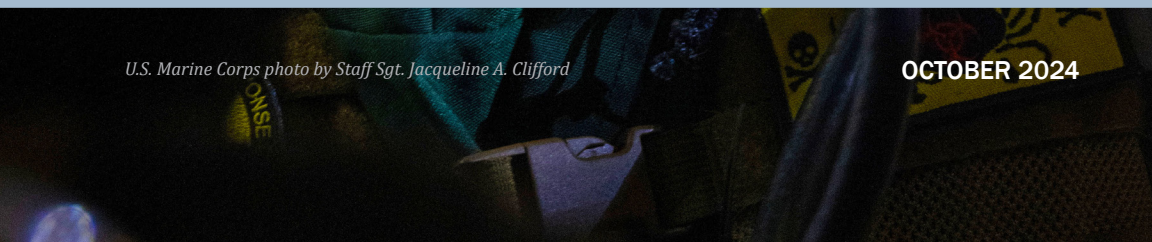
AM I PROTECTED?

What You Need to Know About Hazardous Materials and CBRN Personal Protective Equipment Standards and Certified Products



U.S. Marine Corps photo by Staff Sgt. Jacqueline A. Clifford

OCTOBER 2024

PERSONAL PROTECTIVE EQUIPMENT IS SELF-DEFENSE.

- Author Unknown

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About This Guide

Purpose of this Guide

Hazardous material emergencies can occur anywhere, involve any number of substances, and result in a diverse set of environmental and operational conditions. In these situations, when action is needed to save lives and protect property, personal protective equipment (PPE) is the only viable protection for responders who may come into contact with hazardous substances.

Standards and regulations are often developed in response to a problem. The incidents described in this guide helped create the protective equipment standards that exist today. This illustrates that these standards are based on the hard lessons of the real world where people can be hurt, or worse.

Real Incidents, Real Tragedies Shaped Today's Standards

In 1983, a rail car is leaking anhydrous dimethylamine in Benicia, California, and the local Hazmat team responds. Suddenly, a team member notices the visor lens of his totally encapsulated suit is cracking. The team quickly exits the vapor cloud, but not before the visor has broken open and the team member is exposed. Fortunately, the self-contained breathing apparatus prevented respiratory damage, but the team member develops severe dermatitis. A subsequent National Transportation Safety Board report determines that, although the manufacturer recommended its suits for the chemical involved, the visor was susceptible to degradation and permeation by the chemical. Information on the visor was not addressed or provided by the manufacturer.

The National Fire Protection Association (NFPA) began developing PPE standards in the early 1980s with these incidents in mind. The standards were in direct response to responders needing protective clothing and respirators that provide appropriate, consistent level of protection, regardless of the manufacturer.

Continuing a 36-year mission to better protect the health and safety of all people responding to hazardous materials and other emergency incidents, the Irregular Warfare Technical Support Directorate (IWTSD) has prepared this guide with technical review provided by various NFPA stakeholders to meet four primary purposes.

1. To inform the first responder community and PPE manufacturers of the history, value, and importance of specific NFPA standards.
2. To provide information on how PPE is tested to best ensure the protection of the wearer in a variety of potential situations.
3. To promote the use of independently certified PPE by all responders.
4. To describe best practices for selection, care, and maintenance of PPE addressed in NFPA standards.

Your Protection Drives Industry Standards

Why Standards?

Before NFPA standards, first responders chose from a selection of protective clothing products used by the military as chemical warfare suits. These products lacked broad compatibility and performance against the multitude of chemicals and conditions being encountered by emergency responders in a vast range of industry and transportation accidents. Product testing was limited, and manufacturer claims varied considerably, presenting a very confusing picture to the emergency responder community.

For respirators, first responders originally had to rely on respirators primarily designed for industrial purposes or similar military-type products that did not always meet the needs of first responders, which had broader protection needs often for use in rugged, more demanding conditions.

Today, emergency services end-users and protective clothing/equipment manufacturers depend on the standards developed by NFPA to help define the appropriate PPE for hazardous materials incidents. These standards have become the benchmarks for establishing protective clothing and equipment minimum design and performance requirements.

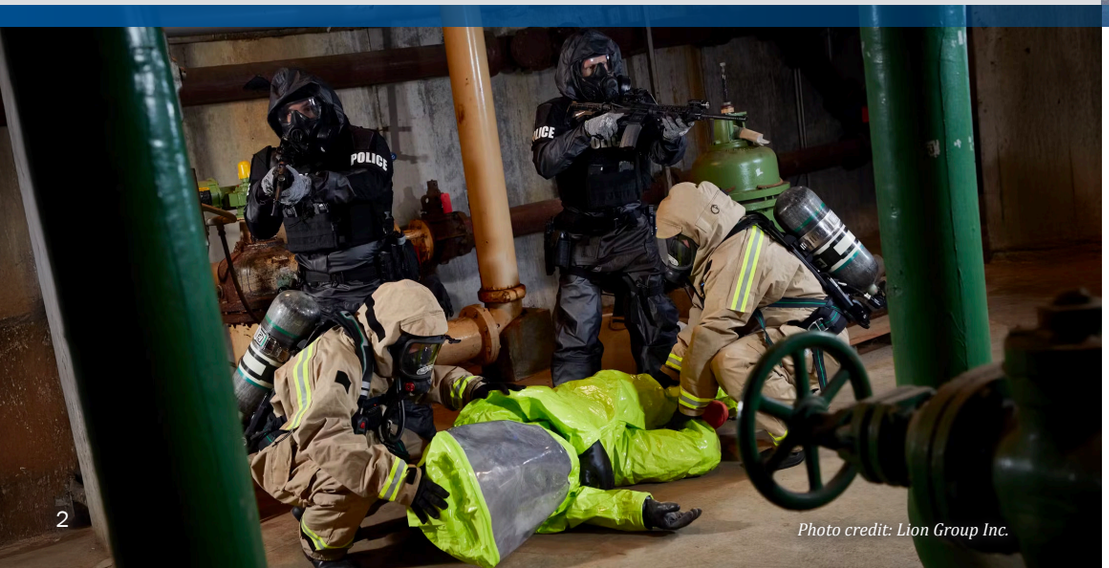

Photo credit: Lion Group Inc.

An anhydrous ammonia leak takes place in 1984 at the Dixie Cold Storage Warehouse Company, in Shreveport, Louisiana. Employees try to repair the leak but fail. Two members of the Fire Department's Hazardous Material Unit then try to isolate the leak. However, the leak causes an explosion resulting in a fire and severe damage to the building. Two firefighters are trapped inside and are severely burned. One of the firefighters dies of his injuries and the other is hospitalized in critical condition.

One conclusion from the subsequent investigation was that the firefighters should have used a flash cover over their suits; however, at that time, it was unknown whether flash covers as then designed would have adequately changed the outcome. As a result of this incident, the committee responsible for the fire service protective clothing and equipment standards added flash fire protection as an option to both NFPA 1991 and NFPA 1992 standards, developing and validating new criteria and test methods to meet this protection need.

Photo credit: U.S. Chemical Safety and Hazard Investigation Board.

Benefits of NFPA Standards

When you wear a certified ensemble or respirator, NFPA standards assure you that it is designed and tested for use in a specific hazardous environment. Specific benefits of NFPA standards include:

- Uniform product testing and evaluation.
- Criteria based on specific end-user needs.
- Minimum requirements for clothing element, ensemble, or respirator design, performance, documentation, and labeling.
- Required third-party certification for both initial product qualification, annual retesting, with continued review of manufacturer compliance and quality.

Advent and Evolution of NFPA Standards

Chemical Protection

In 1990, three new NFPA standards were approved—NFPA 1991, NFPA 1992, and NFPA 1993. These three standards established minimum requirements for chemical protective suits and supplemented the U.S. Environmental Protection Agency's (EPA) Level A and B designations with performance-based specifications. Since 1990, these standards have been revised to keep pace with end-user and manufacturer feedback, advances in materials, and modern evaluation methods, including incorporating the requirements from NFPA 1993 into NFPA 1992.

NFPA 1991 and 1992 have profoundly affected the products offered by industry. Prior to their introduction, there were no manufacturers who provided suits that demonstrated protection against a broad range of chemicals and addressed performance for all parts of the ensemble—suit, visor, gloves, footwear, and seams. The idea of suits having limited flame resistance in combination with material chemical resistance was thought to be unattainable. Once implemented, these standards prompted manufacturers to develop new material technologies and product designs, establishing fully qualified ensembles that improved the level and consistency of protection for first responders.

> The acronym "CBRN" is used to refer to chemical, biological, radiological, and nuclear hazards. In the context of NFPA standards, the level of protection against these hazards is defined by the performance tests that demonstrate PPE effectiveness, particularly for radiological hazards (see Radiological Protection on Page 7).

A key distinction that the standards provided was the association of vapor protection with EPA Level A totally encapsulating chemical protective suits and liquid-splash protection with EPA Level B (and C) chemical splash suits. Specific tests were applied for demonstrating vapor and liquid protection for whole suits and suit materials as shown in the following table.

Definitions of Protective Clothing Types by Performance Tests in NFPA Standards

Type of Ensemble	Defines	Material Performance	Clothing Performance
Vapor-protective (NFPA 1991)	EPA Level A	Permeation resistance	Gas-tight integrity
Liquid-splash protective (NFPA 1992)	EPA Level B	Penetration resistance	Liquid-tight integrity

Before 9/11, NFPA was completing work on a standard for chemical and biological agent terrorism response. At that time, NFPA 1994 set criteria for three different classes of protective ensembles that:

- Entailed hazards and responses associated with the intentional release of chemical warfare agents (CWAs), toxic industrial chemicals (TICs), and biological agents.
- Addressed a wider range of first responders, including special operations teams, law enforcement personnel, emergency medical technicians, first receivers, and others who were expected to require protection during such events.

Subsequent revisions to NFPA 1994 addressed biological and radiological particulates; incorporated new methods of evaluation; and improved the understanding of ensemble selection by aligning the ensemble use with respirator use and the CBRN criteria developed for respiratory protection.

Biological Protection

A related standard for first responders and other emergency personnel is NFPA 1999, *Standard on Protective Clothing and Ensembles for Emergency Medical Operations*. This standard was originally developed to address protective garments, gloves, and facewear designed to protect people providing emergency medical care against exposure to liquid-borne pathogens during emergency medical operations in response to the OSHA Final Rule (29 CFR Part 1910.1030). The first edition of the standard was introduced in 1992, with successive editions made in the following years to incorporate improved requirements and broaden the scope of the standard. For example, the standard now extends to both first responders engaged in emergency medical operations as well as first receivers. Several categories of protective clothing are covered by the standard including single- and multiple-use garments, examination gloves, cleaning gloves, work gloves, various eye and face protection devices such as goggles, faceshields, and medical face masks, footwear, footwear covers, helmets, and certain respirators.

A significant amendment was made to the standard in April 2015 to provide a comprehensive revision that entailed creating new product categories of single-use and multiple-use ensembles to address first responder needs for protection against the Ebola virus. The updated 2018 edition of NFPA 1999 established the design, performance, certification, and labeling requirements for complete ensembles by specifying combinations of clothing items. The new ensembles are intended to protect individuals against highly infectious diseases that can be transmitted by both liquid and aerosol contact. NFPA 1999 has also taken more relevance for airborne transmissible diseases such as COVID-19.

Photo credit: IPP, Inc.


Photo credit: IPP, Inc.

Ebola Epidemic in West Africa Drives Ensemble Approach

In late 2014, the United States experienced a "scare" with the identification that individuals coming from West Africa were potentially infected with Ebola Virus Disease (EVD). This situation exposed multiple gaps and ill-preparedness for dealing with a highly fatal disease that was transferrable primarily by contact with contaminated surfaces and aerosols. Conventional practices for using piecemeal clothing items were found to be ineffective due to lack of effective interfaces. Moreover, donning and doffing procedures, especially when contaminated, took on significant importance given the findings that two nurses at a Dallas hospital may have been infected with EVD while removing their contaminated PPE following interaction with patient with EVD. In West Africa, it was estimated that over 5% of fatalities were healthcare providers. U.S. agencies responding to crisis had to rethink PPE solutions.

NFPA 1999, which was originally focused on separate emergency medical protective clothing items, was rapidly amended to address full ensembles, which included the integration of garments, gloves, footwear, hoods, and respirators configured to offer minimum protection in both a disposable and reusable approach. Extensive work also went into the development of assessment methods for contaminated doffing, which were included in the amended NFPA 1999.

Radiological Protection

The "RN" of "CBRN" is not always properly understood. Radiological hazards are encountered in various forms, which classically include:

- Alpha particles
- Beta particles
- Gamma rays
- X-rays

Radiation hazards can also been classified as non-ionizing and ionizing radiation.

While all PPE provides some attenuation against these forms of radiation, the NFPA standards stipulate protection against only non-ionizing radiation or particle-based ionizing radiation. Despite the existence of test methods that can measure the level of attenuation for X-rays and some other forms of high energy radiation, the NFPA standards provide statements that indicate that the different ensembles do not provide protection against ionizing radiation (as well as cryogenic liquid exposures, and explosions). Instead, ensemble integrity against particulate exposure, which may include radiologically contaminated particles that are released either by explosions or other contaminated sources, is evaluated.

For first responders, the principal protection is attained through the use of ensembles that include suitable respirators that are rated for CBRN protection. These include the use of particle-protective ensembles for events mainly to manage extrication and treatment of victims exposed to radiological materials including radiological explosive devices and the fallout from a nuclear detonation. The PPE must be used to maintain a protection level As Low as Reasonably Achievable (ALARA) and according to recommended occupational dose limits.

Photo credit: IPP, Inc.

Related Forms of Protection

Beyond Hazmat and CBRN PPE, there is a range of other clothing subject to other NFPA standards, which offers varying levels of protection against hazardous materials, CBRN agents, and other hazards. Sometimes this PPE is used because other PPE is not available. In other cases, this PPE may be also be certified against Hazmat/CBRN standards. Relevant standards include:

- NFPA 1971 is for firefighter turnout gear, considered to offer some penetration resistance against hazardous liquids and liquidborne pathogens
- NFPA 1951 addresses technical rescue ensembles, that includes an option for barrier protection that specifies liquid and viral penetration resistant materials
- NFPA 2112 establishes criteria for industrial work uniforms for protection against flash fires, including those of chemical accidents

NFPA 1990, Standard for Protective Ensembles for Hazardous Materials and CBRN Operations — Overview

Individual standards that previously included NFPA 1991 (vapor-protective ensembles), NFPA 1992 (liquid splash-protective ensembles and clothing), and NFPA 1994 (Hazmat/CBRN protective ensembles) were consolidated into a new NFPA 1990, Standard for Protective ensembles for Hazardous Materials and CBRN Operations. The new standard harmonized many of the requirements and test methods that were previously applied in all three original standards. Other important changes included:

- Footwear options now include ensemble socks, full boots, and outer boots.
- A new flame break open test was added for some ensembles.
- Improved overall ensemble flash fire testing procedures were devised.
- Additional methods for conducting chemical resistance testing were added.

A new Class 5 ensemble was also established within NFPA 1994 (see below).

New Class 5 Ensemble

NFPA 1994 created a new Class 5 ensemble that provides minimal chemical protection in the form of liquid repellency, but is intended for those responses involving little to no toxic risk where instead the principal hazard is exposure to flash fires. An example scenario for the use of Class 5 ensembles is an overturned pressurized hydrocarbon fuel tanker, where the exposure concerns include the ignition of leaking gas that results in a chemical flash fire. The protective clothing thermal insulation needed for this type of event is greater than flame-resistant uniforms but lighter than turnout clothing to provide sufficient thermal and physical protection. Many of the requirements are based on the technical rescue ensembles that are standardized as part of NFPA 1951 (see Page 7).

Photo credit: Orange County Register

NFPA 1990, Standard for Protective Ensembles for Hazardous Materials and CBRN Operations — Overview (continued)

While the three standards have been combined into one document, the original designations – NFPA 1991, NFPA 1992, and NFPA 1994 – have been maintained for purposes of labeling and in the individual specifications of ensemble types.

The table below summarizes the key aspects of the ensembles covered in the new NFPA 1990 and the relationship of each ensemble to the commonly referred to OSHA/EPA Levels of Protection:

Ensemble Description Using Performance-Based Standard(s)	Integrity†	Material Barrier†	OSHA/ EPA Level
NFPA 1991 worn with NFPA 1981 or NFPA 1986 SCBA	Vapor – Ultrahigh	Permeation – Ultrahigh	A
NFPA 1994 Class 1 worn with NFPA 1981 or NFPA 1986 SCBA	Vapor – High	Permeation – High	A
NFPA 1994 Class 2/2R worn with NFPA 1981 or NFPA 1986 SCBA	Vapor – Moderate	Permeation – Moderate	B
NFPA 1992 worn with NFPA 1981 or NFPA 1986 SCBA	Liquid – High	Penetration	B
NFPA 1994 Class 2/2R worn with NIOSH CBRN APR or PAPR**	Vapor – Moderate	Permeation – Moderate	C
NFPA 1992 worn with NIOSH CBRN APR or PAPR	Liquid – High	Penetration	C
NFPA 1994 Class 3/3R worn with NFPA 1981 or NFPA 1986 SCBA*	Vapor – Low	Permeation – Low	B
NFPA 1994 Class 3/3R worn with NIOSH CBRN APR or PAPR	Vapor – Low	Permeation – Low	C
NFPA 1994 Class 4/4R worn with NFPA 1981 or NFPA 1986 SCBA*	Particle	Viral Penetration	B
NFPA 1994 Class 4/4R worn with NIOSH CBRN APR or PAPR	Particle	Viral Penetration	C
NFPA 1994 Class 5 worn with NFPA 1981 or NFPA 1986 SCBA	None	Repellency/ Absorption	B

Legend

† Levels for integrity and material barrier defined by specific test criteria in standard; Additional information is provided in "How Equipment is Tested to Meet Operational Requirements" on page 32.

