levels.

Respiratory Equipment. A positive pressure, self-contained breathing apparatus (SCBA) or combination SCBA/supplied-air breathing apparatus certified by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA) or the appropriate approval agency for use in atmospheres that are immediately dangerous to life or health (IDLH).

Seam. Any permanent attachment of two or more chemical-protective clothing materials, excluding external fittings, gaskets, and suit closure assemblies, in a line formed by joining the separate material pieces.

Shall. Indicates a mandatory requirement.

Should. This term, as used in the Appendix, indicates a recommendation or that which is advised but not required.

Suit Closure. The suit component designed and configured to allow the wearer to enter (don) and exit (doff) the chemical-protective suit.

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

Vapor-Protective Suit. A chemical-protective suit that protects against chemical vapors, gases, and liquids and meets all requirements of NFPA 1991, *Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies*.

Visor or Faceshield Material. The transparent chemical-protective clothing material that allows the wearer to see outside the chemical-protective suit.

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

Chapter 2 Certification

2-1 General.

2-1.1* Liquid splash-protective suits that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

2-1.2 Liquid splash-protective suits shall be certified to only one NFPA standard.

2-1.3 All certification shall be performed by an approved certification organization.

2-1.4 Compliant liquid splash-protective suits shall be listed and labeled. Such liquid splash-protective suits shall also have a garment label that meets the requirements specified in Section 2-4 of this chapter.

2-1.5 Liquid splash protective suits shall not be certified for chemicals or specific chemical mixtures with known or suspected carcinogenicity as indicated by any one of the following documents:

(a) N. Irving Sax, *Dangerous Properties of Industrial Chemicals*

(b) NIOSH Pocket Guide to Chemical Hazards

(c) U.S. Coast Guard Chemical Hazard Response Information System (CHRIS), Volumes 1-3, Hazardous Chemical Data.

2-1.6 Liquid splash protective suits shall not be certified for chemicals or specific chemical mixtures with skin toxicity notations as indicated by the following reference:

(a) American Conference of Governmental Industrial Hygienists, Threshold Limit Values and Biological Exposure Indices for 1988–1989.

2-2 Certification Program

2-2.1* The certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified. The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

2-2.2 The certification organization shall refuse to certify products to this standard that do not comply with all requirements of this standard.

2-2.3* The contractual provisions between the certification organization and the manufacturer shall specify that certification is contingent on compliance with all applicable requirements of this standard. There shall be no conditional, temporary, or partial certifications. Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not manufactured in compliance with all applicable requirements of this standard.

2-2.4* For certification, laboratory facilities and equipment for conducting proper tests shall be available, a program for calibration of all instruments shall be in place and operating, and procedures shall be in use to ensure proper control of all testing. Good practice shall be followed regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

2-2.5 Manufacturers shall be required to establish and maintain a program of production inspection and testing.

2-2.6 The manufacturers and the certification organization shall evaluate any changes affecting the form, fit, or function of the certified product to determine its continual certification to this standard.

2-2.7* Product certifications shall include a follow-up inspection program, with at least 2 random and unannounced visits per 12-month period.

2-2.8 The certification organization shall have a program for investigating field reports alleging malperformance or failure of listed products.

2-2.9 The operating procedures of the certification organization shall provide a mechanism for the manufacturer to appeal decisions. The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

2-2.10 The certification organization shall be in a position to use legal means to protect the integrity of its name and label. The name and label shall be registered and legally defended.

2-3 Inspection and Testing.

2-3.1 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to assure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified as being compliant with the standard are compliant. The reliability and confidence levels shall be included in the manufacturer's technical data package.

2-3.2 Testing for determining material and component compliance with the requirements specified in Chapter 3 of this standard shall be performed on samples representative of materials and components used in the actual construction of the liquid splash-protective suit. The certification organization shall be permitted to also use sample materials cut from a representative liquid splash-protective suit.

2-3.3 Any combination of materials or multi-piece garment that is needed to meet any of the performance requirements specified in Chapter 4 of this standard shall also be required to meet all the requirements for that particular segment of the liquid-splash protective suit.

2-4 Garment Labeling.

2-4.1* The liquid splash-protective suit shall have a garment label permanently and conspicuously attached to the inside of the garment upon which at least the following warning and information are printed in at least $1/16$ in. (1.5mm) high letters.

"ALL SEPARATE GARMENTS COMPRISING THIS LIQUID SPLASH-PROTECTIVE SUIT MEET THE REQUIREMENTS OF NFPA 1992, *LIQUID SPLASH-PROTECTIVE SUITS FOR HAZARDOUS CHEMICAL EMERGENCIES*, 1990 EDITION, FOR THE CHEMICALS LISTED BELOW. THE TECHNICAL DATA

PACKAGE CONTAINS ADDITIONAL INFORMATION ON THESE AND ANY ADDITIONAL CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS SUIT IS CERTIFIED.

