NFPA®

1991

Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents

2016

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NFPA®1991

Standard on

Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents

2016 Edition

This edition of NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies and CBRN Terrorism Incidents*, was prepared by the Technical Committee on Hazardous Materials Protective Clothing and Equipment and released by the Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on November 14, 2015, with an effective date of December 4, 2015, and supersedes all previous editions.

This edition of NFPA 1991 was approved as an American National Standard on December 4, 2015.

Origin and Development of NFPA 1991

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 U.S. Department of Transportation (DOT) issued a position that requested private sector standards development to 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 time also directly requested that the NFPA develop documents on hazardous chemical protective clothing. The Environmental Protection Agency (EPA), the U.S. 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 those standards and assigned the project to the Technical Committee on Fire Service Protective Clothing and Equipment. The Technical Committee established a standing Subcommittee on Hazardous Chemicals Protective Clothing, which began work in Phoenix, Arizona, in March 1986. Representatives from the USCG, FEMA, and OSHA participated on the subcommittee.

At the same time, the American Society for Testing and Materials (now ASTM International) 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-protection and one for liquid-splash protection. NFPA 1991 addresses vapor-protective ensembles designed to protect emergency response personnel against exposure to specified chemicals in vapor and liquid-splash environments during hazardous materials 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 21 chemicals, as specified in ASTM F1001, *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*. These chemicals were selected because they are representative of the classes of chemicals that are encountered during hazardous chemical emergencies.

NFPA 1991 includes performance requirements that were established to reflect simulated use conditions. A suit pressurization test is used to check the airtight 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 1 hour or more by each chemical in the NFPA battery. Manufacturers can certify protective suits for additional chemicals if

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 in which they will be used.

The first edition of NFPA 1991 was voted on by the Association at the 1989 Fall Meeting in Seattle, Washington, on November 15, 1989, and had an effective date of February 5, 1990.

The Subcommittee on Hazardous Chemicals Protective Clothing began an early revision (4-year cycle) of the 1990 edition of NFPA 1991 in December 1991. During 1993, the NFPA restructured the manner in which committees were organized, and all standing subcommittees were eliminated. Within the Technical Committee on Fire Service Protective Clothing and Equipment, the former standing subcommittees were reorganized as task groups to address specific technical issues, and the technical committee assumed the entire responsibility for NFPA 1991.

The second edition of NFPA 1991 encompassed revised scope and purpose sections to include optional components for enhanced protection and replacement items. Test methods were updated and refined to better ensure repeatability of testing results. Extensive changes were made to the product labels to better accommodate the optional and replacement items.

The second edition was acted on by the membership of the Association at the NFPA Annual Meeting in San Francisco, California, on May 18, 1994, and was issued with an effective date of August 5, 1994.

In January 1995, the entire project for fire service protective clothing and equipment was reorganized by the Standards Council. The new project has a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on Hazardous Chemicals Protective Clothing was established as the new Technical Committee on Hazardous Materials Protective Clothing and Equipment and has the responsibility for NFPA 1991.

The third edition, with the new title of *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, represented a complete revision of the second edition and addressed the protection as an ensemble rather than as separate items, but it did provide for replacement elements for gloves and footwear. The third edition was presented to the Association membership at the 1999 November Meeting in New Orleans, Louisiana, on November 17, 1999, and was issued by the Standards Council with an effective date of February 11, 2000.

The 2005 edition (the fourth edition) was a complete revision of NFPA 1991 and was reformatted according to the new style for all NFPA codes and standards. As a result, chapter titles and numbering, as well as paragraph numbering, were changed. While the 2005 edition's content was in a different order than in previous editions, all the material remained. The Committee included in Chapter 4 new requirements for manufacturers' quality assurance programs, and for situations in which hazards involving compliant products are believed to exist, including the appropriate actions in addressing those situations if there is a previously unknown threat to the users. These new requirements apply to all fire and emergency services product standards that are the responsibility of this Project. The formerly optional requirements for protection from chemical and biological terrorism agents are no longer optional and were incorporated into the base requirements for all vapor-protective ensembles. The change provided this additional protection from CBR(N) exposures for the hazardous materials protective ensemble that offers the highest level of protection for emergency responders: the vapor-protective ensemble.

The other two optional requirements, chemical flash fire protection for escape only and liquefied gas protection, remained as optional features that purchasers can specify in purchase specifications. All labeling, design, performance, and testing requirements were reviewed and refined as necessary.

The Technical Committee finished its work on the fifth edition of NFPA 1991 with a complete revision in 2015. A relatively long interval between the fourth and fifth editions occurred due to the Technical Committee's attempts to investigate and transition the permeation resistance requirements for ensemble materials (suit, visor, gloves, footwear, and seams) to a new test method in which the cumulative permeation mass replaced the use of breakthrough time as the basis of acceptable material performance. Cumulative permeation mass is the total amount of chemical that permeates through the chemical in 1 hour. In contrast, breakthrough time was defined as the elapsed time that occurs before the rate of permeation through the material is equal to 0.1 $\mu m/cm^2 \cdot min$. The Technical Committee adopted material permeation resistance criteria on the basis of cumulative permeation mass because this measurement was considered to be more repeatable and meaningful in terms of end user exposure. Extensive research supported this change. The Technical Committee further identified a number of other priorities for modification of NFPA 1991 through a comprehensive survey to industry end users to either improve current criteria or address unmet needs. Other changes in the 2016 edition include the following:

(1) A title change to include CBRN terrorism incidents, based on the transfer of Class 1 requirements from NFPA 2001 and the reorganization of NFPA 1994.

(2) A mandatory requirement for encapsulation of the wearers and their breathing apparatus has been affirmed based on the anticipation of non-encapsulating requirements being included as new set of Class 1 criteria in NFPA 1994.
(3) Overcovers and detachable visor materials are no longer permitted for achieving certification for base ensemble criteria.
(4) Tape is prohibited from being used to secure or seam components of the ensemble.
(5) Protective covers are required to protect the suit closure.
(6) A vapor inward leakage test using sulfur hexafluoride has been replaced with the Man-in-Simulant Test (MIST) performed at a higher concentration.
(7) Some changes have been made in the chemical battery, with acrolein and acrylonitrile replacing cyanogen chloride, hydrogen cyanide, and phosgene as more relevant skin toxic chemicals; more persistent chemical warfare agent Soman (GD) has replaced Sarin (GB).
(8) An impact resistance requirement for the visor has replaced burst and puncture/tear testing of visor materials.
(9) A field of vision assessment has been added to the evaluation of the ensemble.
(10) A maximum time has been set for individual wearers to be able to remove and reinsert their hands into the ensemble glove system.
(11) Improvements have been made to the flame resistance test and its interpretation.
(12) Several test methods for glove and footwear test methods and criteria have been updated.
(13) Modifications have been made to increase the repeatability of the flash fire test.
(14) The shelf life of the ensemble is required to be reported.

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