* Respirator combination above minimum requirement; ** Respirator combination below minimum requirement

⚠ NOTICE - Ensemble selection is subject to the disclaimer on the inside of the back cover.

NFPA 1990/NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies

Purpose and Scope

- Specifies the requirements for vapor-protective ensembles intended to offer the highest level of chemical protection.
- Provides performance consistent with EPA/OSHA Level A.
- Used with minimum NFPA 1981 or NFPA 1986-compliant self-contained breathing apparatus (SCBA) or SCBA/supplied air respirator (SAR) respiratory protection in immediately dangerous to life and health (IDLH) environments.

Features

- Fully encapsulated suits cover both the wearer and the respirator.
- Entry zippers may be on the back or front (usually diagonal across the body.
- Generally have a built-in face shield or visor, attached gloves, and sock-like extensions of the suit.
- Single- and multi-layer material approaches applied.
- Multiple gloves used to meet hand protection requirements.
- Suits generally use outer boots combined with the sock-like extensions of the suit (attached socks) where splash flaps cover the top of the outer boots.
- Covers or flaps are required for certain components such as exhaust valves and closures.
- Provided in at least four sizes.

Performance Attributes

- Provides gas-tight integrity (will hold pressure).
- Resists inward leakage of hazardous vapors.
- Demonstrates long-term integrity against liquid (spray) penetration.
- Materials and seams resist permeation of a broad range of liquid and gaseous chemicals, including TICs and CWAs with levels at 100% concentration over one-hour period.
- Meets minimum standards for strength, durability, and functionality.
- Offers limited material flame and burn-through resistance.
- Optional criteria define additional protection against chemical flash fires for escape purposes and/or ability to withstand contact with liquefied gases.

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NFPA 1990/NFPA 1992, Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies

Purpose and Scope

- Specifies the requirements for liquid splash-protective ensembles; not intended for protection from gases or vapors.
- Covers full ensembles and separate garments, gloves, and footwear (garments, gloves, and footwear may be separately certified as standalone products).
- Provides performance consistent with EPA/OSHA Level B.
- Used with minimum NFPA 1981 or NFPA 1986-compliant SCBA or SCBA/SAR respiratory protection in IDLH environments.

Features

- One- or multiple-piece garments.
- Entry zippers vary in their location based on type of garment design.
- Some products include attached gloves and footwear.
- Garments may cover respirator (encapsulating ensembles) or have respirator on the outside (non-encapsulating ensembles).
- Requires interfaces for ensembles with respirator (if not encapsulated), gloves, and footwear.
- Multiple gloves may be used to meet hand protection requirements.
- Suits generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Garments provided in at least four sizes; gloves in five sizes.
- Garments may be breathable.

Performance Attributes

- Demonstrates integrity against liquid (spray) penetration.
- Materials resist liquid penetration against low volatility chemical or chemicals with high vapor pressures that do not readily produce vapors over one-hour period.
- Meets minimum standards for strength, durability, and functionality (levels lower than NFPA 1991).
- Optional criteria define additional protection against chemical flash fires for escape purposes.
- Some products may also be certified to NFPA 1999 (EMS), NFPA 1951 (technical rescue), and NFPA 2112 (industrial flash fire protection).

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 1

Purpose and Scope

- Defines ensembles that protect against CWAs, TICs, biological agents (bloodborne pathogens), and particulates.
- Intended for IDLH environments requiring minimum use of SCBA that comply with NFPA 1981 or NFPA 1986.
- Provides protection against vapors, liquid droplets, and aerosols where potential skin contact is expected to be at moderate levels. These ensembles can be suitable for a wide range of Hazmat missions.
- Provides performance consistent with EPA/OSHA Level A.

Features

- One-piece or multiple-piece garments; may or may not cover respiratory protective equipment.
- Requires interface with SCBA (if not encapsulated), gloves, and footwear.
- Entry zippers may be on the back (either horizontal or vertical), front (usually diagonal across the body), or some other unique positioning.
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against vapors and aerosols and prevent inward leakage of liquid spray (less than NFPA 1991).
- Materials and seams resist permeation by selected CWAs and TICs with testing of gases/vapors at 10,000 ppm and liquids at 20 g/m^2 (considered realistic high exposure concentrations).
- Meets minimum standards for strength, durability, and functionality (same as NFPA 1991).
- Offers limited material flame and burn-through resistance.
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).
- Some Class 1 ensembles also certified to Class 2.

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 2

Purpose and Scope

- Defines ensembles that protect against CWAs, TICs, biological agents (bloodborne pathogens), and particulates.
- Intended for IDLH environments requiring minimum use of SCBA that comply with NFPA 1981 or NFPA 1986.
- Provides protection against vapors, liquid droplets, and aerosols where potential skin contact is expected to be limited.
- Provides performance consistent with EPA/OSHA Level B.

Features

- One-piece or multiple-piece garments; may or may not cover respiratory protective equipment.
- Requires interface with SCBA (if not encapsulated), gloves, and footwear.
- Entry zippers may be on the back (either horizontal or vertical), front (usually diagonal across the body), or some other unique positioning.
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against vapors and aerosols and prevent inward leakage of liquid spray.
- Materials and seams resist permeation by selected CWAs and TICs with testing of gases/vapors at 350 ppm and liquids at 10 g/m^2.
- Materials and seams also prevent penetration of bloodborne pathogens.
- Meets minimum standards for strength, durability, and functionality.
- Not evaluated for limited flame resistance (some products may have this property).
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).
- Some Class 2 ensembles also certified to Class 1.

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 2R

Purpose and Scope

- Defines ensembles that protect against CWAs, TICs, biological agents (bloodborne pathogens), and particulates.
- Intended for IDLH environments requiring minimum use of SCBA that comply with NFPA 1981 or NFPA 1986.
- Provides protection against vapors, liquid droplets, and aerosols where potential skin contact is expected to be limited.
- Provides higher levels of physical hazard resistance and increased durability over Class 2 ensembles.
- Provides performance consistent with EPA/OSHA Level B.

Features

- One-piece or multiple-piece garments; may or may not cover respiratory protective equipment.
- Requires interface with SCBA (if not encapsulated), gloves, and footwear.
- The entry zipper is on the back of the suit for the current certified product.
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against vapors and aerosols and prevent inward leakage of liquid spray.
- Materials and seams resist permeation by selected CWAs and TICs with testing of gases/vapors at 350 ppm and liquids at 10 g/m^2.
- Materials and seams also prevent penetration of bloodborne pathogens.
- Meets minimum standards for strength, durability, and functionality (criteria equivalent to Class 1).
- Not evaluated for limited flame resistance (some products may have this property).
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 3

Purpose and Scope

- Defines ensembles that protect against CWAs, TICs, biological agents (bloodborne pathogens), and particulates.
- Intended for incidents classified below IDLH conditions and where CBRN-approved air-purifying respirators (APRs) or powered air-purifying respirators (PAPRs) are the minimum inhalation protection requirement.
- Provides lower level of protection against vapors, liquid droplets, bloodborne pathogens, where direct skin contact is not likely.
- Provides performance consistent with EPA/OSHA Level C when worn with CBRN APR or PAPR.

Features

- One-piece or multiple-piece garments.
- Requires interface with APR or PAPR, gloves, and footwear.
- Entry zippers are generally on front (diagonal across the body).
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against vapors and aerosols (lower protection factors than Class 2 ensembles).
- Ensembles prevent inward leakage of liquid spray (shorter liquid exposure durations than Class 2 ensembles).
- Materials resist permeation by selected CWAs and TICs with testing of gases/vapors at 40 ppm and liquids at 10 g/m^2 under air flow conditions.
- Materials and seams prevent penetration of bloodborne pathogens.
- Meets minimum standards for strength, durability, and functionality (lower requirements than Class 2).
- Garment materials must be breathable to aid in heat stress relief.
- Not evaluated for limited flame resistance (some products may have this property).
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 3R

Purpose and Scope

- Defines ensembles that protect against CWAs, TICs, biological agents (bloodborne pathogens), and particulates.
- Intended for incidents classified below IDLH conditions and where CBRN-approved air-purifying respirators (APRs) or powered air-purifying respirators (PAPRs) are the minimum inhalation protection requirement.
- Provides lower level of protection against vapors, liquid droplets, bloodborne pathogens, where direct skin contact is not likely.
- Provides higher levels of physical hazard resistance and increased durability over Class 3 ensembles.
- Provides performance consistent with EPA/OSHA Level C when worn with CBRN APR or PAPR.

Features

- One-piece or multiple-piece garments.
- Requires interface with APR or PAPR, gloves, and footwear.
- Entry zippers are generally on front (diagonal across the body).
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against vapors and aerosols and prevent inward leakage of liquid spray.
- Materials and seams resist permeation by selected CWAs and TICs with testing of gases/vapors at 40 ppm and liquids at 10 g/m^2 under air flow conditions.
- Materials and seams also prevent penetration of bloodborne pathogens.
- Meets minimum standards for strength, durability, and functionality (criteria equivalent to Class 2).
- Garment materials must be breathable to aid in heat stress relief.
- Not evaluated for limited flame resistance (some products may have this property).
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 4

Purpose and Scope

- Defines ensembles that protect against biological agents (bloodborne pathogens) and particulates.
- Intended for incidents classified below IDLH conditions and where air-purifying respirators (APRs) or powered air-purifying respirators (PAPRs) are the minimum inhalation protection requirement.
- Provides protection against biological aerosols or liquids and radiological particulates (example applications include white powder (anthrax) responses or biological exposure events, such as potential victims of Ebola virus)
- Does NOT offer protection against CWAs or TICs
- Provides performance consistent with EPA/OSHA Level C when worn with CBRN APR or PAPR.

Features

- One-piece or multiple-piece garments.
- Requires interface with APR or PAPR, gloves, and footwear.
- Entry zippers are generally on front (diagonal across the body).
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against particulate penetration.
- Materials and seams prevent penetration of bloodborne pathogens.
- Meets minimum standards for strength, durability, and functionality.
- Garment materials must be breathable to aid in heat stress relief (more breathable than Class 3).
- Not evaluated for limited flame resistance.
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).

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NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 4R

Purpose and Scope

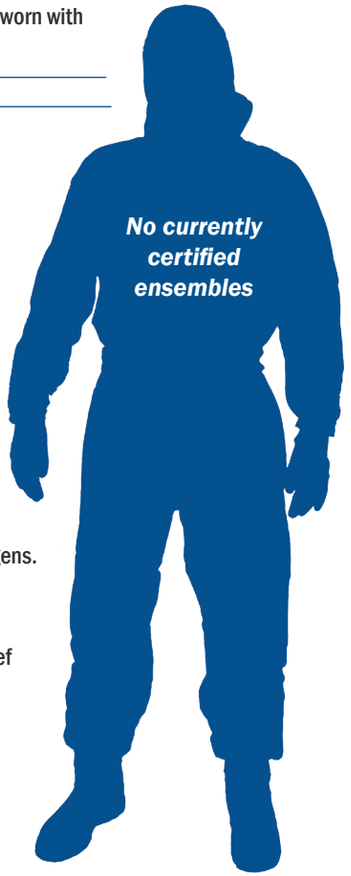
- Defines ensembles that protect against biological agents (bloodborne pathogens) and particulates.
- Intended for incidents classified below IDLH conditions and where air-purifying respirators (APRs) or powered air-purifying respirators (PAPRs) are the minimum inhalation protection requirement.
- Provides protection against biological aerosols or liquids and radiological particulates (example applications include white powder (anthrax) responses or biological exposure events, such as potential victims of Ebola virus)
- Does NOT offer protection against CWAs or TICs
- Provides higher levels of physical hazard resistance and increased durability over Class 4 ensembles.
- Provides performance consistent with EPA/OSHA Level C when worn with CBRN APR or PAPR.

Features

- One-piece or multiple-piece garments.
- Requires interface with APR or PAPR, gloves, and footwear.
- Entry zippers are generally on front (diagonal across the body).
- Multiple gloves may be used to meet hand protection requirements.
- Garments generally use outer boots combined with attached socks with splash flaps covering tops of outer boots.
- Typically single-layer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Ensembles demonstrate integrity against particulate penetration.
- Materials and seams prevent penetration of bloodborne pathogens.
- Meets minimum standards for strength, durability, and functionality (criteria equivalent to Class 2).
- Garment materials must be breathable to aid in heat stress relief (more breathable than Class 3R).
- Not evaluated for limited flame resistance.
- Intended for single exposure; some products may be worn more than once.
- Optional criteria define additional protection against chemical flash fires and for stealth (non-conspicuous color and noise).



NFPA 1990/NFPA 1994, Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incident – Class 5

Purpose and Scope

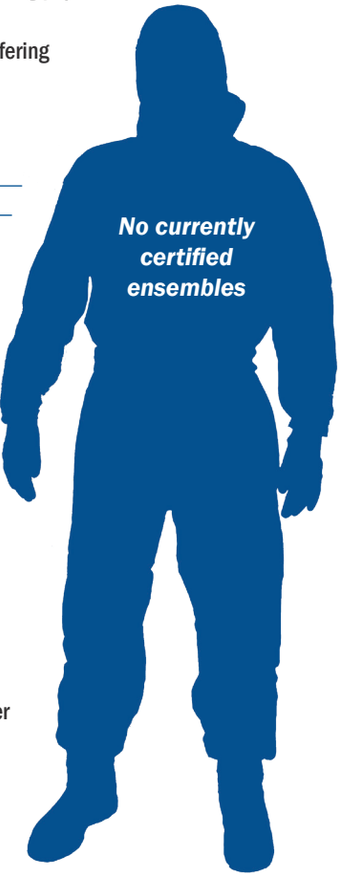
- Defines ensembles that protect against hazardous incidents involving flammable gases not toxic to the skin where the potential exists for chemical flash fires
- Intended for IDLH environments requiring minimum use of SCBA that comply with NFPA 1981 or NFPA 1986.
- Offers limited liquid protection principal in the form of repellency.

Features

- One-piece or multiple-piece garments.
- Can be similar to lightweight, few layer turnout clothing used by firefighters.
- Separate gloves used to meet hand protection requirements offering physical ruggedness and waterproof designs.
- Separate footwear used to meet foot protection requirements offering physical ruggedness and waterproof designs.
- Expected multilayer construction.
- Ensembles provided in at least four sizes.

Performance Attributes

- Primary requirements taken from NFPA 1951 for technical rescue garments in terms of material strength, ruggedness, and durability.
- Demonstrates mandatory flash fire performance in simulated full scale testing.
- Provides thermal protective performance and resistance to extended flame exposure.
- Does NOT include any performance criteria for chemical or biological fluid penetration.
- Requires use of materials that offer high levels of repellency against low surface tension liquids.
- Meets relatively high criteria for strength, durability, and functionality.
- Garments have minimum level of breathability (more breathable than Class 3; same as Class 4).
- Intended for multiple exposures and uses; can be laundered after use.



NFPA 1990 Other Certified Items

Items included garments, gloves, footwear, and hoods are separately certified to the different requirements of individual standards within NFPA 1990. The individual certifications of these ensemble elements by manufacturers can then be combined with suits, other protective clothing, and respirators as part of ensembles offered by other manufacturers without the ensemble manufacturer having to separately test items they don't produce. Possible individual element certifications include:

- Glove systems and outer boots for NFPA 1991 as part of vapor-protective ensembles
- Individual non-encapsulating garments (suits and coveralls), gloves, outer boots, footwear covers, and hoods for NFPA 1992 that are part of liquid splash-protective ensembles
- Individual non-encapsulating garments (suits and coveralls), gloves, outer boots, footwear covers, and hoods for NFPA 1994 that are part of Hazmat/CBRN-protective ensembles

Footwear Options

NFPA 1990 defines three types of footwear, that includes (1) *full boots* that fully meet the respective requirements of the portion of the standard (e.g., complies with NFPA 1991, 1992, or 1994) for foot protection; (2) *outer boots* that provide physical protection to the wearer's feet but rely on the attached sock of the suit for chemical barrier protection; and (3) *footwear covers* that offer some contamination protection to underlying footwear, but where the covered boot provides physical protection, which may or may not then be reliant on a suit sock for chemical protection. These different configurations are intended to offer first responder different footwear options based on their mission needs.