Acetone	Sodium Hydroxide
Diethylamine	Sulfuric Acid
Ethyl Acetate	Tetrahydrofuran
Hexane	Toluene

WARNING

USE THIS GARMENT FOR PROTECTION FROM LIQUID SPLASHES ONLY. LIQUIDS GIVE OFF VAPORS, AND THIS GARMENT MAY NOT PROTECT YOU FROM CONTACT WITH THESE VAPORS. DO NOT USE THIS GARMENT IF VAPORS ARE HAZARDOUS. THE USER MUST CONSULT THE TECHNICAL DATA PACKAGE, MANUFACTURER'S INSTRUCTIONS, AND MANUFACTURER'S RECOMMENDATIONS BEFORE USE. DO NOT USE FOR ANY FIRE FIGHTING APPLICATIONS OR FOR PROTECTION FROM RADIOLOGICAL, BIOLOGICAL, OR CRYOGENIC AGENTS, OR IN CHEMICAL VAPOR, FLAMMABLE, OR EXPLOSIVE ATMOSPHERES. CHEMICAL CONTAMINATION OF THIS SUIT MAY WARRANT ITS DISPOSAL. MAINTAIN ONLY IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. NO PROTECTIVE CLOTHING CAN PROVIDE PROTECTION FROM ALL CONDITIONS–USE EXTREME CARE FOR ALL EMERGENCY OPERATIONS, PARTICULARLY IN HAZARDOUS ATMOSPHERES. FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN SERIOUS INJURY OR DEATH."

Manufacturer's name
Manufacturer's address
Country of manufacture
Suit model, style, and serial number
Date of manufacture
Size
Garment material
Visor material
Glove material
Boot material

"DO NOT REMOVE THIS LABEL"

2-4.2 All portions of the required label shall be printed at least in English.

2-5 User Information.

2-5.1* Liquid splash-protective suit manufacturers shall provide the following instructions and information with each suit:

(a) Cleaning instructions;

(b) Marking and storage instructions;

(c) Frequency and details of inspections;

(d) Maintenance criteria;

(e) How to use test equipment, where applicable;

(f) Methods of repair, if recommended by manufacturer;

(g) Warranty information.

2-5.2 Liquid splash-protective suit manufacturers shall furnish training materials that address, but are not limited to:

(a) Donning procedures;

(b) Doffing procedures;

(c) Safety considerations;

(d) Optimum storage conditions;

(e) Recommended storage life;

(f) Decontamination recommendations and considerations;

(g) Retirement considerations;

(h) Closure lubricants, if applicable;

(i) Visor/faceshield antifog agents or procedures.

2-5.3* Liquid splash-protective suit manufacturers shall furnish a log book with each liquid splash-protective suit along with instructions on its proper completion and maintenance.

Chapter 3 Documentation Requirements

3-1 Technical Data Package.

3-1.1* The manufacturer shall furnish a technical data package with each liquid splash-protective suit.

3-1.2 The technical data package shall contain all documentation required by this standard and the data showing compliance with this standard.

3-1.3 In the technical data package, the manufacturer shall describe the Liquid Splash-Protective Suit in terms of manufacturer trade name and model number, manufacturer replaceable components and available options, accessories such as testing devices, and sizes.

3-2 Suit Material and Component Descriptions.

3-2.1 When specific clothing items and equipment are required for certifying the protective suit to this standard, the manufacturer shall list these clothing items and equipment in the technical data package.

3-2.2 The manufacturer shall provide, in the technical data package, the list and descriptions of the following suit materials and components, if applicable:

(a) Garment material;

(b) Visor/faceshield material;

(c) Glove material and assembly;

(d) Boot or bootie material and assembly;

(e) Zipper/closure type and materials;

(f) Material seam types and composition;

(g) Exhaust valve types and material(s);

(h) External fitting types and material(s);

(i) External gasket types and material(s).

3-2.2.1 All descriptions of material composition shall specify either the generic material names or trade names if the composition of the material is proprietary.

3-2.2.2 Descriptions of respective suit materials and components shall include the following information, if applicable:

(a) Visor/Faceshield Material

1. The availability of any permanent or detachable covers and films.

(b) Gloves

1. Type of linings or surface treatments;
2. Available glove sizes.

(c) Boots or Booties

1. Type of linings or surface treatments;
2. Type of soles or special toe reinforcements;
3. Available boot sizes.

(d) Suit Zipper or Closure

1. The material(s) of construction for the closure (including chain, slide, pull, and tape for zippers);
2. The location and the length of the completed closure assembly;
3. A description of any protective covers or flaps.

(e) Suit Exhaust Valves or Ports

1. Type, such as flapper, pressure demand;
2. Number and method of attachment to the suit;
3. A description of any protective covers or pockets.