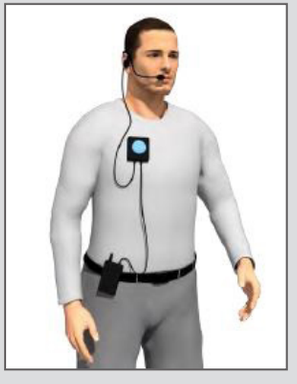
Like ensembles, these separate elements meet all the respective design, performance, and labeling criteria for the respective standard, and class and performance as applicable.

Photographs provided by and used with permission of W.L. Gore & Associates (gloves) Lac-Mac Ltd. (jacket and bib overalls) Dunlop Protective Footwear (green boots), and Haix (black boot)

Non-Certified Accessories

Other items may be worn with certified protective ensembles that provide specific purposes but are not subject to NFPA 1990 specific requirements or third-party certification. Examples include:

- Personally worn cooling systems
- Communications equipment
- Equipment carrying vests or harnesses
- Specialized covers (such as a specific cover for the SCBA when worn on the outside of non-encapsulating ensembles)

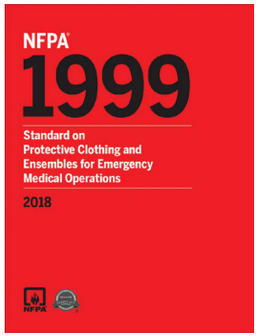


In most cases, there are no standards for these items. However, if an interface is provided for a specific item that affects the integrity or performance of the ensemble, then the interface (such as a pass-through or external fitting) must be evaluated as part of the NFPA 1990 ensemble certification.

Some claims based on independent testing may indicate relevant performance to existing NFPA standards but cannot reference NFPA standards for compliance purposes. Further, the wearing of the accessory cannot compromise the performance of the ensemble including the functionality of the wearer. In most cases, the impact of the accessory can only be determined when the respective response organization carries out field testing with the ensemble configured with the intended accessories to assess its possible interference with operator function.

Photographs provided by Draeger (top), Pacific Northwest National Laboratories (middle), and IPP, Inc. (bottom).

NFPA 1999, Standard on Protective Clothing Ensembles for Emergency Medical Operations — Overview



NFPA 1999 is intended to address a range of different protective clothing and equipment items that are used by emergency medical responders prior to their arrival at medical care facilities, by medical first receivers at medical care facilities, during emergency medical operations, and by healthcare workers providing medical and supportive care. The standard differentiates between single use items, which are considered disposable, and multiple use items that can be reused when subject to proper cleaning and decontamination.

Specific categories for each type of individual items of emergency medical protective clothing and equipment include those in the table below:

Type of Protection	Protective Item
Body/torso/arms/legs	• Single-use protective garments (may be full or partial body) • Multiple-use protective garment (may be full or partial body)
Hands	• Single-use examination gloves • Single-use cleaning/utility gloves • Multiple-use work gloves
Eyes/face	• Single-use face masks • Single-use eye and face protection devices • Multiple-use eye and face protective devices
Feet and ankles	• Single-use footwear covers • Multiple-use footwear • Medical care facility footwear
Head	• Helmets
Inhalation	• Powered Air-Purifying Respirators using loose-fitting hood

Typically a first responder would select the items that are needed, which at minimum includes single-use examination gloves, with the addition of other items as needed depending on the assessed hazards and risk of exposure. NFPA 1999 also defines single-use and multi-use ensembles that combine the necessary items into a full ensemble, including the specification of a suitable respirator that is not necessarily addressed in NFPA 1999.

NFPA 1999, Standard on Protective Clothing and Ensembles for Emergency Medical Operations — Overview

Purpose and Scope

- Specifies the requirements for single-use and multiple-use emergency medical protective ensembles and clothing for protecting against liquid-borne or airborne highly infectious diseases.
- Single-use ensembles and clothing are intended for one-time use.
- Multiple-use ensembles and clothing are intended for repeated use with reuse predicated on their adequate cleaning and decontamination before reuse.

Features

- Both single-use and multiple-use ensemble types provide full body coverage with no exposed skin.
- Single-use ensembles include single-use coveralls or two-piece garments, two pairs of examination gloves, multiple-use footwear, medical facility footwear, or single-use footwear covers, ANSI Z87.1 compliant eye/face protection devices (e.g., goggles or faceshields), and an N95 filtering facepieces that is also an approved FDA surgical mask.
- Multiple-use ensembles include multiple-use coveralls or two-piece garments, cleaning or work gloves worn over examination gloves, multiple-use footwear or medical facility footwear, and either a full face APR with P100 filters or tight-fitting or loose-fitting (hooded) PAPR having an HE protection level.

Performance Attributes

- Prevents inward leakage of liquid spray (multiple-use ensembles are tested for a longer duration exposure).
- Materials and seams prevent penetration of bloodborne pathogens (multiple-use ensemble evaluated after repeated laundering).
- Garments meet minimum standards for strength, durability, and functionality (multiple-use garments evaluated under more severe conditions with higher criteria).
- Individual criteria established for ensemble elements including gloves, footwear, eye/face protection devices, and helmets.
- Garments must have minimum level of breathability.
- Also allows for certification of individual single- and multiple-use garments, different gloves (examination, cleaning, work), eye and face protection devices, footwear, footwear covers, and helmets.

Photographs provided by and used with permission of Innotex and Blauer Manufacturing Company, Inc.

Standards for Respiratory Protection

History for NFPA Standards Development

Requirements for respiratory protection specific to hazardous environment for first responders have been developed over two decades. The first respirator standard for firefighters was developed under the designation 19-B in 1971 and simply prohibited the use of filter-type canister masks and required the use of a self-contained breathing apparatus (SCBA). A new NFPA 1981 standard replaced NFPA 19-B in 1981 and required the SCBA to be open-circuit, positive pressure, and rated for a minimum service life of 30 minutes as approved by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) per the then applicable criteria in Title 30 Code of Federal Regulations Part 11 (30 CFR Part 11).

NFPA 1981, *Standard on Open-Circuit SCBA for Emergency Services*, was subsequently revised seven more times in 1986, 1992, 1997, 2092, 2007, 2013, and 2019 (current edition). Each revision progressed the requirements beyond the prerequisite 30 CFR Part 11 criteria, which were updated to new regulations in 42 CFR Part 84 in June 1995. Additional design, performance, labeling, and certification criteria were established over the years that included:

- Evaluation of different environmental conditions to replicate field use for maintaining positive pressure.
- The incorporation of a total heat and flame exposure test.
- The addition of third party certification specific to NFPA requirements.
- Testing for lens abrasion and communications effectiveness.
- The addition of a heads-up display (HUD), rapid intervention team universal air coupler (RIT UAC).
- Broadening the use for emergency services.
- Implementation of CBRN protection criteria cited in the NIOSH Statement of Standard.
- The design of the SCBA with an emergency breathing safety system (EBSS).
- Updated communications and data logging capabilities.

The first edition of NFPA 1986, *Standard on Respiratory Protective Equipment for Tactical and Technical Operations*, was first promulgated in 2017. This standard was primarily based on paring down the criteria in NFPA 1981 as applicable to Hazmat and tactical responses, mainly removing some of the more stringent criteria and modifying the required alarms.

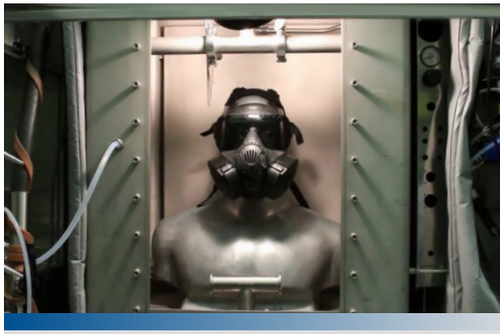
A second edition came out in 2023 that included a modification of the cold temperature performance requirement. As with NFPA 1981, NFPA 1986 requires prerequisite approval for SCBA according to the 42 CFR Part 84 requirements.

NFPA 1987, *Standard on Combination Unit Respirator Systems for Tactical and Technical Operations*, represented a departure from NFPA 1981 and NFPA 1986 by incorporating a combination of respiratory protection devices in one unit where one unit would have the capabilities of an SCBA and at least one other capability would be either an air-purifying respirator (APR) or powered air-purifying respirator (PAPR). The standard also uniquely establishes its own certification requirements that are not reliant on NIOSH approval per 42 CFR Part 84. A key requirement within this new standard is the control of switching from one respirator protection mode to another.

History for NIOSH Statements of Standard for CBRN

The National Institute for Occupational Safety and Health (NIOSH) developed specific standards for Chemical, Biological, Radiological, and Nuclear (CBRN) respirators to address the need for respiratory protection during emergencies and terrorist attacks. These standards evolved in response to the growing recognition of potential CBRN threats in both military and civilian contexts, especially after significant incidents like the 1995 Tokyo subway sarin attack and the 9/11 attacks in 2001.

Prior to the 9/11 attacks, NIOSH had developed standards for general industrial and occupational respirators, focusing on protection from dust, fumes, gases, and biological hazards like pathogens. The need for specialized standards addressing CBRN hazards in a terrorism context was not fully realized or standardized before the 9/11 era. The terrorist attacks and the subsequent anthrax letter attacks in the



Rapid Development of SMART-MAN Test Capabilities

A key part of the work for putting together the NIOSH CBRN Statements of Standard was establishing test protocols to reliably evaluate key respirator components for their protection against CWAs. To this end, method development in conjunction with U.S. Army procedures first put together in 1998 for warfighter gas masks and related equipment were adapted for the testing of emergency responder SCBA, PAPR, and APR using a manikin torso and head connected to a breathing machine that could evaluate if any nerve or blister CWAs entered the breathing zone over the extended exposure period.

An extensive study was made by the government authorities to set appropriate challenge exposure techniques and concentrations along with acceptable performance criteria. As a consequence of applying this test methodology, many respirator manufacturers were required to upgrade their respirator materials and designs.

Photo credit: Dugway Proving Ground

same year highlighted the vulnerabilities to CBRN threats. Emergency responders, such as firefighters, law enforcement, and hazardous materials (Hazmat) teams, were directly exposed to such risks.

NIOSH, working closely with the Department of Homeland Security (DHS), the U.S. Army, and other stakeholders, recognized the need to establish stringent standards for respirators that could protect users from CBRN agents in terrorism or emergency situations. In 2003, NIOSH introduced the CBRN Statement of Standard for Air-Purifying Respirators (APRs), marking a significant milestone. This standard specified the requirements for APRs that could protect emergency responders from CBRN threats.

Following the initial CBRN standard for APRs, NIOSH developed and released standards for other types of respirators:

- In 2003, NIOSH issued the CBRN Statement of Standard for Open-Circuit Self-Contained Breathing Apparatus (SCBA), which addresses SCBA commonly used by firefighters and first responders. These devices provide breathable air from an independent source, making them critical for environments where the air is severely contaminated or oxygen-deficient.
- In 2006, NIOSH released the CBRN Statement of Standard for Powered Air-Purifying Respirators (PAPRs). These respirators use a blower to pull contaminated air through filters and provide clean air to the user.
- NIOSH also developed standards for CBRN escape respirators, which are designed for quick escape from hazardous CBRN environments.

NIOSH has continuously updated the CBRN respirator standards to reflect new scientific knowledge, testing methodologies, and emerging threats. The CBRN APR standards, for example, include testing against a wide range of chemical warfare agents like sarin (GB) and mustard gas (HD), as well as toxic industrial chemicals (TICs). The CBRN standards for respirators are among the most rigorous, incorporating advanced filtration requirements, durability under extreme conditions, and compatibility with other PPE. They are incorporated by reference with the NFPA 1990 standard.

To ensure transparency and trust, respirators meeting NIOSH CBRN standards carry specific labeling that indicates CBRN approval. The equipment undergoes testing to ensure it meets the minimum performance levels required to provide protection against CBRN agents.

Overview of NIOSH Regulations on Other Respirators

Other than the CBRN Statements of Standard, Hazmat and CBRN first responders and operators rely on other types of standards that are not addressed in NFPA standard but instead are approved by NIOSH under the federal regulations provided in Title 42 Code of Federal Regulations Part 84, Approval of Respiratory Devices (42 CFR Part 84). These regulations together with specific Standard Technical Procedures developed by NIOSH establish the specific classification, design, performance, labeling, and approval requirements for permitting respiratory devices to be approved. These regulations cover a wide range of respirator products that offer specific characteristics that address specific performance needs of operators against different hazards.

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

Purpose and Scope

- Specified requirements for open-circuit SCBA that can be used in IDLH atmospheres.
- Also applies to SCBA combined with supplied air respirators (SCBA/SARs)
- When combined with appropriate protective clothing, provides performance meeting EPA/OSHA Level A.
- Intended to provide respiratory protection to emergency service personnel during firefighting, rescue, hazmat, terrorism incidents, and similar operations where combustion or toxic products, oxygen deficiency, and particulates are present.

Features

- Approved by NIOSH as open circuit SCBA according to 42 CFR Part 84.
- Operates as pressure demand (maintain positive pressure).
- Rated service time of at least 30 minutes.
- Two independent end-of-service time indicators.
- Electronics are intrinsically safe in hazardous environments
- Heads-up display (HUD) in facepiece showing remaining air cylinder levels and other signals such as low power.
- Voice communications system, minimum non-electronic that can be also include electronic supplemental system.
- Rapid intervention crew/company universal air connection (RIC UAC) to provide replenishment of air to cylinder.
- Data logging capabilities for cylinder initial and operating pressure during use.
- Most SCBA also include an integrated personal alert safety system (PASS), a device for detecting lack of motion.

Performance Attributes

- Approved by NIOSH as compliant with Statement of Standard for NIOSH CBRN SCBA Testing for protection against CWAs and TICs.
- Provides positive pressure at flowrates at 103 liters per minute (high work rates).
- Maintains positive pressure operation and full functionality over range of temperature extremes, vibration, particulate, and high heat/flame exposures.
- Resists ignition and degradation when exposure to direct flame and high heat.
- Facepiece not compromised by high radiant heat exposure.
- Electronics resistant to heat and water ingress.

NOTICE - At time of printing, NFPA 1981 was consolidated into a new NFPA 1970 standard with some changes related to service life alarms, design features and performance criteria.

Photographs provided by and used with permission of Mine Safety Appliances Co. and Draeger.

NFPA 1986, Standard on Respiratory Protection Equipment for Tactical and Technical Operations

Purpose and Scope

- Specifies requirements for open-circuit SCBA that can be used in IDLH atmospheres.
- Also applies to SCBA/SARs.
- When combined with appropriate protective clothing, provides performance meeting EPA/OSHA Level A or B.
- Intended to provide respiratory protection to emergency service personnel during rescue, hazmat, tactical law enforcement, confined space entry, terrorism incidents, and similar operations where combustion or toxic products, oxygen deficiency, and particulates are present.
- Not suitable for firefighting.

Features

- Approved by NIOSH as open circuit SCBA according to 42 CFR Part 84.
- Operates as pressure demand (maintain positive pressure).
- User viewable pressure gauge and additional end-of-service time indicator.
- Voice communications system, minimum non-electronic that can be also include electronic supplemental system.
- May have a HUD in facepiece showing remaining air cylinder levels and other signals such as low power.
- May have RIC UAC to provide replenishment of air to cylinder.
- May have an EBSS to permit sharing of air supply in emergency situation.

Performance Attributes

- Approved by NIOSH as compliant with Statement of Standard for NIOSH CBRN SCBA Testing for protection against CWAs and TICs.
- Provides positive pressure at flowrates at 103 liters per minute (high work rates).
- Maintains positive pressure operation and full functionality over range of temperature extremes, vibration, particulate, and high heat/flame exposures.
- Electronics resistant to water ingress.
- Electronics are intrinsically safe in hazardous environments.
- Optional criteria for toxic industrial chemical permeation resistance, HUD performance, RIC UAC, and EBSS performance.

Photograph provided by and used with permission of Avon Protection

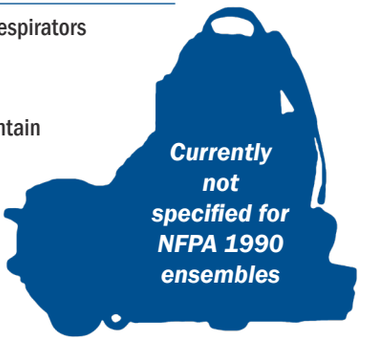
NFPA 1987, Standard on Combination Unit Respirator Systems for Tactical and Technical Operations

Purpose and Scope

- Specifies requirements for combination unit respirators that includes respiratory equipment entailing different combination of open-circuit SCBA, APRs, and PAPRs that can be operating different respirator protection modes.
- Intended for use by emergency services personnel in non-firefighting operations and atmospheres that include escape/entry in to IDLH atmospheres when operated in open-circuit SCBA mode and entry into non-IDLH and escape from IDLH and non-IDLH atmospheres when in APR mode or PAPR.
- When combined with appropriate protective clothing, provides performance meeting EPA/OSHA Level A or B when operated in open-circuit SCBA mode.
- When combined with appropriate protective clothing, provides performance meeting EPA/OSHA Level C when operated in APR and PAPR modes.
- Intended to provide respiratory protection to emergency service personnel during rescue, hazmat, tactical law enforcement, confined space entry, terrorism incidents, and similar operations where combustion or toxic products, oxygen deficiency, and particulates are present.
- Not suitable for firefighting.

Features

- Integrated respiratory equipment that combines two or more respirators among an open-circuit SCBA, APR, and PAPR.
- Indicates operating mode (respiratory type) when activated.
- Open circuit SCBA portion operates as pressure demand (maintain positive pressure).
- Open circuit SCBA portion provides user viewable pressure gauge and additional end-of-service time indicator.
- Voice communications system, minimum non-electronic that can be also include electronic supplemental system.
- Open circuit SCBA portion may have a HUD, RIC UAC, and EBSS.



Performance Attributes

- Approved by NIOSH as compliant with Statement of Standard for NIOSH CBRN SCBA, PAPR, or APR Testing for protection against CWAs and TICs depending on respirators combined.
- Criteria for open circuit SCBA portion are similar to NFPA 1986 requirements.
- Criteria for PAPR and APR portions reflect NIOSH approval criteria for these devices established in 42 CFR Part 84.
- Optional criteria for toxic industrial chemical permeation resistance, HUD performance, RIC UAC, and EBSS performance.

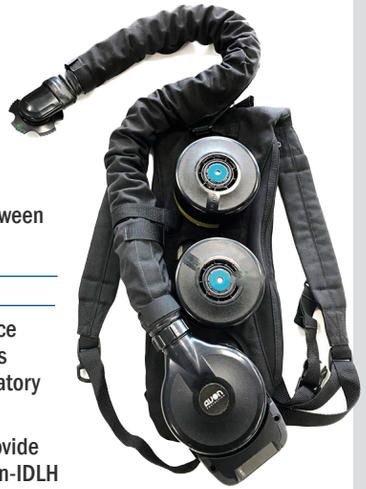
NIOSH CBRN Statements of Standard

Purpose and Scope

- Establish requirements for enhanced performance of specific respiratory devices for protecting end users against increased hazards from potential exposure to CWAs and TICs.
- Statement of Standard for CBRN SCBA applies to open-circuit SCBA that are approved by NIOSH under Subpart H of 42 CFR Part 84 (self-contained breathing apparatus) and NFPA 1981.
- Statement of Standard for CBRN SCBA similarly applies to SCBA certified to NFPA 1986 and the open-circuit portion of combined unit respirators certified to NFPA 1987.
- Statement of Standard for CBRN PAPR applies to powered air-purifying respirators (PAPR) approved by NIOSH under Subpart L (chemical cartridge respirators)
- Statement of Standard for CBRN APR applies to air-purifying respirators (APR) approved by NIOSH under Subpart I (gas masks)

Features

- Respirators approved to respective Statement of Standard also meet respective, applicable criteria in 42 CFR Part 84 for general design and performance requirements.
- Respirators may have some of the same features as their non-CBRN counterparts, but include materials and components that have been “enhanced” for resistance against CWAs and TICs.
- In the case of CBRN APR and PAPR, only specialized CBRN canisters can be used for filtering contaminated air that are capable of neutralizing or filtering CWAs, TICs, biological agents, and radiological particles.
- Canisters have a universal thread to allow interchangeability between different approved CBRN APR and PAPR



Performance Attributes

- Open-circuit SCBA provide permeation and penetration resistance against distilled sulfur mustard (HD) and sarin (GD) at IDLH levels under dynamic exposure conditions and demonstrate high laboratory respiratory protection level (LRPL).
- PAPR withstand a range of environment exposure conditions, provide permeation and penetration resistance against HD and GD at non-IDLH levels under dynamic exposure conditions, demonstrate and acceptable LRPL, and use canisters that provide acceptable service life against selected TICs.
- APR provide similar attributes as PAPR but are also demonstrate acceptable breathing resistance, weight, field of view, lens qualities, and practical performance.

Photographs provided by and used with permission of Draeger and Avon Protection

Other Respirators for CBRN/First Responder Protection

The large majority of hazardous materials and CBRN operational missions dictate the use of approved CBRN based respirators; however, there are certain responses that either dictate or permit alternative forms of NIOSH-approved respirators. Some examples of specific respirator types and their uses include:

- Wearing of disposable filtering facepiece respirators or reusable air purifying respirators (APR) outfitted with particulate filters for protection of operators from inhalation of potentially infectious aerosols or other particulate only types of hazards (e.g., fentanyl or other opioid drugs).
- Use of standard air-purifying respirators (APR) or powered air-purifying respirators (PAPR) that target specific chemical contaminants.
- Employment of closed-circuit, self-contained breathing apparatus for long duration rescues such as those that occur in tunnels and other subterranean spaces, or were extended service life is required under IDLH conditions.

Filtering facepiece respirators (FFRs) became commonplace during the pandemic as a means of infection control and personal protection among first responders. NFPA 1999 establishes two ensembles where these types of respirators are part of the overall ensemble for protecting the wearer from biological aerosols. While there are many different types of FFRs, the most common are N95 and P100 respirators, where the “N95” designation indicates that the media that provides a 95% or greater filtration efficiency for removal of non-oily submicron particulates under specific test conditions while “P100” connotes filtration efficiencies exceeding 99.97% under the similar test conditions for both oily and non-oily particulates.

A more durable and sustainable form of respiratory device is an elastomeric APR outfitted with a suitable particulate filter that is typically rated as a P100 filter cartridge. Some facepieces for open-circuit SCBA are convertible using an adapter for use as an APR.

Closed-circuit SCBA differ from open circuit SCBA by recycling and re-using exhaled air rather than releasing it into the environment. Closed-circuit SCBA, also known as rebreathers, circulate exhaled air through an absorbent that removes the carbon dioxide while using a separate small cylinder to inject oxygen to make up for its depletion through breathing. As a consequence, rebreathers can provide substantially longer service life, but require careful controlled management of the air quality that is accomplished by the use of different types of sensors as part of the overall respiratory equipment. In addition, the reaction for scrubbing the carbon dioxide from exhaled air creates heat that the closed-circuit SCBA, must effectively remove. NIOSH applies specific requirements relative to the testing and approval of closed-circuit SCBA. Currently, there is no NIOSH CBRN Statement of Standard.

Photographs provided by and used with permission of Moldex Metric and Draeger

How Equipment Is Tested to Meet Operational Requirements

Criteria for Testing Protective Ensembles and Clothing

An essential component of the NFPA PPE standards is the operational relevance of the testing. In developing the NFPA standards, specific test methods and validated criteria for establishing acceptable performance can be summarized by five basic questions.

1 Does the ensemble prevent the penetration of specific chemicals and other substances into the ensemble that may be encountered during emergency operations?

Overall ensemble integrity tests correspond to expected types of exposure stated in each standard and address the most likely pathway for wearer exposure to hazardous substances—ensemble interfaces, seams, and closures.

2 Do the materials used in the construction of the ensemble adequately resist permeation and penetration of hazardous substances under relevant exposure conditions?

Resistance of barrier materials and seams is the most extensive requirement of each standard. Each ensemble element, including the suit (or garment), visor, gloves, footwear, and primary seams of the ensemble, are tested; closures are also tested for penetration resistance in NFPA 1991.

- Permeation resistance testing is used for vapor, gases, and highly toxic chemicals.
- Liquid penetration resistance is used when ensembles are expected to protect against short-term chemical contact by liquid splashes.
- Viral penetration resistance testing is used on all NFPA 1994 (except Class 1) and NFPA 1999 ensembles.

Because it is impossible to test with every possible chemical, specific chemicals have been chosen to represent a range of chemical exposure concerns. The table on page 38 shows the range of chemicals used in the evaluation of ensemble materials that are part of each standard. It includes chemicals that are both skin toxic and those that are predictive for a range of chemicals that can affect protective ensemble materials. Some chemicals were selected to represent different classes of chemicals.

In March 1995, members of the Aum Shinrikyo religious sect released the chemical warfare agent Sarin in the Tokyo subway system, killing 12 and injuring over 5,000. The consequences of this attack were in part mitigated by the primitive dispersal method chosen and the low concentration of the Sarin. However, the incident demonstrated that all first responders, not just specialized hazardous materials teams, needed access to practical protective ensembles for responding to potential terrorism events involving both chemicals and biological agents.

This incident, and the threat of others like it, led to the development of NFPA 1994 for a broad range of emergency response organizations. In 2001, the anthrax letters killed 5 individuals and injured 17 others in the United States, closing the Hart Senate Office Building. Related response incidents involved a wide range of clothing choices. Although NFPA 1994 had just become available, this incident prompted the modification of NFPA 1994 to address protection needs for "white powder" calls with the adoption of a new Class 4.

Photo credit: Lion Group, Inc.

The development of NFPA 1994 for addressing non-warfare agent TICs, was further validated when Iraqi insurgents used chlorine containers in conjunction with improvised explosive devices in terrorist activity against local citizens and U.S. military personnel beginning in 2006. In fact, the anticipated use of TICs in terrorist incidents is the reason chlorine was specifically included as a test agent in the original development of the standard.

Chemicals Specified in NFPA Hazmat Protective Ensemble Standards

Known Skin Toxicity Hazards		No Skin Toxicity Hazards*	
Acrylonitrile†	Methanol	Acetone	Hydrogen chloride (gas)
Carbon disulfide	Methyl chloride (gas)	Ammonia (gas)	Isooctane‡
Diethylamine†	Nitrobenzene	1,3-Butadiene (gas)	Isopropanol
Dimethylformamide	Soman (GD)	Butyl acetate	Methyl isobutyl ketone
Dimethyl sulfate	Tetrachloroethylene	Chlorine (gas)	Sodium hydroxide
Distilled mustard (HD)	Tetrahydrofuran	Dichloromethane	Sodium hypochlorite
Hexane		Ethanol‡	Sulfuric acid
		Ethyl acetate†	Toluene‡
		Ethylene oxide (gas)	

** Some chemicals may be corrosive or otherwise harm skin without being toxic.*
† Tested as a vapor in NFPA 1994;
‡ Combined as a mixture for NFPA 1992 penetration testing.

How Equipment Is Tested to Meet Operational Requirements (continued)

3 Does the ensemble have the durability and physical properties necessary for the expected use?

The required testing criteria in the standards provides confidence that the protective capabilities will be maintained over time. Ensembles are subjected to repeated flexing and abrasion to simulate use prior to barrier testing. Suit/garment and visor materials are evaluated for burst strength, puncture/tear or impact resistance, and cold temperature stiffness; glove materials are tested for cut resistance, puncture resistance, and cold temperature stiffness; and footwear is tested for cut resistance, puncture resistance, abrasion resistance, impact/compression resistance, and slip resistance.

4 Will ensemble materials contribute to wearer injury in the event of accidental short-term exposure to severe hazards such as flame, flash fire, or liquefied gases?

During an emergency response, accidental flame contact may occur. To assure ensembles do not readily ignite and continue to burn, test methods are applied to:

- Assess the ease of ignition and the propensity for continued burning of ensemble materials when exposed to a flame (NFPA 1991 and NFPA 1994 Class 1).
- Evaluate melt-through of material when exposed to a short-duration high radiant source (NFPA 1991 and NFPA 1994 Class 1).
- Apply additional criteria for those ensembles that claim protection against chemical flash fires for escape purposes (NFPA 1991, NFPA 1992, and NFPA 1994 only).
- Offer a separate option for protection against liquefied gases—ammonia, chlorine, and ethylene oxide (NFPA 1991 only).

5 Will the ensemble limit user functionality and their ability to complete required missions and response activity?

Protection requirements do not come at the expense of ensemble functionality. Each standard addresses functionality by testing ensembles with their elements to ensure that responders can readily complete mission-based tasks. Materials are required to be breathable for stress reduction for applications where protection will not be compromised. Functional aspects tested include visor clarity, accommodation of hard hats, glove impact on dexterity and hand function, and footwear levels of slip resistance (traction) on smooth surfaces.

Additional information on product testing is provided in Appendix A.

Criteria for Testing Respirators

The same principles that apply for how that ensembles and clothing are tested equally apply to the testing of respirators. However, there are some key differences in the manner in which product testing is carried out and out performance criteria have been established.

- The majority of requirements for qualifying respirators derive from the National Institute for Occupational Safety and Health (NIOSH) regulations that specify certain design and performance criteria using Standard Technical Procedures (STPs) written and applied by NIOSH in the approval of respirators.
- Additional criteria specific to emergency responders are then added to address operationally relevant areas of performance both in the respective NFPA standards and in the NIOSH CBRN Statements of Standards.

In providing inhalation protection against hazardous materials and CBRN agents, the premises of respirator performance are based on the following key factors:

1. Type of Respirator

- Air-Purifying Respirators (APR) or Powered Air-Purifying Respirators (PAPR): These devices use filters, cartridges, or canisters to remove specific contaminants from the air before it is inhaled. APRs are suitable for environments where the air contains oxygen and the hazardous substances can be filtered.
- Supplied-Air Respirators (SAR) or Self-Contained Breathing Apparatus (SCBA): These respirator provide clean air from a cylinder or a remote source and are used when oxygen levels are low or when hazardous materials are immediately dangerous to life and health (IDLH).

2. Filtration Efficiency

- The respirator's ability to filter out specific particles, chemicals, or gases is essential. NIOSH classifies filters based on their efficiency (e.g., N95 filters at least 95% of airborne particles).
- Particulate filters are rated based on their percent efficiency and resistance to oil (e.g., N, R, P classifications) as determined by specific NIOSH STPs and test conditions.
- Chemical cartridges are designed to remove specific gases or vapors. It is important to match the cartridge to the hazard.

Criteria for Testing Respirators

(continued)

3. Fit and Seal

- A tight seal between the respirator and the user's face is crucial to prevent unfiltered air from entering (referred to as a "tight-fitting" facepiece).
- Fit testing should be conducted to ensure the respirator fits properly. This can involve either qualitative or quantitative tests based on OSHA-specified test methods.
- Facial hair, incorrect sizing, and improper donning can compromise the seal.
- Other respirators, particularly PAPR, may use a hood, helmet, or a suit to contain the air in the wearer's breathing zone, and are considered "loose-fitting."

4. Hazard Type and Concentration

- Different respirators are designed to protect against specific hazards, such as particulates, gases, vapors, or a combination of these.
- The concentration of hazardous materials in the air (measured in parts per million or milligrams per cubic meter) will determine the level of protection required.
- Respirators have an assigned protection factor (APF) established by OSHA that defines the level of protection they are capable of providing.

Photo credit: U.S. Navy

Occupational Exposure Level

Different organizations define inhalation protection based on various permissible occupational exposure levels or concentrations of specific air contaminants. Concentrations at or above IDLH provide the dividing line between air-supplying respirators such as SCBA offering the highest level of respiratory protection and PAPR or APR, which can be used in environments where the contaminant is lower than IDLH concentration. Other potentially relevant concentrations are established by OSHA (permissible exposure levels), NIOSH (recommended exposure levels), and ACGIH (threshold limit values) for general worker protection. Acute Exposure Guideline Levels (AEGLs) establish airborne concentration levels to help responders deal with emergencies involving chemical spills or other catastrophic events where members of the general public are exposed to a hazardous airborne chemical.

5. Oxygen Levels

- Most air-purifying respirators require a minimum oxygen level (usually 19.5%) in the environment, as they do not provide oxygen but filter contaminants from the existing air.
- In oxygen-deficient environments, a supplied-air respirator (SAR) or SCBA is necessary.

6. Duration of Exposure

- The length of time the respirator can effectively protect the user is a consideration. This is particularly important for supplied-air respirators, where the air supply may be limited, and for air-purifying respirators, where filter cartridges may become saturated over time.
- Certain respirators are required to have end-of-service-time indicators (EOSTI) that provide an individuation for the remaining service life for the respirators.

7. Respirator Maintenance

- Regular maintenance and inspection are crucial to ensure the respirator functions properly.
- Filters and cartridges must be replaced regularly, and the facepiece, straps, and other components must be checked for wear and tear.
- A damaged or improperly maintained respirator can fail to protect the user.

8. Environmental Conditions

- Environmental factors like humidity, temperature, and the presence of oil aerosols can affect the performance of the respirator, especially for particulate filters.
- High heat and humidity can affect the respirator's seal and comfort.

9. User Training

- Users must be trained on the proper use, fitting, and limitations of the respirator to ensure it provides adequate protection.
- Training should include how to don and doff the respirator correctly, how to check for a proper seal, and how to maintain and store the respirator.

Criteria for Testing Respirators

(continued)

10. Regulatory Compliance

- Respirators must meet the standards set by regulatory agencies such as NIOSH (National Institute for Occupational Safety and Health) and be worn in the accordance to the respiratory protection regulations established by OSHA or other national authorities, ensuring they are suitable for specific hazardous environments.

For more advanced respirators meeting NFPA standards and the NIOSH CBRN Statements of Standard as applied to emergency responders and other operators, additional rigorous criteria are applied that address specific emergency or tactical scene design and performance attributes that include or can include:

- Evaluation of protective performance under higher breathing rates.
- Continued protection and functionality under various harsh exposure conditions (temperature extremes, vibration, impact, particulate environments, and "high heat/flame contact" [see photo]).
- Overall respirator integrity.