3-2.3 The manufacturer shall describe, in the technical data package, the type of seams or methods of attachment for the following suit material and component combinations:

(a) Garment material-garment material;

(b) Garment material-visor;

(c) Garment material-glove;

(d) Garment material-boot;

(e) Garment material-suit closure.

3-3 Chemical Penetration Resistance Documentation.

3-3.1 The manufacturer shall measure and document in the technical data package the penetration resistance of the garment material for one hour against each chemical in the NFPA battery of chemicals, and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit, using the test method specified in Section 5-2 of this standard.

3-3.2 If different than the garment material, the manufacturer shall similarly measure and document in the technical data package the penetration resistance of other primary chemical-protective suit materials for one hour against each chemical in the NFPA battery of chemicals, and any additional chemical or specific chemical mixtures for which the manufacturer is certifying the suit, using the test method specified in Section 5-2 of this standard.

3-3.3* Manufacturers shall document in the technical data package, the "pass" and "fail" results of the penetration testing as a matrix of data for primary chemical-protective suit materials versus the NFPA battery of chemicals, and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. The data in the matrix shall be reported as "pass" if no penetration of the material is observed within 1 hour, or "fail" if penetration is observed in less than 1 hour. The manufacturer shall also report the conditions established for this testing as required in Section 5-2 of this standard.

3-3.4 The manufacturer shall document, in the technical data package, all chemicals and specific chemical mixtures for which the primary suit materials have been found compliant when tested as specified in Section 4-2 of this standard.

Chapter 4 Design and Performance Requirements

4-1 Overall Suit and Suit Component Requirements.

4-1.1 All external fittings shall be free of rough spots, burrs, or sharp edges that could tear the garment material.

4-1.2 Sample suits shall be tested for water-tight integrity and allow no water penetration when tested as specified by Section 5-1 of this standard.

4-2 Primary Suit Material Requirements.

4-2.1 Samples of the primary suit materials shall exhibit no penetration for at least one hour for each of the NFPA battery of chemicals when tested as specified in Section 5-2 of this standard.

4-2.2 For any additional chemicals or specific chemical mixtures that are not constrained by 2-1.5 or 2-1.6 of this standard and for which the manufacturer is certifying the suit, samples of the primary suit materials shall exhibit no penetration for at least 1 hour for each additional chemical or specific chemical mixture when tested as specified in Section 5-2 of this standard.

4-2.3* Primary suit materials shall not ignite in less than 3.0 seconds, shall not burn a distance of greater than 4.0 inches (102 mm), shall not sustain burning for more than 10 seconds, and shall not melt or drip when tested for flame resistance as specified in Section 5-3 of this standard.

4-3 Additional Garment and Glove Material Requirements.

4-3.1* Garment and glove materials shall exhibit no penetration for at least one hour for each of the NFPA battery of chemicals, and for any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit, when tested as specified in Section 5-4 of this standard.

4-3.2* Garment and glove materials shall exhibit no penetration for at least 1 hour for each of the NFPA battery of

chemicals, and for any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit, when tested as specified in Section 5-5 of this standard.

4-3.3* Garment and glove materials shall have a modulus of rigidity of 1100 or less at -13°F (-25°C) when tested for cold weather performance as specified in Section 5-6 of this standard.

4-4 Additional Garment Material Requirements.

4-4.1* Garment material samples shall be tested for bursting strength and have a bursting strength of not less than 100 psi (7.0 kq/cm^2) in accordance with ASTM D 751, *Methods of Testing Coated Fabrics*, Bursting Strength, using the Mullen Burst machine.

4-4.2* Garment material samples shall be tested for tear resistance and shall have a tear resistance of not less than 11 lb (5 kg) when tested in accordance with ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting.*

4-5 Additional Visor or Faceshield Material Requirement.

4-5.1* Visor or faceshield material samples shall be tested for total visible luminous transmittance and percentage haze as specified in Section 5-7 of this standard. Visor material samples shall transmit not less than 85 percent of incident visible radiation. The percentage haze of visor material samples shall not exceed 6 percent.

4-6 Seam Requirements.

4-6.1* Seams shall exhibit no penetration for at least one hour for each of the NFPA battery of chemicals and for any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit, when tested as specified in Section 5-5 of this standard.

4-6.2* All seams shall possess a breaking strength of not less than 30 lbf/2 in. (2.88 kN/m) when tested in accordance with ASTM D 751, *Methods of Testing Coated Fabrics, Seam Strength.*

4-7 Suit Closure Assembly Requirements.

4-7.1* Sample suit closure assemblies shall show no penetration for at least one hour for each of the NFPA battery of chemicals, and for any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit, when tested as specified in Section 5-2 of this standard.

The suit closure assembly to be tested shall be preconditioned by 50 cycles of completely opening and completely closing the closure assembly.