Functional performance of supplemental respirator features (primarily SCBA) can include:

- Supplemental EOSTI Heads-up display (HUD) for providing key respirator metrics
- Rapid Interventional Crew Universal Air Connector (RIC UAC) to provide on scene refill of air cylinder
- Emergency Breathing Safety System (EBSS) to permit sharing air in an emergency
- Data logging capabilities
- Specific performance against CBRN agents and toxic industrial chemicals as shown in the table to the right:

Photo credit: Intertek Testing Services

Chemical Warfare Agents Used to Evaluate Full Respirator System
Distilled sulfur mustard (HD)
Sarin (GB)

Toxic Industrial Chemical for Assessing Canister Filter Performance	
Ammonia	Hydrogen sulfide
Cyanogen chloride	Nitrogen dioxide
Cyclohexane	Phosgene
Formaldehyde	Phosphine
Hydrogen cyanide	Sulfur dioxide

As with ensemble and clothing, testing against the more difficult chemicals or representative chemicals is applied to anticipate a broader range of possible chemical exposures. In the case of SCBA, testing of chemical warfare agents HD and GB are considered to predict performance against a wide range of agents and toxic industrial chemicals. However, while this same "systems" level testing is applied to APR and PAPR, filters are evaluated against a large range of known difficult chemical challenges for breakthrough concentrations to below permissible exposure levels.

As with protective ensembles, specific criteria for respirators relative to certain missions are not always addressed by standards. For example, certain missions may require stealth and weapons sighting capabilities, especially for certain DOD missions and law enforcement operations. Other capabilities often include the ability to integrate respirators with other protective equipment, particularly the ensembles, and protective elements such as helmets, communication devices, and hydration devices. Where these items directly impact the product performance, the integration is often assessed during some parts of the certification process or approval.

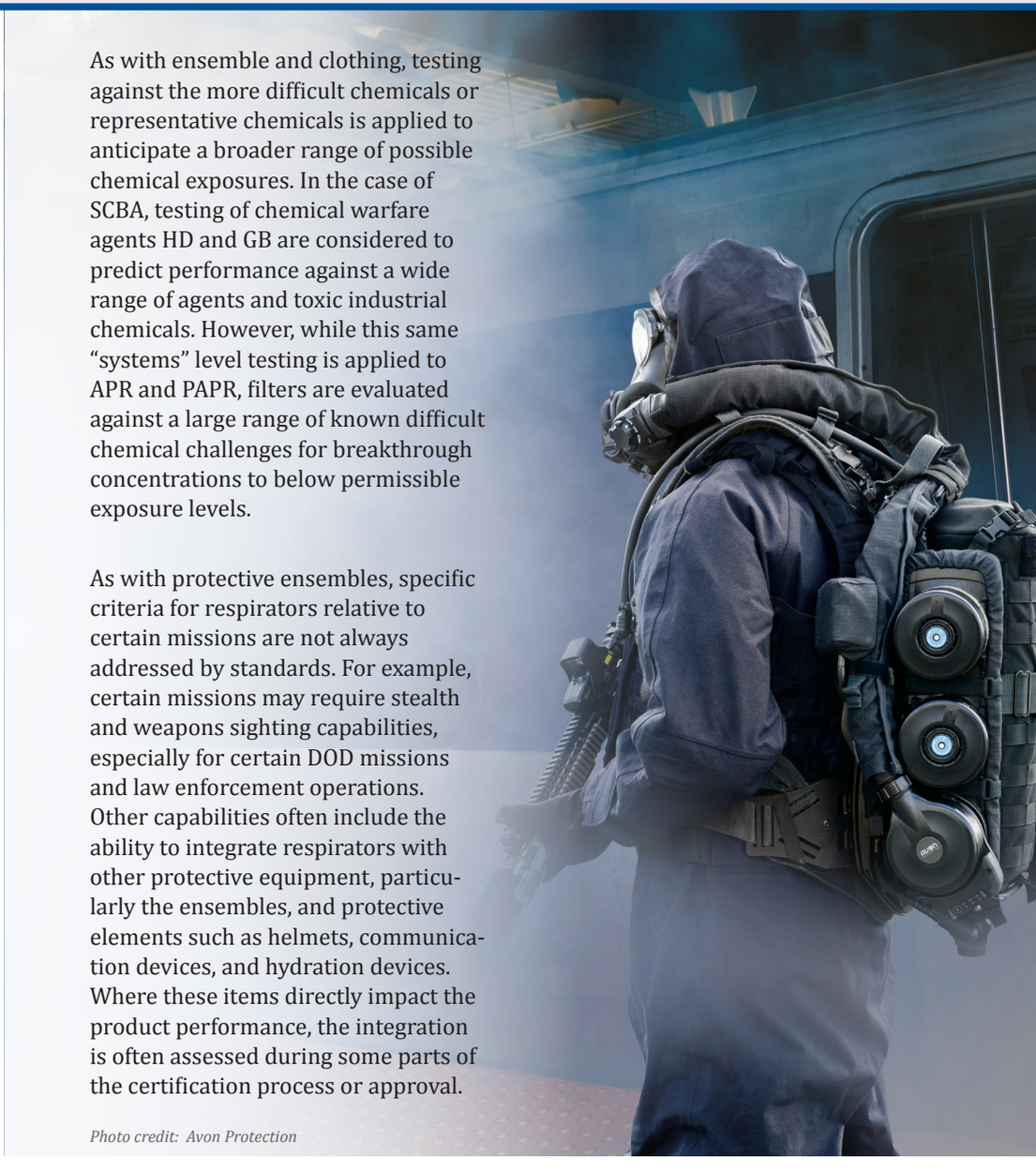


Photo credit: Avon Protection

The Value of the Standards Process and Certification

A Fair, Balanced Process

NFPA standards are developed through a voluntary consensus process accredited by the American National Standards Institute. The process ensures the balanced participation of users, enforcers, labor, research and testing organizations, consumers, manufacturers, and special experts. No single interest category may constitute more than one-third of the committee voting membership. Standards are developed in an open and transparent way, with specific stages for public input and comment.

Performance Specifications

NFPA standards are minimum performance specifications. These standards also specify minimum design, labeling, and information requirements.

Manufacturers can and do exceed the established criteria. End-user organizations can specify higher limits or set additional criteria to meet their intended protection applications.

For NFPA 1990 and NFPA 1999 standards, manufacturers must provide a technical data package that consists of detailed descriptions of all ensemble parts and components and includes the performance data that demonstrates compliance of the ensemble with the respective standard. The technical data package is available from the manufacturer upon request. This information can be useful to help end user organizations compare compliant products and any understand differences.

Photo credit: Lion Group, Inc.

Product Certification Process

- The ensemble, ensemble element, or clothing item must meet all criteria in the standard in order to be considered compliant. No partial certifications are allowed.
- For both NFPA 1990 and NFPA 1999, individual elements of the ensemble may be certified, which most commonly include gloves and footwear for NFPA 1991, 1992, 1994, and 1999 that not permanently attached to the ensemble. Certification organizations may also recognize specific components, such as garment materials or glove systems, meeting the applicable portions of the respective standard.
- Each standard requires independent, third-party certification, minimum manufacturer quality assurance (including manufacturer ISO 9001 quality standard registration), and annual recertification.
- Certifying organizations use unannounced visits to audit manufacturer products for compliance with the applicable standard. Annual testing of products sampled from the manufacturer is conducted to ensure products remain compliant.
- The criteria for third-party certification in all four standards exceed industry practices applied in other PPE specifications and standards used in the chemical or biological protection industry, including requirements for a recall or safety alerts, if necessary.

Additional Approval Process for Respirators

Certain respirators, including those that comply with NFPA 1981 and NFPA 1986, must first be approved by NIOSH as SCBA according to the requirements of 42 CFR Part 84. This approval process is quite rigorous and involves several elements:

- Pre-submission data to support performance claims
- Detailed engineering diagrams
- An operational, already applied quality management system with a product quality plan for specific sampling and testing of product
- On-going manufacturer quality audits

Similar approval procedures are in place for respirators meeting NIOSH Statements of Standard for CBRN protection on different qualified products.

In the early 1990s, the committee responsible for the NFPA chemical protective ensemble standards received a complaint that some encapsulated suits would over inflate and prevent first responders from moving or accessing certain areas of the response scene. In one reported incident, a first responder working at the scene of a highly hazardous chemical release was required to operate a vehicle. However, when the first responder sat inside the cab of the vehicle, the back of his suit pressed against the seat and blocked the suit's only exhaust valve. Subsequently, the suit over inflated, prevented him from performing his critical task, and required his rescue by other responders who twisted the responder inside the cab allowing the suit to vent the accumulated SCBA exhaust air. As a result of this and other incidents, NFPA 1991 was modified to include a new test method and requirements to ensure adequate ventilation of the suit in the event of an SCBA failure or blocked valve.

Is Your Equipment Certified?

Look for the Label

Despite the existence of some NFPA standards for over 40 years, there are still many products in the marketplace today that are not compliant. This guide is not intended to be a comprehensive portrayal of all ensembles and respiratory equipment that are currently certified to be compliant with NFPA standards. Nearly all ensembles shown in this guide are photographs of certified ensembles and respirators. To determine if the ensemble or respiratory that you are using is certified to a particular NFPA standard, examine the product label. This label is typically located in a readily visible area on inside the garment or clothing item. For SCBA, the label will appear on the back plate that faces the wearer. Specific things to look for on an NFPA label include:

Identifies the manufacturer and specific equipment (or parts) that must be worn as part of the ensemble to be compliant with the cited standard.

Provides the mark or logo of the independent organization that certifies the ensemble's compliance with an NFPA standard.

Identifies the specific NFPA standard the equipment meets.

Specifies the edition of the standard the ensemble meets. Standards are updated periodically and some ensembles may be certified to an older edition of the applicable standard.

Indicates compliance of the product with any optional, additional certifications.

Provides manufacturer instructions for the selection, use, and care of the ensemble, or refers end user to separate written instructions.

CERTIFICATION

[redacted] SEI CERTIFIED MODEL NFPA 1994 - 2022 NFPA 1992 - 2022

THIS CLASS 3R NON-ENCAPSULATING HAZARDOUS MATERIALS AND CBRN PROTECTIVE ENSEMBLE MEETS THE REQUIREMENTS OF NFPA 1994, INCORPORATED IN THE 2022 EDITION OF NFPA 1990, FOR THE ABOVE NOTED CLASS.

- THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON HAZARDOUS MATERIALS AND CBRN AGENTS FOR WHICH THIS ENSEMBLE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.
- FOR COMPLIANCE WITH NFPA 1994, THE FOLLOWING ADDITIONAL COMPONENTS MUST BE WORN IN CONJUNCTION WITH THIS HAZARDOUS MATERIALS AND CBRN PROTECTIVE ENSEMBLE: AVON C50 APR/PAPR/MP-PAPR, AVON FM53 APR/PAPR/MP-PAPR, AVON M53A1 APR/PAPR/MP-PAPR, AVON FM54 APR/PAPR/MP-PAPR, SCOTT AV3000 SURESEAL APR/PAPR, OR SCOTT AV3000 HT APR/PAPR; AND COMPLIANT OUTER BOOT FOOTWEAR. OUTER BOOT FOOTWEAR OPTIONS WORN WITH THIS ENSEMBLE MUST MEASURE AT LEAST 150MM (6 IN.) HIGH AND BE CERTIFIED TO NFPA 1951, NFPA 1971, NFPA 1991, NFPA 1992, NFPA 1994, OR NFPA 1999.
- TO REDUCE THE RISK OF INJURY OR DEATH, YOU MUST ASSEMBLE AND WEAR TOGETHER ALL OF THE ABOVE ITEMS. ALWAYS MAKE SURE THAT ALL GARMENT TO ENSEMBLE ELEMENT INTERFACES HAVE THE PROPER OVERLAP AND THAT ALL ITEMS FIT PROPERLY. REFERENCE THE RWZ9435AG RC3 ENSEMBLE USER GUIDE FOR PROPER DONNING AND USE INSTRUCTIONS.

THIS NON-ENCAPSULATING LIQUID SPLASH-PROTECTIVE ENSEMBLE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, INCORPORATED IN THE 2022 EDITION OF NFPA 1990, AND THE ADDITIONAL REQUIREMENTS INDICATED BELOW.

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS NON-ENCAPSULATING ENSEMBLE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.

ADDITIONAL REQUIREMENT	YES	NO
LIMITED CHEMICAL FIRE PROTECTION FOR ESCAPE ONLY IN THE EVENT OF A FLASH FIRE		√
CLAIM OF OPTIONAL BREATHABILITY FOR GARMENT MATERIALS	√	

FOR COMPLIANCE WITH NFPA 1992, THE FOLLOWING ADDITIONAL COMPONENTS MUST BE WORN IN CONJUNCTION WITH THIS LIQUID SPLASH PROTECTIVE ENSEMBLE: AVON C50 APR/PAPR/MP-PAPR, AVON FM53 APR/PAPR/MP-PAPR, AVON M53A1 APR/PAPR/MP-PAPR, AVON FM54 APR/PAPR/MP-PAPR, SCOTT AV3000 SURESEAL APR/PAPR, OR SCOTT AV3000 HT APR/PAPR; AND COMPLIANT OUTER BOOT FOOTWEAR. OUTER BOOT FOOTWEAR OPTIONS WORN WITH THIS ENSEMBLE MUST MEASURE AT LEAST 150MM (6 IN.) HIGH AND BE CERTIFIED TO NFPA 1951, NFPA 1971, NFPA 1991, NFPA 1992, OR NFPA 1999.

DO NOT REMOVE THIS LABEL

Photograph provided by and used with permission of Blauer Manufacturing Co.

Independent, Third-Party Certification*

Currently, two organizations provide independent, third-party certifications of ensembles, ensemble elements, clothing items, and respirators that meet NFPA standards:

- Safety Equipment Institute (SEI) – *www.SEInet.org*
- UL Solutions (UL) – *http://iq.ulprospector.com/info/* (keys words of "NFPA" and the number of the respective standard for obtaining complete product listings)

Both organizations maintain lists of certified products that can be used to confirm that specific manufacturer products are certified and continue to be certified. These lists identify specific features and components that comprise the certified product. The NFPA standards prohibit manufacturers from claiming compliance to a previous, superseded edition of the respective standard over 12–18 months following the release of the new edition.

Get Involved!

The NFPA standards described in this guide are developed by different NFPA technical committees that include:

- Hazardous Materials Protective Clothing and Equipment (responsible for NFPA 1990 [including NFPA 1991, 1992, and 1994] and NFPA 1891)
- Emergency Medical Protective Clothing and Equipment (responsible for NFPA 1999)
- Respiratory Protection Equipment (responsible for NFPA 1981 and NFPA 1852)
- Tactical and Technical Operations Respiratory Protection Equipment (responsible for NFPA 1986 and 1987)

These committees are responsible for the continuing development of these standards, and strongly encourage end-user and manufacturer involvement in communicating their importance. NFPA technical committee meetings are open to everyone.

Information on the standards and the technical committees is available at the NFPA website, which is *www.nfpa.org* and can be accessed searching on the respective standard (e.g., NFPA 1990). The webpage for the standard provides options for accessing the standard, a link to submit a membership application, and historical information related to the standard.

**See next page for more information on NIOSH approval of respirators.*

Respirator Approval and Listings

While not a committee-based process like NFPA, regulations governing approval of respirators provide for the listing of approved products that are readily accessible through the Center for Disease Control and Prevention, NIOSH website pages at: *https://www.cdc.gov/niosh/npptl/topics/respirators/cel/default.html*

The website provides several ways to search for approved respirators by approval number (also called a "TC" number) or manufacturer. There are also options for simple and advanced searches. The returned information provides schedule number (related to the respirator type), approval number, manufacturer, and relevant models number.

Approved respirators are required to have specific labeling directly on most types of respirators and a special CBRN label when meeting the respective NIOSH CBRN Statement of Standard.

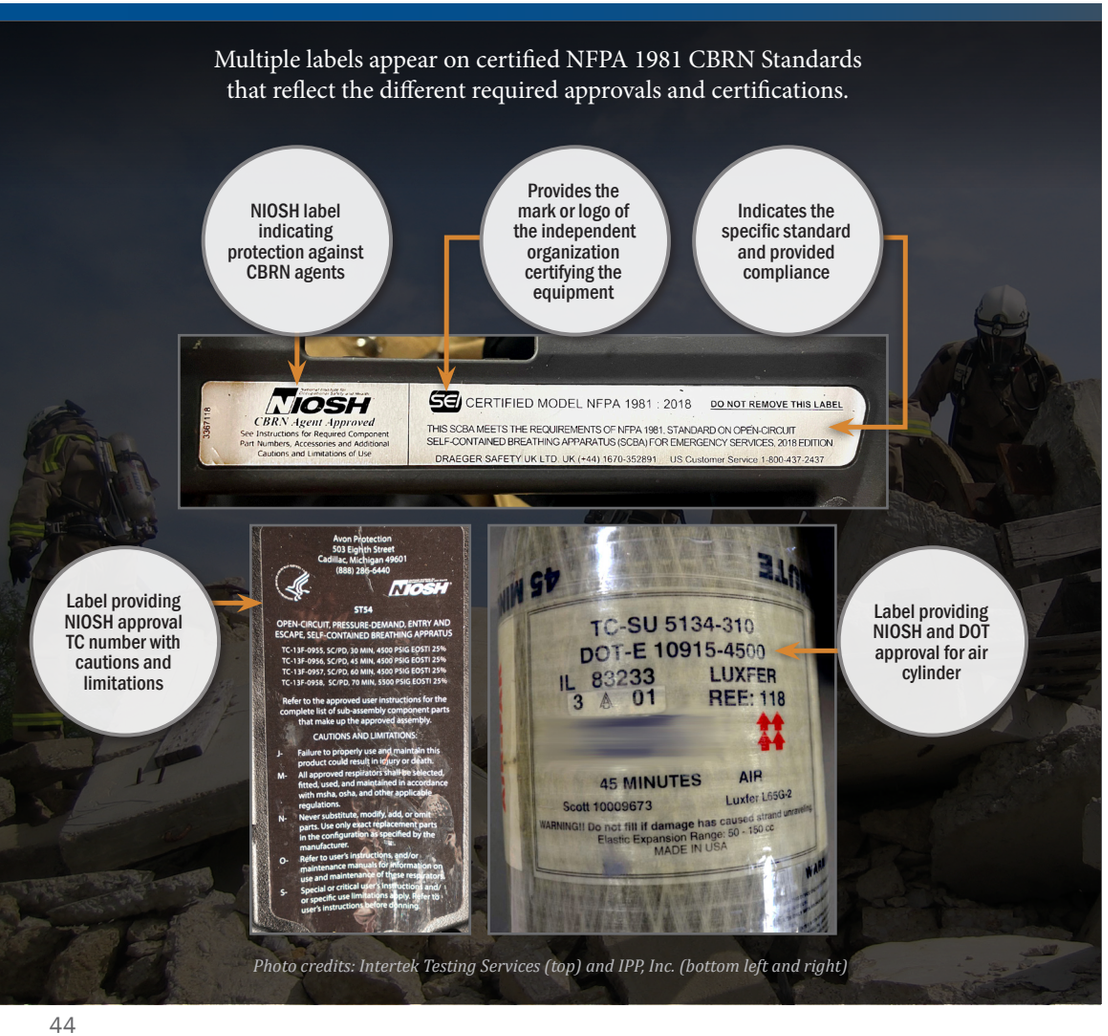


Photo credits: Intertek Testing Services (top) and IPP, Inc. (bottom left and right)

Proper Selection, Care, and Maintenance of Ensembles

Learning the capabilities and limitations of the different protective ensembles and related equipment for Hazmat responses and CBRN operations is an essential first step in having an understanding of PPE protection. Nevertheless, related complimentary knowledge is needed for how these ensembles are selected, used and cared for.

NFPA 1891 is a standard that provides guidelines for the selection, care, and maintenance of hazardous materials (Hazmat) and Chemical, Biological, Radiological, and Nuclear (CBRN) protective ensembles. It is aimed at organizations for ensuring the effectiveness and longevity of these critical protective clothing items and associated equipment. Here are the important points to consider:

1. Selection of Hazmat and CBRN Ensembles

- **Risk Assessment:** Selection must be based on a thorough risk assessment, considering the specific types of hazardous materials, CBRN agents, and the expected exposure levels. *Appendix B provides a detailed approach for a selection process that leads to deciding which of the NFPA 1990 or NFPA 1999 ensembles best fit the protection needs of a given set of exposure conditions.*
- **Ensemble Classification:** NFPA 1891 recognizes the different ensembles addressed in the NFPA 1990 and NFPA 1999 standards listed below:
  - » **NFPA 1991:** Vapor-protective ensembles with the highest protection against vapor, gases, and splashes.
  - » **NFPA 1992:** Liquid splash protective ensembles.
  - » **NFPA 1994, Class 1 through 5:** Range of protective ensembles with varying levels of vapor, liquid, or particulate integrity.
  - » **NFPA 1999:** Single or multiple-use ensemble for protection from airborne and liquid borne biological hazards.
- **Compatibility with Respiratory Protection Equipment:** The ensemble must be compatible with the selected respirator (e.g., SCBA, PAPR, or APR).
- **Material Properties:** The fabric of the ensemble must resist permeation, degradation, and penetration by hazardous materials. Key properties include:
  - » Resistance to permeation or penetration by CWAs, TICs, and other hazardous substances.
  - » Physical hazard resistance and durability for physical protection and holding up to rigors of use.
  - » Heat and flame resistance when required.
- **Certification and Labeling:** The ensemble should be certified to meet the requirements of NFPA standards, and labeling should clearly state the type of protection provided and the limitations.

Proper Selection, Care, and Maintenance of Ensembles (continued)

2. Inspection and Testing

Some products should periodically be tested when inspected, particularly full-encapsulating NFPA 1991 suits using an inflation kit as specified in the standard.

- **Inspection:** Regular inspection is critical to detect signs of wear, contamination, or damage. Inspections should be performed:
  - » Before and after each use.
  - » Periodically during storage.
  - » After decontamination procedures.
- **Cleaning and Decontamination:**
  - » Follow manufacturer guidelines for cleaning, ensuring the removal of any hazardous materials or agents.
  - » Specialized cleaning procedures may be required for decontamination after exposure to CBRN agents. Using appropriate cleaning agents and techniques to avoid damaging the material is critical.
- **Storage:** Proper storage is necessary to maintain the integrity of the ensemble:
  - » Store in a cool, dry, and ventilated area, away from direct sunlight and chemical exposure.
  - » Avoid folding or compressing the ensemble to prevent damage to materials.
- **Drying:** If the ensemble becomes wet (due to cleaning or exposure), ensure it is completely dried in a controlled environment before storage to prevent mold, mildew, or material degradation.

3. Repair and Replacement

- **Damage Assessment:** If an ensemble shows any damage (e.g., tears, abrasions, or degradation), it must be repaired or replaced immediately. Repair is possible for minor damage using manufacturer-approved materials and techniques.
- **Limitations of Repair:** Some damage may compromise the suit's integrity (e.g., chemical permeation) beyond repair, in which case the ensemble should be discarded. Ensemble repairs are limited to those items specified by the manufacturer.
- **Tracking Wear and Service Life:** NFPA 1891 emphasizes tracking the service life of the ensemble. Most manufacturers specify a service life based on frequency of use, exposure to chemicals, and environmental factors.
  - » Recordkeeping for each ensemble should include inspection results, cleaning history, and repairs performed.

If a suit reaches the end of its service life or is heavily contaminated, it must be removed from service and disposed of according to hazardous waste regulations.

4. Training for Users

- **Proper Use Training:** Personnel must be trained on the correct procedures for donning and doffing the ensemble to avoid contamination and ensure the integrity of all interfaces between clothing items, including the selected respirator.
- **Emergency Procedures:** Training should cover emergency doffing procedures in case of suit failure or contamination during a hazardous event.
- **Maintenance and Care Training:** Personnel responsible for maintaining the ensembles should be trained on how to inspect, clean, decontaminate, and store the suits properly.

5. Decontamination and Disposal

- **Field Decontamination:** After exposure to hazardous materials, field gross decontamination is essential before removing the suit to prevent secondary contamination.
- **Disposal:** If the ensemble becomes irreversibly contaminated or reaches the end of its service life, it must be disposed of as hazardous waste, following appropriate regulations and guidelines to prevent environmental contamination.

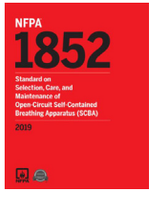
Photo credit: W.L. Gore & Associates

6. Recordkeeping and Documentation

- **Documentation:** Maintain detailed records of each ensemble's use, including inspections, cleaning, repairs, and any exposures to hazardous materials. This helps in tracking wear, service life, and compliance with safety protocols.
- **Tracking Contaminant Exposure:** Record any potential contamination events and ensure that suits are inspected and decontaminated as needed after such events.

In addition to the requirements directed towards establishing organization responsibilities, NFPA 1891 provides extensive annex language to provide guidance that help meet selection, care, and maintenance requirements. By adhering to these criteria and guidelines, organizations can ensure the safety and effectiveness of Hazmat and CBRN ensembles, extending their service life and maintaining high levels of protection for personnel.

Selection, Care, and Maintenance of Respirators



NFPA 1852 was developed by NFPA to provide guidelines for the selection, care, and maintenance of self-contained breathing apparatus (SCBA), including those compliant with NFPA 1981 and. SCBA 1986. These requirements are directed toward the end user organization to ensure the safety of firefighters and emergency responders who work in hazardous environments where breathable air may be compromised. Key aspects of NFPA 1852 include:

Selection of Respirators: Criteria for choosing SCBA equipment should be based on operational needs, ensuring compliance with OSHA regulations and other industry safety standards.

Inspection: Routine inspections of SCBAs require daily, monthly, and annual checks to ensure they are functioning correctly.

Maintenance: Procedures are outline for regular maintenance, emphasizing manufacturer guidelines and requirements for certified personnel to perform repairs and adjustments.

Testing: Describes performance testing protocols, including flow tests to ensure the SCBA delivers air properly, ensuring that all units meet performance criteria throughout their life cycle. Routine testing of air quality supplied from compressors and other sources is required.

Record Keeping: Detailed documentation of inspections, maintenance activities, and repairs are mandatory to provide a traceable history of SCBA performance and upkeep.

Training: End users and maintenance personnel must receive proper training on the operation, inspection, and care of SCBAs.

Upgrades and Retirement: The ability for an organization to keep using SCBA is specified based on the edition of the NFPA 1981 or NFPA 1986 standard for which it is compliance, which permits some older edition SCBA be retrofitted to later compliance through upgrade kits offered by some manufacturers.

The standard aims to ensure that SCBA units are reliable and safe for use in life-threatening situations by firefighters and other emergency personnel.

Appendix A: Matrix of Ensemble Test Methods and Criteria

A cornerstone of the standards and regulations governing Hazmat and CBRN protective ensembles and equipment are the individual design and performance requirements, where most acceptance criteria are based on specific test methods or other observation/measurements. The committees developing standards endeavor to use the same hazard and risk assessment approaches that PPE end users apply to identify the areas of key concern where specific requirements should be set to establish minimum protection to wearers. Key elements of this the process include:

- Establishing known areas of product performance consistent with end user protection expectations.
- Selecting existing evaluation methods or creating new tests to evaluate product performance in meaningful ways.
- Verifying that selected methods rate or rank product performance according to their observed performance in the field.
- Setting minimum performance criteria that relate back to end user expectations.
- Ensuring that tests are reproducible among different laboratories and repeatable within a given laboratory.
- Setting design criteria where reliable performance and test method cannot be established to further promote minimum health and safety needs.

In this appendix, different matrices are provided that provide the relative criteria that address both ensembles as part of NFPA 1990 and 1999 as well the individual types of respiratory protective equipment that are governed by other NFPA standards and government regulations.

The respective charts denote where specific performance properties are called out in the respective standards and a relative rating for some of these properties in some cases as to their rigor. These later ratings provide a generic discrimination of the relative protective level that helps distinguish differences between standards and may help end users decide appropriate levels as part of their hazard and risk assessment for selecting ensembles and protective equipment. Some of these differences are apparent as the basis for the ensemble selection decision logic presented in Appendix B.

MIST – Man-In-Simulant Test

Appendix A: Matrix of Ensemble Test Methods and Criteria

Many different tests are performed on ensembles and their materials and components. Tests have been selected or independently developed for each area of ensemble performance. The following table lists these tests as applied to each NFPA standard and indicates, where appropriate, the respective level of performance for those properties that vary between standards.

Matrix of Performance Properties Applied in NFPA Standards

Performance Areas	NFPA 1990/ 1991	NFPA 1990/ 1992	NFPA 1990/ 1994 Class 1	NFPA 1990/ 1994 Class 2	NFPA 1990/ 1994 Class 3	NFPA 1990/ 1994 Class 4	NFPA 1990/ 1994 Class 5	NFPA 1999 Multi-use	NFPA 1999 Single use
Ensemble/Clothing Integrity Tests									
Inflation (gas-tight integrity)*	◆		◈*						
Overall air flow capacity (SCBA failure)	◆		◈*						
Vapor Integrity (Man-in-Simulant Test)	●		⭘	◉	○	○			
Liquid-tight integrity	●	⭘	⭘	⭘	◉			◉	○
Glove liquid integrity	◆								
Footwear liquid integrity	◆								
Particulate inward leakage						◆			
Material Barrier Tests									
Permeation resistance - Standard industrial chemicals - Toxic industrial chemicals - Chemical warfare agents	● ● ●		⭘ ⭘ ⭘	◉ ◉ ◉	○ ○ ○				
Liquid penetration resistance	Closure	◆					***		
Viral penetration resistance				◆	◆	◆	***	◆	◆
Liquid repellency resistance							◆		
Durability/Physical Properties									
Garment burst strength	●	●	●	⭘ ●**	◉ ⭘**	◉ ⭘**		⭘	○
Garment puncture-tear resistance	●	●	●	⭘ ●**	◉ ⭘**	◉ ⭘**		◉	○
Garment tensile/tear strength							***		◆
Garment seam strength	◉	◉	●	◉	◉	◉	***	◉	○
Garment closure strength	◉	◉	●	◉	◉	◉	***	◉	○
Interface material strength	◈	◆	◆	◆	◆	◆		◆	
Visor impact resistance	◆	◈	◈	◈	◈	◈		◈	
Glove cut/puncture resistance	●	◉	⭘	⭘	◉	◉	●	◉	○

Matrix of Performance Properties Applied in NFPA Standards

Performance Areas	NFPA 1990/ 1991	NFPA 1990/ 1992	NFPA 1990/ 1994 Class 1	NFPA 1990/ 1994 Class 2	NFPA 1990/ 1994 Class 3	NFPA 1990/ 1994 Class 4	NFPA 1990/ 1994 Class 5	NFPA 1999 Multi-use	NFPA 1999 Single use
Durability/Physical Properties (continued)									
Footwear upper cut/puncture resistance	◆	◆	◆	◆	◆	◆	◆	◆	◆
Footwear sole abrasion/puncture resistance	◆	◆	◆	◆	◆	◆	◆	◆	◆
Footwear toe impact/compression resistance	◆	◆	◆	◆			◆	◈	◈
Cold temperature performance	◆	◆	◆	◆	◆	◆		◆	◆
Abrasion/flexing barrier durability preconditioning	●	⭘	◉ ⭘**	◉ ⭘**	◉ ⭘**	◉ ⭘**		⭘	
Exhaust valve mounting strength	◆	◈	◈	◈	◈	◈			
External fitting pull out strength	◆	◈	◈	◈	◈	◈			
Other Hazards									
Limited flame resistance	◆		◆						
Flame break open resistance	◆								
Overall flash fire performance	◇	◇	◇	◇	◇	◇	◆		
Heat transfer performance	◇	◇	◇	◇	◇	◇	***		
Full flame resistance	◇	◇	◇	◇	◇	◇	***		
Liquefied gas protection	◇								
Stealth (noise and color)			◇	◇	◇	◇			
Functional Tests									
Ensemble ergonomics	◆	◆	◆	◆	◆	◆		◆	◆
Exhaust valve leakage	◆	◈	◈	◈	◈	◈			
Garment breathability		◇		◇	⭘	●	●	●	⭘
Visor clarity	◆	◈	◈	◈	◈	◈		◈	
Ensemble field of vision	◆	◈	◈	◈	◈	◈		◈	
Hand removal from gloves	◆		◈*	◈*					
Glove-hand dexterity	○	⭘	◉	◉	⭘	⭘	◉	⭘	●
Footwear traction	◆	◆	◆	◆	◆	◆	◆	◆	◆

Legend

* Criteria applied for encapsulating ensembles only
** Applies to ruggedized (Class 2R, 3R, or 4R ensembles)
*** References criteria in NFPA 1951 for technical rescue protective clothing

◆ Requirement applied within standard
◈ Requirement applied if applicable
◇ Optional requirement within standard. (If manufacturer chooses to apply option, then relevant criteria become mandatory).

● Criteria very high
⭘ Criteria high
◉ Criteria moderate
○ Criteria low

Low criteria is a relative term and does not mean that ensemble provides little or no protection. All indications of criteria are relative; "relatively" low criteria does not mean that ensemble provides low levels of performance. Note that some properties have only two or three categories of criteria.