4-7.2* The suit closure assembly shall possess a breaking strength of not less than 30 lbf/2 in. (2.88 kN/m) when tested in accordance with ASTM D 751, *Methods of Testing Coated Fabrics, Seam Strength.*

Chapter 5 Test Methods

5-1 Overall Suit Water Penetration Test.

5-1.1 Sample liquid splash-protective suits shall be selected for overall suit water penetration testing as specified in Section 2-2.1 of this standard.

5-1.2* Additional protective clothing components and equipment that are necessary to provide full-body splash protection to the wearer shall be tested in conjunction with the protective suit.

5-1.3 A human form mannequin shall be selected that is of appropriate size for the suit to be tested. The mannequin shall be water resistant. During the test the mannequin arms shall be placed by the sides of the mannequin torso, and the mannequin legs shall not be bent.

5-1.4* An inner garment shall cover all areas of the mannequin as an aid to observe water penetration. The inner garment shall be constructed from a fabric that is easily watermarked.

5-1.5 Five nozzles shall be oriented with respect to the mannequin as specified in Figure 5-1.5.

5-1.6* The nozzles shall conform to the specifications in Figure 5-1.6.

5-1.7 The water distribution system shall deliver a minimum of 3 l/min through each nozzle.

5-1.8* Water used for overall suit penetration testing shall contain a non-foaming surfactant that lowers the surface tension to less than 34 dynes/cm.

5-1.9 The inner garment and protective suit, and other protective suit components and equipment to be tested, shall be inspected for total dryness before they are donned on the mannequin. The inner garment shall be donned on the mannequin underneath the protective suit to be tested. The protective suit shall be donned on the mannequin in accordance with manufacturer instructions. Additional protective clothing components and equipment shall be donned on the mannequin and attached to the suit in accordance with manufacturer directions.

5-1.10 Water shall be sprayed at the suited mannequin for a duration of 15 minutes for each of the suit orientations specified in Figure 5-1.5.

5-1.11 Water penetration shall be determined by removing the protective suit and any other protective clothing components or equipment from the mannequin and examining the inner garment, garment liners, and garment interior for signs of wetness. Any evidence of water penetration shall constitute failure of the protective suit for this test.

5-2 Chemical Penetration Resistance Test.

5-2.1 For the purpose of this standard, the NFPA battery of chemicals shall consist of the liquids specified in ASTM E 1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Material*, that are not constrained by 2-1.5 or 2-1.6 of this standard.

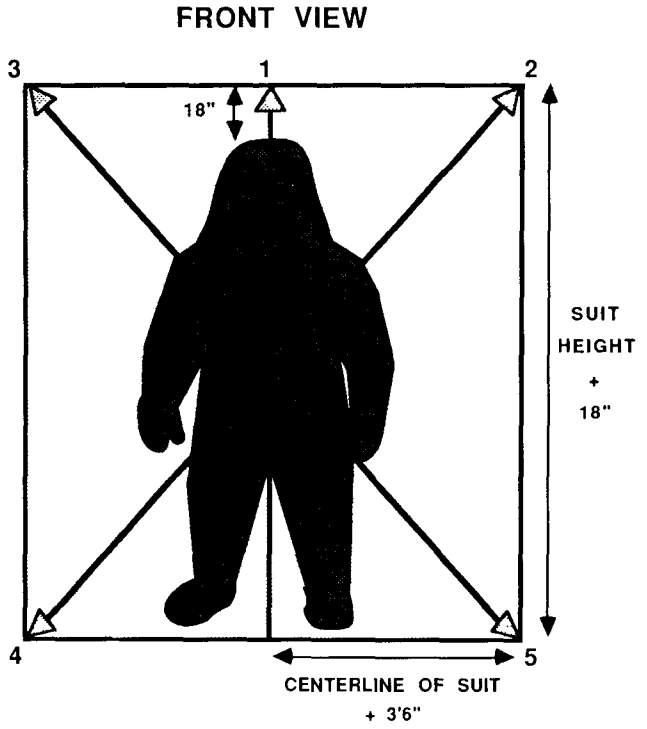

Figure 5-1.5 Overall suit penetration test garment/mannequin orientations.

5-2.2 Penetration resistance testing of material and seam specimens shall be conducted in accordance with ASTM F 903, *Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, using the following modifications:

(a) All tests shall be conducted at 77°F, ± 5°F (25°C, ± 3°C).

(b) A minimum of three material, seam, or suit closure assembly specimens shall be tested for each chemical.

(c) Each suit material or seam specimen to be tested shall be contacted with test chemicals in the following manner:

1. 5 minutes at atmospheric pressure;
2. 1 minute at 2 psi gauge (0.141 kg/cm^2);
3. 54 minutes at atmospheric pressure.

(d) The test cell shall be modified to accommodate the shape of the suit closure assembly without affecting other parts of the test procedure.

5-2.3 An observation to determine specimen penetration shall be made at the end of the chemical contact period. Observed or detected liquid penetration at the end of the test shall constitute failure of this test.