Appendix A: Matrix of Ensemble Test Methods and Criteria

Matrix of Requirements Applied in Respirator Standards and Regulations

Requirement	NFPA 1981	NFPA 1986	NFPA 1987	NIOSH CBRN PAPR	NIOSH CBRN APR
NIOSH Approvals					
42 CFR Part 84 Approval	SCBA	SCBA	**	PAPR	APR
CBRN SCBA Statement of Standard	SCBA	SCBA	**	PAPR	APR
Design Attributes					
No. end-of-service time indicators (EOSTI)	2	1			
EOSTI alert level (percent or psi pressure)	35%	25%	< 290		
Heads-up display (HUD)	◆	◇	◇		
Voice communications system	◆	◆	◆		
Electronic voice communications system	◇	◇	◇		
Rapid intervention crew/universal air connection (RIC/UAC)	◆	◇	◇		
Emergency breathing safety system (EBSS)	◇	◇	◇		
Cylinder and viewable breathing air gauges	◆	◆	◆		
Data logging capability	◆				
Performance Tests					
Airflow performance (103 L/min)	◆	◆	◈	◈	
Environmental temperature performance	◆	◆	◈	◈	
Vibration/drop resistance performance	◆	◆	◈	◈	
Corrosion resistance performance	◆	◆	◈	◈	
Particulate resistance performance	◆	◆	◈		
Heat and flame resistance performance	◆	◈	◈		
Elevated temp. heat/flame performance	◆				
Heat/immersion leakage performance	◆	◈	◈		
Lens radiant heat resistance	◆				
Lens abrasion resistance	◆	◆	◈		
Textile fabric flame and heat resistance	◆				
EOSTI performance	◆	◆	◈		
HUD and RIC UAC performance	◆	◇	◇		
EBSS performance	◇	◇	◇		
Breathing air cylinder retention	◆	◆			
Communications systems performance	◆	◆			
Low power capacity	◆	◆			
Regulator detachment strength	◆				
Canister filtration/breakthrough concentrations			◆	◆	◈
Overall TIC permeation resistance		◇	◇		

Legend

◆ Requirement applied within standard
◈ Requirement applied with lower or modified criteria
◇ Requirement applied if applicable

** Depends on combined unit respirator configuration
Most SCBA, PAPR, and APR tests written directly into standard without referencing 42 CFR Part 84.

Appendix B: Suggested Steps for Selecting Correct Ensemble

PPE selection for a specific response or operational mission should account for the specific hazard levels as well as an understanding for the specific types of available protective ensembles that can provide appropriate levels of protection. Selection of appropriate Hazmat and CBRN PPE depends on a thorough hazard and risk assessment that identifies the specific exposure threats and conditions at the response or operations scene.

The selection process in this appendix follows with the hazard and risk information through a series of decisions to determine which type of ensemble provides the needed minimum protection.

Decisions are set as part of the logical approach where depending on the answers provided, a certain pathway is taken that ultimately ends in a recommended protective ensemble that meets a specific standard and class.

Primary Assumptions

Several assumptions must be made to make the selection process more manageable that include:

1. The selection process is limited to Hazmat, CBRN, or emergency medical protective clothing for emergency response or related operations.
2. Individuals involved in the selection process have training in Hazmat response or CBRN operations at an appropriate level for the selection of PPE.
3. Individuals involved in the selection also have knowledge of the types of chemical or biological protective clothing used as part of ensembles.
4. At least some forms of clothing and equipment that meet the NFPA standards are available for use.

Key Information Needed

To make specific selection decisions, the following information is needed:

1. Type of hazards present in the response area.
2. Expected form of exposure to the type of hazard.
3. Expected severity of the hazards or potential consequences of exposure.
4. Portions of the body that are likely to come in contact with the hazard.
5. Presence of other types of hazards (heat, cold, physical, etc.).
6. Response needs and type of response environment.
7. Length of time of the work to be performed while wearing PPE.

NOTICE - Ensemble selection is subject to the disclaimer on the inside of the back cover.

General Approach for Selection Decision

Information gained primarily from the hazard assessment is used to answer a series of questions that result in specific decisions. Depending on the answer, other questions are asked, and those answers lead to different paths that ultimately end with a specific, recommended PPE. This process is known as a *decision logic*, and it begins with asking the most significant questions first so that better-performing PPE will be selected first to ensure appropriate levels of protection to operators and technicians.

STEP 1: Perform Hazard and Risk Assessment

PPE selection starts with a detailed hazard and risk assessment that includes a characterization of the site where the PPE will be used. The hazard assessment is intended to identify all primary hazards that can create potential harm to the responding operators or technicians.

Hazard and risk assessments also take into consideration the likelihood and the consequences of exposure to a specific hazard. Both of these factors combined establish the potential risk. For example, a low risk might exist for a hazard that is infrequently encountered and produces only moderate effects. Conversely, exposure to a highly hazardous substance that can produce immediate acute effects would be charged as a high risk.

Hazards can be characterized in a number of ways. For this document, hazards are identified as specific to the substance, the working environment, and the type of work performed.

Chemical, Biological, and Radiological Hazards. The principal hazards during hazardous materials or CBRN responses include hazards posed by specific substances in the response environment. Chemical substances are of varying toxicity and harmful effects where exposure can occur in a variety of forms:

1. Gas or vapor
2. Liquid or aerosol
3. Solid

Biological substances can be presented as either liquids or aerosols, although some forms of solid biotoxins or spores exist.

Radiological substances can be experienced as electromagnetic radiation or as contaminated gases, liquids, or solids.

Risk escalates with increasing volume and concentration, or strength, of the substance or hazard combined with the length of time exposure occurs.

Environmental Hazards. The environment where responders must work can equally affect the hazards present. Environmental factors include the following:

1. *Size of the space* — confined spaces represent special hazards because the environment limits the dilution or release of the substance and creates other hazards such as slips and falls and limited ease of escape.
2. *Ambient temperature* — will affect how quickly volatile substances evaporate. High temperatures can lead to heat stress; cold environments can create hypothermic conditions.
3. *Physical environment* — can lead to hazards that affect response activity and can compromise the barrier materials or integrity of the ensemble. Some aspects of the physical environment can allow substances to accumulate in certain areas, which creates higher risk.

Photo Credit: IPP, Inc.

Work/Task Hazards. The type of work can also contribute to hazards at the response scene. Wearing PPE for extended periods of time while undertaking moderate to hard work can create heat stress. In addition, the types of activities required can place strains on the individual operator or technician that can lead to mistakes or possible injuries. Work on elevated platforms creates potential fall and dropped object hazards.

STEP 2: Determine Known Threats

After information is obtained from the hazard and risk assessment, the very first decision to make is whether the hazards are identifiable. If the hazards are unknown then a separate decision has to be made whether entry into the site is actually needed.

1. If there is no significant consequence for not responding, then no entry should be made.
2. Even if there is potential loss of life or significant loss of property, any decision to enter a response area where the hazards are not completely characterized brings significant risk and should be avoided until more information is obtained to ensure the safety of the first responders.
3. When entry into the site is determined as necessary, then the highest level of protection should be chosen in the form of an NFPA 1991–certified ensemble with both flash fire escape and liquefied gas protection.

Appendix B: Suggested Steps for Selecting Correct Ensemble
(continued)

STEP 3: Determine Flash Fire Threats

The next key decision is to determine if there is a potential flash fire or explosive situation involved for the particular response or operation.

This decision is best supported by having portable monitoring equipment to measure the lower explosive limit (LEL). If monitoring equipment or circumstances indicate a LEL that is 10 percent or greater, then the environment should be considered a flash fire or explosive risk. It is possible that certain chemicals and the conditions of their storage for release will make this determination evident automatically.

As part of this decision, it is necessary to determine whether there is also a toxic threat posed by the substances at the response scene.

1. If toxic threats do not exist and there is no threat of explosion, wear an NFPA 1994 Class 5 ensemble (or other appropriate flame resistant clothing compliant to either NFPA 1971 or NFPA 2112).
2. If toxic threats do exist, then choose an NFPA 1991 ensemble that also meets the optional flash fire escape requirements.

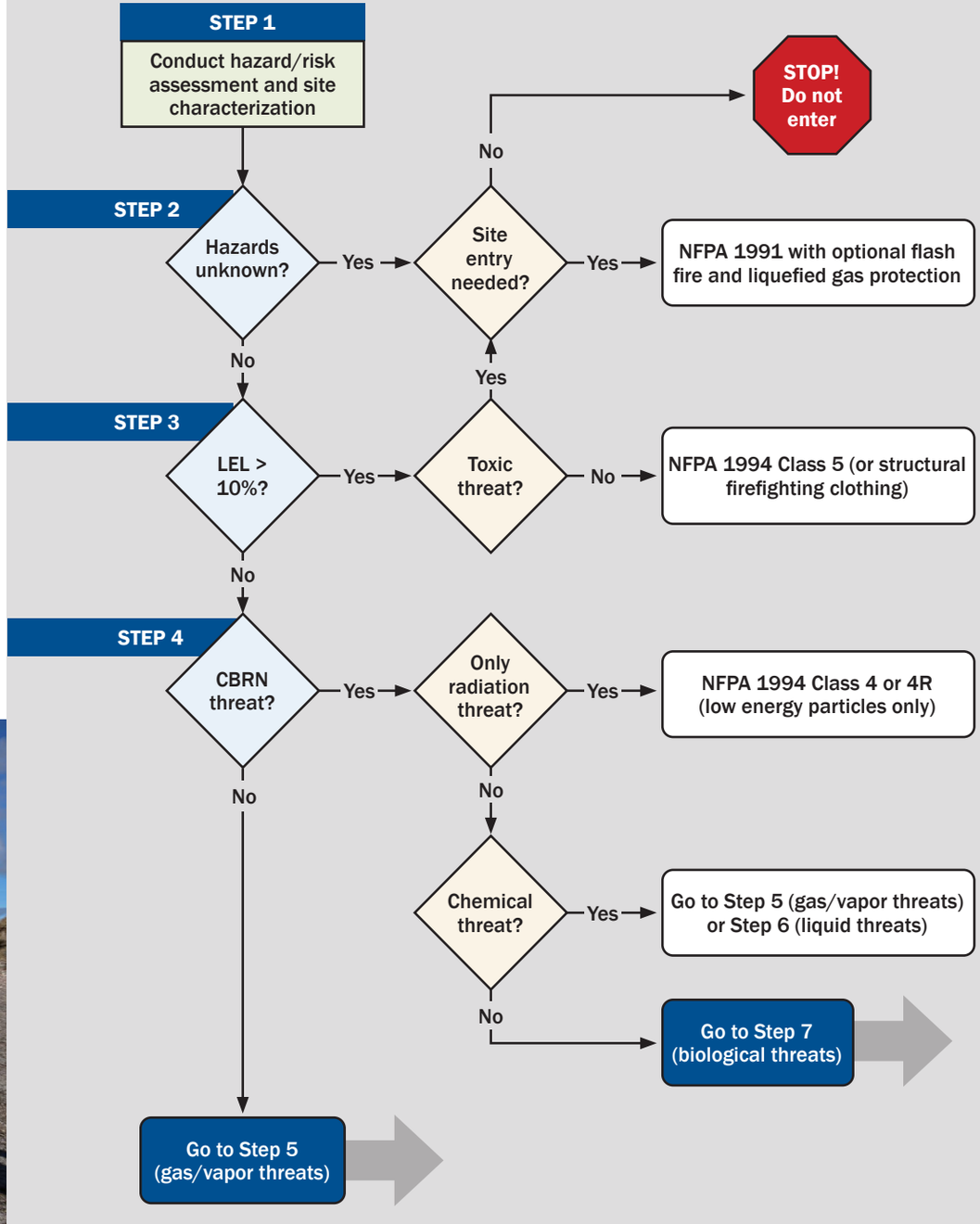
STEP 4: Determine CBRN Threats

If there is the potential for exposure to a CBRN agent, then a series of determinations are needed to present the correct path for choosing appropriate PPE.

The first determination as part of this decision process is to identify whether the agent is chemical, biological, or radiological/nuclear.

1. If the agent is radiological/nuclear in nature and limited to contaminated particles that are of relatively low radiation levels, then choose an NFPA 1994 Class 4 or Class 4R ensemble.
2. If the agent is chemical, then follow Step 5 or Step 6 to make decisions for vapor/gas or liquid threats.
3. If the agent is biological, then follow Step 7 to make decisions for biological threats.