5-2.4 The report shall include the pass-fail results for each specimen/chemical combination tested and an identification of the location where penetration occurs, if discernible.

5-3 Flammability Resistance Test.

5-3.1 All samples to be tested shall be conditioned for not less than four hours in standard atmospheric conditions at a relative humidity of 65 percent ± 2 percent and a temperature of 70°F, ± 2°F (21°C, ± 1°C). Samples shall be tested not more than five minutes after removal from conditioning.

5-3.2 Vertical flammability testing shall be performed in accordance with Method 5903, Flame Resistance of Cloth; Vertical, of Federal Test Method Standard 191A, *Textile Test Methods*, with the following modifications:

(a) Specimens shall consist of ten protective clothing material samples measuring 3 × 16 in., ± 1/16 in. (76 × 203 mm, ± 1.6 mm). If the material is anisotropic, specimens shall be cut in both the machine and transverse directions.

(b) Specimens shall be folded such that the folded edge is exposed in the apparatus holder. The fold shall be produced by placing a 1/4 in. (6.4 mm) rod at the bend of the material. The rod shall then be removed after the material is clamped in the holder prior to flame contact. The folded edge of the specimen shall protrude 1/4 in. (6.4 mm) below the lower horizontal end of the metal specimen clamp.

(c) A stopwatch or other time device reading in seconds shall be started. The tip of the flame shall be applied to the end of the specimen until it is ignited, but no longer than 3 seconds. The operator shall observe and note whether or not the specimen ignites and supports self-sustaining burning after removal of the flame from the specimen.

(d) If the specimen fails to ignite in 3 seconds, the time shall be restarted and the flame shall be reapplied to the end of the specimen for an additional 12 seconds. If the specimen ignites, the timer shall be stopped when the flame is extinguished.

(e) The vertical distance, measured from the horizontal edge of the specimen to which the ignition flame is applied, to the farthest point on the specimen visibly charred or melted by the burning process, shall be recorded. This measurement shall be made on the specimen after exposure. The apparent cause of extinguishment, such as melting or dripping, shall be noted.

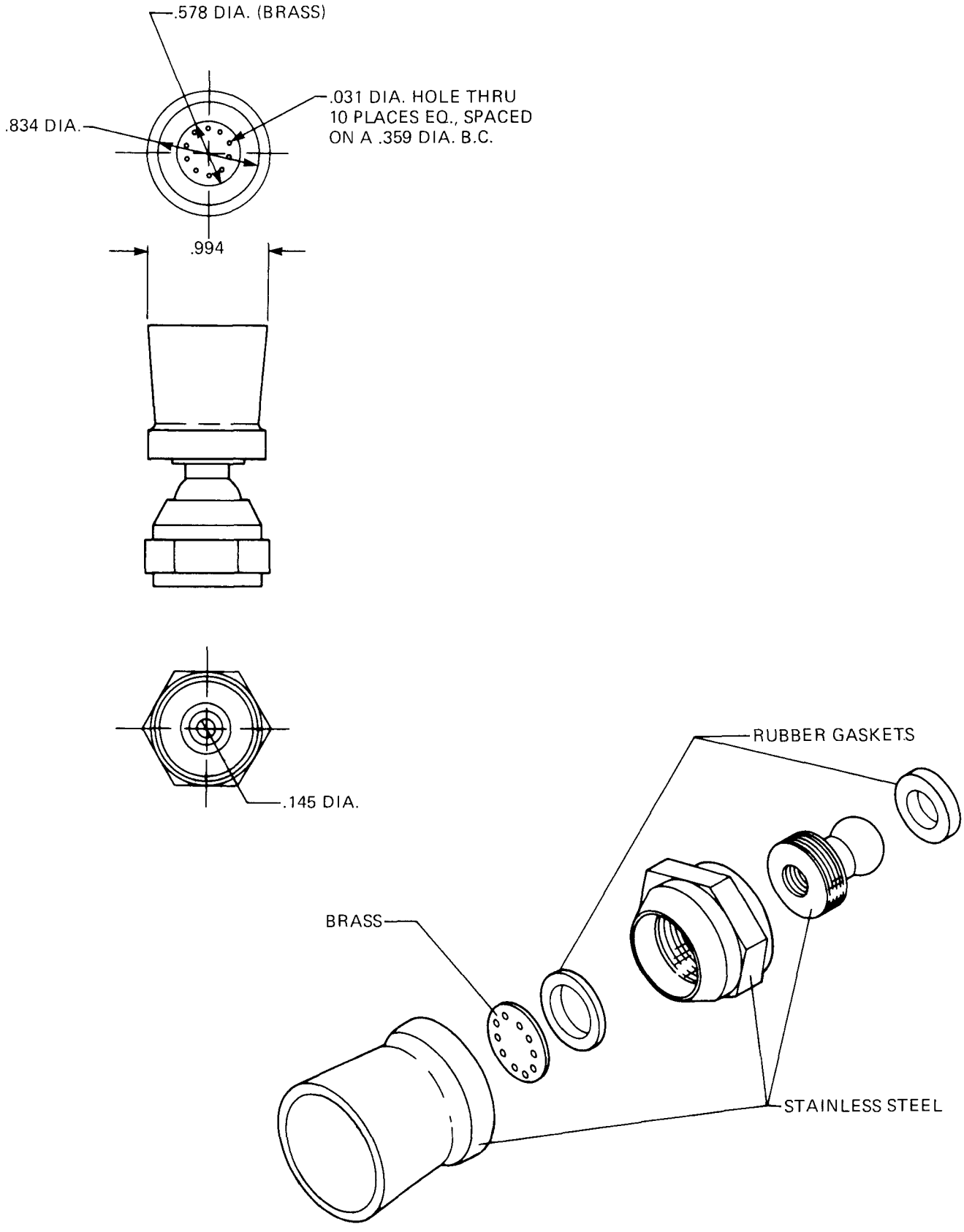
.578 DIA. (BRASS)
.031 DIA. HOLE THRU
10 PLACES EQ., SPACED
ON A .359 DIA. B.C.
.834 DIA.
.994
.145 DIA.
RUBBER GASKETS
BRASS
STAINLESS STEEL

Figure 5-1.6.

5-3.3 The ignition propensity shall be noted as those specimens igniting within the 3-second exposure period, specimens igniting within the 12-second exposure period, and specimens not igniting at all.

5-3.4 Burning time shall be the time, reported in seconds, from the moment that the operator removes the flame from the sample until burning is extinguished.

5-3.5 The distance of burn shall be the distance, reported in inches (cm), from the ignited edge of the sample to the farthest vertical point on the sample that is burned in the test.

5-3.6 The burning behavior of the specimen shall be noted and characterized for the samples that ignite, are self-extinguishing, or as otherwise observed. The specimen shall be considered self-extinguishing if the distance of burning is less than 4.0 inches (10.24 cm)and the burning time is less than 10 seconds. The appearance of decomposition by melting or dripping shall be noted.

5-3.7 Report items shall be summarized as:

(a) Test specimens igniting in 3 seconds or less;

(b) Test specimens igniting in 12 seconds or less;

(c) Test specimens not igniting in the test;

(d) Test specimens with an ignition time exceeding 3 seconds but supporting burning for 10 seconds or more;

(e) Test specimens with an ignition time exceeding 3 seconds but having a burn distance exceeding 4 inches; (10.24 cm)

(f) Notation of specimen melting or dripping.

5-4 Abrasion Resistance Test.

5-4.1* Abrasion resistance testing shall be conducted in accordance with ASTM D 4157, *Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, with the following modifications:

(a) A 5 lb (2.27 kg) tension weight shall be used.

(b) A 3 1/2 lb (1.60 kg) head weight shall be used.

(c) An 80 grit abradant trimite D-weight open coat #1A4180, or equivalent, shall be used.

(d) The specimen shall be abraded for 25 continuous cycles.

(e) Penetration resistance testing as specified in Section 5-2 of this standard shall be substituted for abrasion to rupture and percentage loss in breaking load for interpreting abrasion resistance test results.

5-4.2 Only one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion. The penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test and the center of the abraded sample shall coincide.

5-4.3 The number of samples exhibiting no observable penetration in one hour shall be reported.

5-4.4 Any visual observations such as sample rupture, loss of luster, or deformation of the outside coating for tested specimens shall be reported.

5-5 Flexural Fatigue Test.

5-5.1 Flexural fatigue testing shall be conducted in accordance with ASTM F 392, *Test Method for Flex Durability of Flexible Barrier Materials*, with the following modifications:

(a) In lieu of Flexing Conditions A, B, C, D, or E, test specimens shall have a flex period of 100 cycles at 45 cycles per minute. A cycle shall be a full flex and twisting action.

(b) Penetration resistance testing as specified in Section 5-2 of this standard shall be substituted for pinhole counting.

(c) Anisotropic materials shall be tested in both machine and transverse directions.

(d) Seam samples shall be cut or prepared such that the seam runs through the middle of the sample and is oriented parallel with the force of compression in the test apparatus.

5-5.2 Only one specimen for penetration resistance testing shall be taken from each sample subjected to flexing conditions. The penetration test specimen shall be taken from the exact center of the flexed sample so that the center of the penetration test and the center of the flexed sample shall coincide.

5-5.3 The number of samples exhibiting no observable penetration in one hour shall be reported.

5-5.4 Any unusual visual observations such as delamination or tears for test specimens shall be reported.

5-6 Cold Temperature Performance Test.