Photo credit: Nevada National Security Sites



Appendix B: Suggested Steps for Selecting Correct Ensemble

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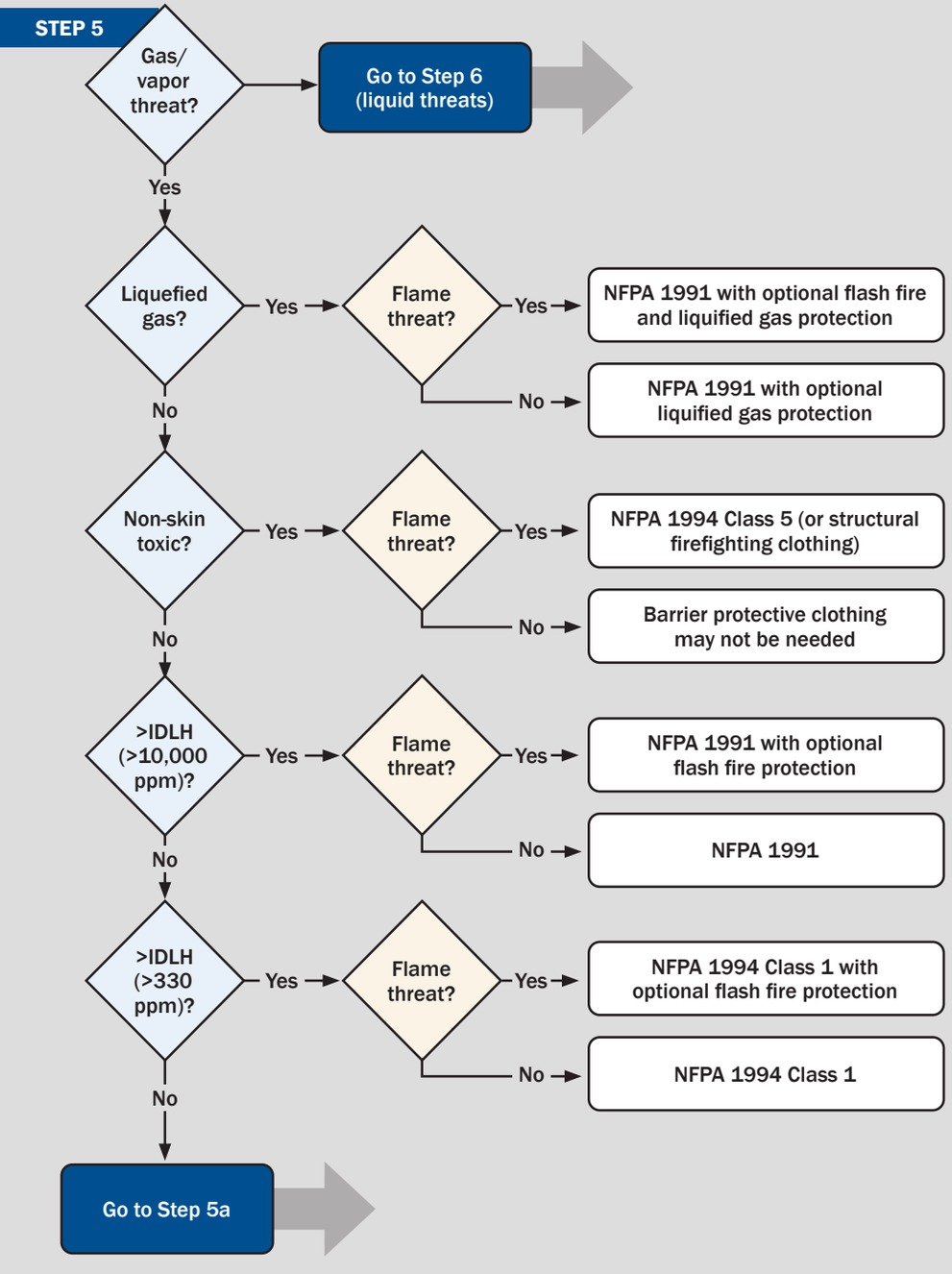
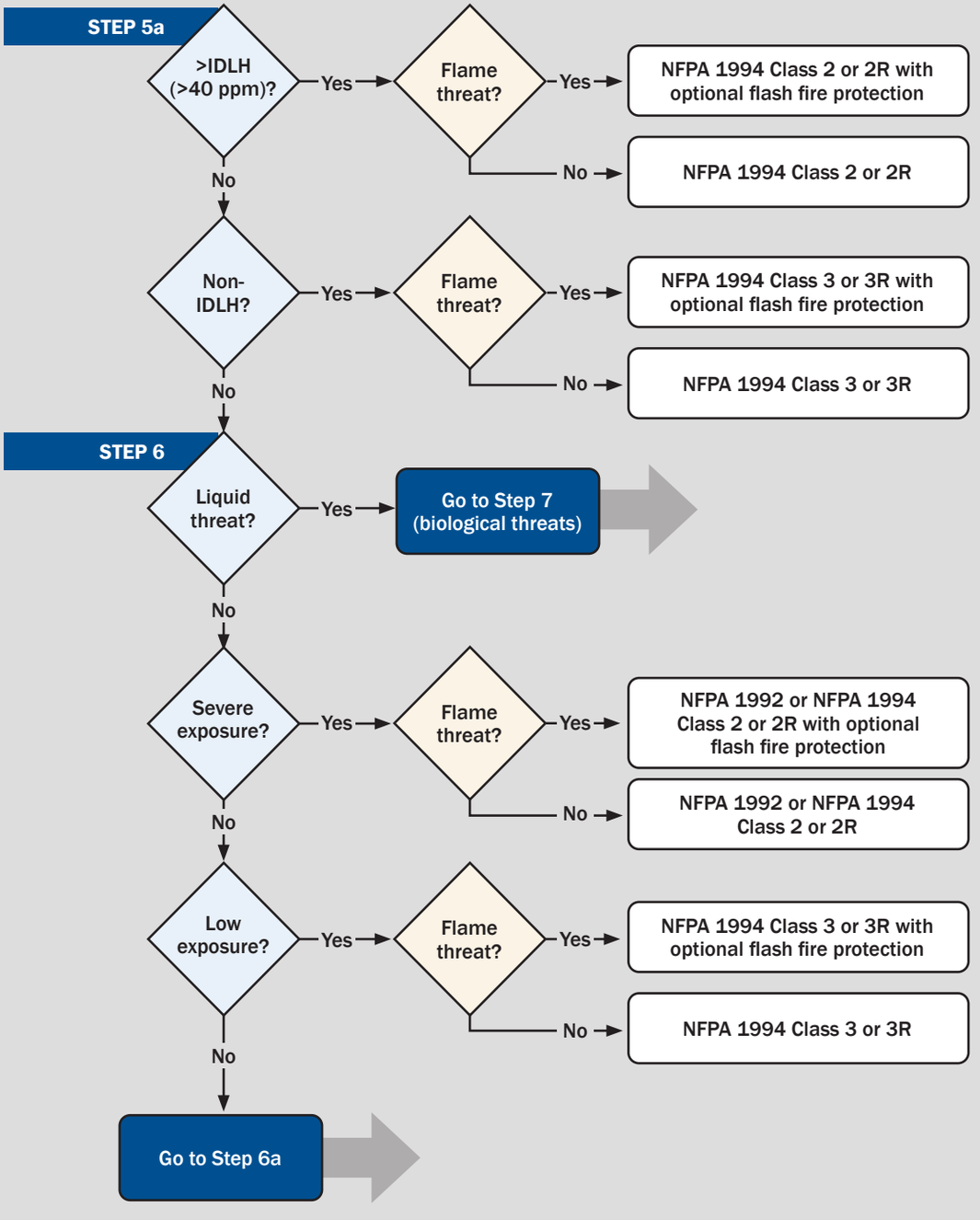
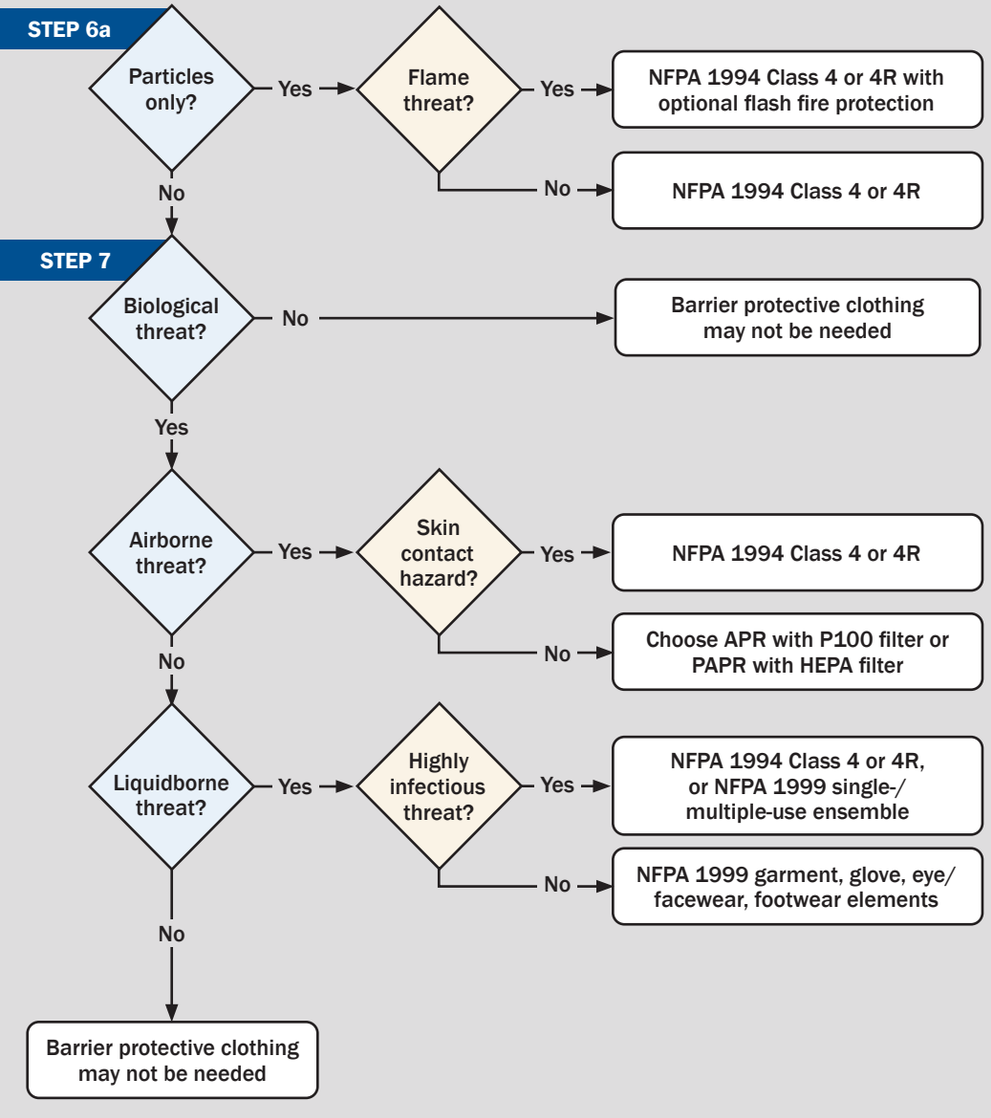




Appendix B: Suggested Steps for Selecting Correct Ensemble
(continued)



STEP 5: Determine Gas/Vapor Chemical Threats

If the hazard/risk assessment identifies chemical agents or substances where exposure can occur either as a gas or a vapor, then the decision logic takes one of four paths, depending on the chemical gas or vapor concentration:

1. The first path is for environments that present an immediately dangerous to life and health (IDLH) concentration or conditions that warrant the wearing of self-contained breathing apparatus (SCBA). IDLH conditions include environments that involve potentially flammable vapor, liquefied gases, and oxygen deficiencies. This path is based on gas/vapor concentrations that are over 10,000 ppm or 1 percent.
2. The second path is also IDLH but exists for substances at lower concentrations (gas/vapor concentrations that are over 350 ppm but equal to or below 10,000 ppm).
3. The third path is also IDLH but exists for substances at even lower concentrations (gas/vapor concentrations that are over 40 ppm but equal to or below 350 ppm).
4. The fourth path is for environments that are not determined to be IDLH and where either air-purifying respirators (APR) or powered air purifying respirators (PAPR) are considered acceptable. For this path, gas/vapor concentrations are at 40 ppm or below.
5. *IDLH, Higher Concentrations.* The following choices are made along the IDLH pathway.
   a. If the substance is a liquefied gas and is flammable, then choose an NFPA 1991 ensemble with the optional liquefied gas protection and flash fire protection.
   b. If the substance is a liquefied gas but is not flammable, then choose an NFPA 1991 ensemble with the optional liquefied gas protection.
   c. If toxic threats do not exist and there is no threat of explosion, wear an NFPA 1994 Class 5 ensemble (or other appropriate flame resistant clothing compliant to either NFPA 1971 or NFPA 2112).
   d. If the substance is flammable vapor at a concentration over 10,000 ppm or 1 percent, then choose an NFPA 1991 ensemble that also meets the optional flash fire protection requirements.
   e. If the substance is vapor at a concentration over 10,000 ppm or 1 percent that is not flammable, then choose an NFPA 1991 ensemble.
   f. If the substance is flammable vapor at a concentration over 350 ppm but at or less than 10,000 ppm or 1 percent, then choose either an NFPA 1994 Class 1 ensemble that also meets the optional flash fire protection requirements.
   g. If the substance is vapor at a concentration over 350 ppm but at or less than 10,000 ppm or 1 percent that is not flammable, then choose an NFPA 1994 Class 1 ensemble.

6. *IDLH, Lower Concentrations.* Some circumstances exist where the principal threat is a gas or vapor but the concentration is deemed relatively low. In these cases, apply the following choices:
   a. If the substance is flammable vapor at a concentration over 40 ppm but at or less than 350 ppm, then choose an NFPA 1994 Class 2 or Class 2R ensemble that also meets the optional flash fire protection.
   b. If the substance is vapor at a concentration over 40 ppm but at or less than 350 ppm that is not flammable, then choose an NFPA 1994 Class 2 ensemble.
   c. If heavy work is expected or the ensemble might be reused, then choose an NFPA 1994 Class 2R "ruggedized" ensemble.
7. *Non-IDLH.* Where relatively low vapor and/or liquid exposures are expected, such as might occur during decontamination, then a lower level of protective ensemble can be used. Where it is acceptable to wear either APR or PAPR, apply the following choices:
   a. If the substance is below IDLH conditions and flame hazard exists, then choose an NFPA 1994 Class 3 or Class 3R ensemble that also meets the optional flash fire protection.
   b. If the substance is below IDLH conditions and there is no flame hazard, then choose an NFPA 1994 Class 3 or Class 3R ensemble.
   c. If the above conditions exist and heavy work is expected or the ensemble might be reused, then choose an NFPA 1994 Class 3R "ruggedized" ensemble.

STEP 6: Determine Liquid/Particulate Chemical Threats

Some assessments will show that gas or vapor hazards do not exist, and the principal hazards are from either liquid or particulate exposure. Liquid exposures might be at various levels depending on the volume, frequency, applied pressure, and length of liquid contact. Severe liquid splash or exposure conditions include high volumes of liquid, frequent splashes, liquid spraying under pressure, or an expected extended exposure to liquid. In contrast, liquid exposure might involve relatively low volumes or, less likely, infrequent contact. In these situations, apply the following choices:

1. If severe liquid splash or repeated/extended exposure liquid hazards exist, then choose an NFPA 1992 or NFPA 1994 Class 2 or Class 2R ensemble.
2. If low volume or infrequent liquid exposure hazards exist, then choose an NFPA 1994 Class 3 or Class 3R "ruggedized" ensemble.
3. If exposure is only expected from solid particles, then choose an NFPA 1994 Class 4 or Class 4R ensemble.
4. If the above conditions exist and heavy work is expected or the ensemble might be reused, then choose Type R "ruggedized" ensembles.

STEP 7: Determine Biological Threats

Biological threats might include bloodborne pathogens in the form of infected blood, body fluids, or other liquids; types of aerosols; or contaminated solid particles or spores. Where biological-only hazards are encountered, apply the following choices:

1. If the primary hazard is from airborne or aerosolized biological substances that are considered dangerous for skin contact, then choose an NFPA 1994 Class 4 or Class 4R ensemble.
2. If the primary hazard is from airborne or aerosolized biological substances that are not transmissible through skin contact, then choose an appropriate respirator such as an air-purifying respirator (APR) with filters, a PAPR-100, or a PAPR with HEPA filter.
3. If the primary hazard is from highly hazardous liquidborne biological substances, then choose either an NFPA 1994 Class 4 or Class 4R or a single-use or multiple-use NFPA 1999 ensemble.
4. If the primary hazard is from potentially infectious blood or body fluids, then choose protective NFPA 1999 garments, gloves, footwear, and face/eyewear to protect the portions of the wearer's body where exposure is expected.
5. If the above conditions exist and heavy work is expected or the ensemble might be reused, then choose NFPA 1994 Type R "ruggedized" or NFPA 1999 multiple-use ensembles.

Other Considerations for PPE Selection

The results of the branched decision making are one or more ensembles certified to a given NFPA standard or class in that standard. In many cases, the response organization might not have all types of ensembles available. When this occurs, a higher-performing ensemble can be selected. The table below provides a hierarchy for each of the major categories of protection.

Major Categories of Protection

Level	Chemical Vapors	Chemical Liquids	Biological Liquids	Biological Aerosols	Radiological Particles
Highest	NFPA 1991	NFPA 1991	NFPA 1991	NFPA 1991	NFPA 1991
↑	NFPA 1994 C1	NFPA 1994 C1	NFPA 1994 C1	NFPA 1994 C1	NFPA 1994 C1
↑	NFPA 1994 C2	NFPA 1994 C2	NFPA 1994 C2	NFPA 1994 C2	NFPA 1994 C2
↑	NFPA 1994 C3	NFPA 1992	NFPA 1992	NFPA 1992	NFPA 1992
↑		NFPA 1994 C3	NFPA 1999 MU	NFPA 1999 MU	NFPA 1999 MU
↑			NFPA 1994 C3	NFPA 1994 C3	NFPA 1994 C3
Lowest			NFPA 1999 SU	NFPA 1994 C4	NFPA 1994 C4

Use of Other Chemical Resistance Data

Applying chemical resistance data for ensemble materials can be an additional factor for selecting an appropriate protective ensemble. NFPA ensembles are tested to a limited number of chemicals. Responses likely will involve chemical(s) that have not been tested. However, most manufacturer data for other chemicals general does not involve testing all elements, i.e., seams, gloves, footwear, and generally is not conducted under NFPA specified test conditions. It is therefore important to use care in applying these "other" data.

Other factors to consider include:

1. *Stealth* — Law enforcement and some DOD missions require responders not to be conspicuous. NFPA 1994 includes optional criteria that address ensemble color and the "acoustical signature" (relative noise generation) of the ensemble.
2. *Equipment compatibility* — Ensemble selection should account for all the items the responder or operator wears, such as cooling vests, body armor, helmets, and communications systems. The ability for individuals to carry out tasks with these additional items should be assessed. Sizing and the ability to fit the individual is equally important as some products may be offered in limited sizes.
3. *Differences in design and conformity levels* — While all products meet the "minimum" requirements of the respective standard, in some cases, it is desirable to select ensembles that exceed certain criteria. Examples can include increased strength and durability, and higher levels of breathability for certain suits.

Photo credit: Avon Protection

List of Acronyms

ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
APF	Assigned Protection Factor
CBRN	Chemical, Biological, Radiological, and Nuclear
CFR	U.S. Code of Federal Regulations
CWA	Chemical Warfare Agent
DHS	U.S. Department of Homeland Security
EBSS	Emergency Breathing Safety System
EMS	Emergency Medical Service
EOSTI	End Of Service Time Indicator
EPA	U. S. Environmental Protection Agency
EVD	Ebola Viral Disease
FFR	Filtering Facepiece Respirator
GB	Sarin (chemical warfare agent)
GD	Soman (chemical warfare agent)
Hazmat	Hazardous Material Response and Operations
HEPA	High Efficiency Particulate Air
HD	Distilled Sulfur Mustard (chemical warfare agent)
HUD	Heads Up Display
IDLH	Immediately Dangerous to Life and Health
ISO	International Standards Organization
IWTSD	Irregular Warfare Technical Support Directorate
LEL	Lower Explosive Limit
MSHA	Mine Safety Health Administration
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PAPR	Powered Air-Purifying Respirator
PPE	Personal Protective Equipment
PPM	Parts Per Million
RIC UAC	Rapid Intervention Crew Universal Air Coupler
SAR	Supplied Air Respirator
SCBA	Self-Contained Breathing Apparatus
SEI	Safety Equipment Institute
STP	[NIOSH] Standard Test Procedure
TIC	Toxic Industrial Chemical
UL	Underwriters Laboratories

DISCLAIMER

The information provided in this guide is intended to serve as a general reference and tool to support decision-making regarding personal protective equipment (PPE) selection, use, and maintenance. It should be used in conjunction with prior training, experience, and organizational protocols. While every effort has been made to ensure the accuracy and relevance of the content, the list, tables, descriptions, and pictures within this booklet are not exhaustive. This guide is meant to assist in decision-making but is not intended to replace formal training or certifications required for handling hazardous materials, CBRN environments, or emergency response. It is not intended to be used as a sole resource for making decisions regarding PPE. The Irregular Warfare Technical Support Directorate (IWTSD) and the author do not assume liability for actions or decisions made based on the information contained in this booklet. All decisions regarding PPE procurement, use, and maintenance are the responsibility of individual organizations, which must assess and assume any associated risks. Users are encouraged to consult with subject matter experts, review applicable standards, and ensure that all PPE selections comply with relevant NFPA, OSHA, and other applicable regulatory guidelines. Always follow your organization's safety protocols and ensure that PPE meets the specific needs of the operational environment.

AM I PROTECTED?

What You Need to Know About
Hazardous Materials and CBRN
Personal Protective Equipment Standards
and Certified Products

www.iwtsd.gov

Chemical, Biological, Radiological, Nuclear, and Explosives Subgroup

Focus Area

Support efforts to protect operators and their interests from attack with CBRN materials or coercion by the threat of its use. Enhance capabilities to respond, decontaminate, and persevere in a CBRN environment.