5-6.1 Cold temperature performance shall be measured in accordance with ASTM D 1043, *Test Method for Stiffness Properties of Plastics as a Function of Temperature by Means of a Torsion Test*, with the following modifications:

(a) The range of test temperatures shall include -40°F to 68°F (-40°C to 20°C).

(b) The torsion weight shall be 16 grams for materials with unit weights of 10 oz/sq yd (340 g/m^2) or more, and 8 grams for materials with unit weights of less than 10 oz/sq yd (340 g/m^2).

5-6.2 The modulus of rigidity shall be measured over the /range of test temperature and specifically reported at -13°F (-25°C).

5-6.3 A graph of stiffness measurement versus temperature shall be reported.

5-7 Luminous (Visible) Transmittance Testing.

5-7.1 Luminous (visible) transmittance shall be measured in accordance with ASTM D 1003, *Test Method for Haze and Luminous Transmittance of Transparent Plastics, Method A*, with the following modifications:

(a) The standard source of radiant energy used in the measurement of luminous transmittance of filter lenses shall be a projection-type lamp T-8, or other high-powered, gas-filled, tungsten-filament incandescent lamp, operated at the color temperature corresponding to Commission Internationale de l'Eclairage (CIE) Source A.

(b) Luminous transmittance shall be determined by measuring the spectral transmittance and calculating the luminous transmittance through the use of published data on the spectral radiant energy of CIE Source A and the relative luminous efficiency of the average eye. The standards of luminous transmittance maintained by the National Bureau of Standards shall be used.

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

6-1.1* ASTM Publications.

ASTM D 751, *Methods of Testing Coated Fabrics*, 1979

ASTM D 1003, *Test Method for Haze and Luminous Transmittance of Transparent Plastics*, 1977

ASTM D 1043, *Test Method for Stiffness Properties of Plastics as a Function of Temperature by Means of a Torsion Test*, 1984

ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting*, 1984

ASTM D 4157, *Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, 1982

ASTM F 392, *Test Method for Flex Durability of Flexible Barrier Materials*, 1979

ASTM F 903, *Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 1987

ASTM F 1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Materials*, 1989.

6-1.2* Other Publications.

(a) *Dangerous Properties of Industrial Chemicals*, 6th Edition; Sax, N. Irving; 1988.

(b) Federal Test Method Standard 191A, *Textile Test Methods*; 1978.

(c) *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, Public Health Services, Publication DHHS No. 85-114; September 1985.

(d) *Threshold Limit Values and Biological Exposure Indices for 1988-1989*; American Conference of Governmental Industrial Hygienists, 1988.

(e) *U.S. Coast Guard Chemical Hazard Response Information System (CHRIS)*, Volumes 1-3, Hazardous Chemical Data, October 1978.

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1.1 Suits that are compliant with this standard are designed to protect the user from direct liquid contact to the specified chemicals. Suits that are compliant with this standard may not be designed to protect the user from chemical exposure by vapors. Use of a suit certified as compliant with this standard presumes chemical exposure by vapor contact is acceptable. However vapor contact with certain chemical exposures is not acceptable. Therefore, this suit will not be certified for these certain chemicals that for the purposes of this standard are characterized by known or suspected carcinogenicity and/or by skin toxicity notations in the specified references.

A-1-1.2 Organizations responsible for specialized chemical response functions including radiological, biological, cryogenics, or fire fighting applications should use protective clothing and equipment specifically designed for those activities.

A-1-1.3 Purchasers should specify desired design features that are not in conflict with the design requirements of this standard. It is strongly recommended that purchasers of liquid splash-protective suits should consider the following:

(a) Emergency response personnel will be wearing many items of protective clothing and equipment. Any interference by one item of another's use might result in inefficient operations or unsafe situations;

(b) Different breathing apparatus, communications systems, cooling devices, and other protective equipment may not be accommodated by the liquid splash-protective suit equally;

(c) Specifications of additional reinforcement in high-wear or load-bearing areas, such as the knees, elbows, shoulders, and back, may be necessary. Reinforcing materials should be the same as the garment material. Purchasers are cautioned that additional weight caused by excessive reinforcement could lead to fatigue or injury.

A-1-3 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 or 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 concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-3 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, 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 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-1-3 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed

unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

A-2-1.1 The compliance of liquid splash-protective suits in meeting this standard is determined by the NFPA battery of chemicals. Each liquid splash-protective suit meeting the requirements of this standard will have a list of chemicals or chemical mixtures associated with it.

A-2-2.1 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-2-2.3 The contractual provisions covering certification programs should contain clauses advising the manufacturer that if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently Listed products.

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

A-2-2.4 Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the certification organization before any major testing is undertaken.

A-2-2.7 Such factory inspections should include, in most instances, witnessing of production tests. With certain products the certification organization inspectors should select samples from the production line and submit them to the main laboratory for countercheck testing. With other products, it may be desirable to purchase samples in the open market for test purposes.

A-2-3.1 Purchasers should be aware that no reliable nondestructive methods exist to determine the level of contamination for exposed liquid splash-protective suits or their materials. Therefore, purchasers will not be able to determine how effective decontamination methods are in removing chemical contamination from the liquid splash-protective suit. Liquid splash-protective suits that have received a significant exposure to a chemical or chemical mixture (in the estimation of the responsible supervisor) should be disposed of.

A-2-5.1 Purchasers should follow the instructions provided by the manufacturer for completing the logbook for their own means of recording suit use and maintenance, and also for documenting levels of contamination when returning suits to the manufacturer.

A-2-5.3 The manufacturer should prepare the logbook so that it provides for at least the following data entries:

(a) Dates of each inspection, inspection findings, and the name of the inspector.

(b) Dates of each use, the length of use, and the user's name.

(c) Names of chemicals the suit is exposed to, including the length and concentration of exposure.

(d) Dates of all repairs, including a description of the repairs, and the name of the person making the repairs.

(e) Dates and types of decontamination the suit is subjected to, and the name of the person or facility responsible for the decontamination.

(f) Dates the suit is taken out of service and the reason for the action.

(g) Dates the suit is returned to the manufacturer and the reason for the return.

A-3-1.1 Purchasers should use the technical data package to compare suit performance data in purchasing liquid splash-protective suits. The purchaser should determine the relative ranking of performance data to aid in this selection process.

A-3-3.3 An abbreviated example of how a test result matrix might be organized is given below:

Chemical	Garment Material	Visor Material	Glove Material	Boot Material
Acetone	Pass	Pass	Pass	Pass
Diethylamine	Fail	Pass	Pass	Pass
Ethyl Acetate	Fail	Fail	Fail	Fail

4-4-2.3 This requirement represents a short duration exposure of a suit to a slowly creeping fire. Purchasers of protective clothing should realize that materials meeting this flame resistance requirement do not provide the user with protection from fire or protection from ignition of chemicals.

A-4-3.1 This requirement is designed to simulate abrasion resulting from crawling on a rough concrete surface.

A-4-3.2 This requirement is designed to simulate the flexing of suit garment material at the elbow during a 1-hour mission.

A-4-3.3 This requirement is based on objectional stiffness for materials at low temperatures.

A-4-4.1 This requirement is designed to simulate material bursting resulting from protruding objects within the chemical protective suit.

A-4-4.2 This requirement is designed to simulate material snagging and subsequent tearing resulting from sharp objects, such as when walking past a protruding nail.

A-4-5.1 This requirement is based on ANSI Z87.1 for helmet visor clarity.

A-4-6.1 Seams are required to meet the same minimum requirements as other liquid splash-protective suit primary materials.

A-4-6.2 This requirement is based on documentation of adequate seam strength from field performance data.

A-4-7.1 Suit closure assemblies are required to meet the same minimum requirements as other liquid splash-protective suit primary materials.

A-4-7.2 Suit closure assemblies are required to meet the same minimum tensile strength requirements as suit seams.

A-5-1.2 Examples of additional protective clothing components and equipment are gloves, boots, hoods, and breathing apparatus.

A-5-1.4 An example of an inner garment fabric is a lightweight, tightly woven (e.g. 2.2 oz/yd^2, 92 × 88), medium or dark colored, 100 percent polyester fabric without surface treatment.

A-5-1.6 Type #SSW1C from Whedon Products, Inc., West Hartford, CT meets this requirement.

A-5-1.8 A 0.1 wt percent solution of Surfynol 104H (available from Air Products and Chemical, Inc., Performance Chemicals, Box 538, Allentown, PA 18105) with water gives a surface tension of 33.8 dynes/cm.

A-5-4.1 Equipment required to perform ASTM D 4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics* is available from J.K. Industries, P.O. Box 6, Villa Park, IL, 60181.

A-6-1.1 ASTM publications can be obtained from American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

A-6-1.2

(a) *Dangerous Properties of Industrial Chemicals* is published by Van Nostrant, Reinhold, N.Y.

(b) Federal Test Method Standard can be obtained from General Services Administration, Specifications Activity; Printed Materials Supply Division; Building 197, Naval Weapons Plant, Washington, DC 20407. Single copies are generally available without charge at the General Services Administration Business Center in cities throughout the U.S. Federal Test Method Standards are also available fromthe U.S. Government Printing Office, Washington, DC 20402.

(c) *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, Public Health Services, Publication DHHS No. 85-114; can be obtained from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(d) *Threshold Limit Values and Biological Exposure Indices for 1988-1989* can be obtained from the American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Bldg D7, Cincinnati, OH 45211.

(e) *U.S. Coast Guard Chemical Response Information System* can be obtained from U.S. Coast Guard Commandant Instruction M 16465, Department of Transportation, Washington, DC.

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