

**NFPA 1994-2018 Edition**

**Standard on Protective Ensembles for First Responders to Hazardous Materials Emergencies and CBRN Terrorism Incidents**

**TIA Log No.: 1371**

**Reference:** Various

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[www.nfpa.org/1994](http://www.nfpa.org/1994)

1. Add an entry to paragraph 2.3.4 ASTM Publications as follows:  
ASTM F903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 2010.
2. Revise 5.3.2 to read as follows:  
**5.3.2\*** The technical data package shall contain all documentation required by this standard and the values obtained from the initial certification showing compliance with the requirements of Chapter 7 in the current edition of this standard, using the reporting formats provided in Table 5.3.2(a), ~~and~~ Table 5.3.2(b), and Table 5.3.2(c) for each ensemble, element, material, or component, as applicable.
3. Revise Table 5.3.2(a) to reflect addition of Chemical penetration testing and add a new Table 5.3.2(c) to capture the reporting of this data.

**Table 5.3.2(a)**

<b>Ensemble or Element</b>	<b>Performance Requirement</b>	<b>Test Method</b>	<b>Requirement</b>	<b>Result</b>
...				
<b><i>Class 1 Garment Elements</i></b>				
...				
<u>Materials and seams</u>	<u>Chemical penetration resistance</u>	<u>Section 8.33</u>		<u>See Table 5.3.2(c)</u>
...				
<b><i>Class 1 Garment Visors</i></b>				
...				
<u>Materials and seams</u>	<u>Chemical penetration resistance</u>	<u>Section 8.33</u>		<u>See Table 5.3.2(c)</u>
...				
<b><i>Elastomeric Interface Materials</i></b>				
...				
	<u>Chemical penetration resistance</u>	<u>Section 8.33</u>		<u>See Table 5.3.2(c)</u>
...				
<b><i>Class 1 Glove Elements</i></b>				
...				
	<u>Chemical penetration resistance</u>	<u>Section 8.33</u>		<u>See Table 5.3.2(c)</u>
...				
<b><i>Class 1 Footwear Elements</i></b>				
...				
	<u>Chemical penetration resistance</u>	<u>Section 8.33</u>		<u>See Table 5.3.2(c)</u>
...				

**Table 5.3.2(c) Format for Reporting Certification Penetration Test Data in Technical Data Package**

<u>Chemical (concentration)</u>	<u>Minimum Requirement*</u>	<u>Garment Material</u>	<u>Garment Seams</u>	<u>Visor Material</u>	<u>Visor Seams</u>	<u>Interface Material</u>	<u>Glove Material</u>	<u>Footwear Upper Material</u>	<u>Hood Material</u>
<u>Sulfuric acid, CAS 7664-93-9, 93.1 %</u>	Pass								

\*A pass result indicates no liquid penetration through the tested specimens after a 1-hour exposure with 1 minute of the exposure at 7.8 kPa hydrostatic pressure.

4. Add new paragraphs to provide new criteria for liquid penetration resistance criteria of ensemble element materials and seams against sulfuric acid to read as follows:

7.1.2.1.1 Class 1 garment materials and seams shall be tested for penetration resistance as specified in Section 8.33, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour.

...

7.1.2.8.1.1 Class 1 garment visor materials and seams shall be tested for penetration resistance as specified in Section 8.33, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour.

...

7.1.2.9.1.1 Where the Class 1 garment includes elastomeric interface materials, each elastomeric interface material shall be tested for penetration resistance as specified in Section 8.33, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour.

...

7.1.3.2.1 Class 1 glove materials and seams shall be tested for penetration resistance as specified in Section 8.33, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour.

...

7.1.4.2.1 Class 1 footwear upper materials and seams shall be tested for penetration resistance as specified in Section 8.33, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour.

5. Revise 8.7.6.1 to read as follows:

**8.7.6.1\*** The following challenge chemicals shall be tested as liquids at a concentration of 95 percent or greater, except where otherwise specified:

(1) Liquid chemical warfare agents for Class 1, Class 2, Class 2R, Class 3, and Class 3R ensemble element materials and seams

(a) Sulfur mustard, distilled [HD, or bis(2-chloroethyl) sulfide, CAS 505-60-2]

(b) Soman (GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-94-0)

(2) Liquid toxic industrial chemicals for Class 1 ensemble elements materials and seams

(a) Dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1)

~~(b) Sulfuric acid, 93.1 percent, specific gravity 1.84, 66° Baumé (CA 7664-93-9)~~

~~(c) Tetrachloroethylene (perchloroethylene, CAS 127-18-4)~~

~~(d) Toluene (toluol, CAS 108-88-3)~~

(3) Liquid toxic industrial chemical for Class 2, Class 2R, Class 3, and Class 3R ensemble elements materials and seams

(a) Dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1)

6. In Table A.8.7.4.4, delete the row with Sulfuric acid as shown legislatively:

**Table A.8.7.4.4 Suggested Collection Media/Sorbents, Detection Techniques, and Analytical Methods by Test Chemical**

<u>Chemical</u>	<u>Examples of Collection/Media Sorbent Bed*</u>	<u>Detection Techniques*</u>	<u>EPA Method</u>	<u>NIOSH Method</u>	<u>OSHA Method</u>
...					
Sulfuric acid	Silica gel, D1 H <sub>2</sub> O	IC pH, conductivity	8	7903/7908	ID-165SG
...					

7. *Revise the section on Final Challenge Battery in A.8.7.6.1 to read as follows:*

**A.8.7.6.1** The selection of the test chemicals takes into account several factors that are described in the sections below.

**Definition of Ideal Chemical Challenge Battery.**

...

**Final Challenge Battery.**

The final challenge battery consisted of 10 toxic industrial chemicals and 2 chemical warfare agents as described in the Table A.8.7.6.1(b). The final list incorporates a wide range of chemical reactivity, solubility and structure-property relationships. Due to limitations in the ability to collect sulfuric acid in vapor phase, liquid penetration resistance testing is used for sulfuric acid in lieu of permeation testing.

8. *Revise the titles of Tables A.8.7.6.1(a) and (b) to read as follows:*

**Table A.8.7.6.1(a) Basis for Selection of NFPA 1994 Chemicals for Permeation and Liquid Penetration Resistance Testing**

**Table A.8.7.6.1(b) Final 10-Chemical Battery for NFPA 1994 Class 1 Permeation and Liquid Penetration Resistance Testing**

9. *Add a new section 8.33 to read as follows:*

**8.33 Chemical Penetration Resistance Test.**

**8.33.1 Application.**

**8.33.1.1** This method shall apply to the CBRN barrier layer and the CBRN barrier layer's seams used in ensembles and ensemble elements for CBRN terrorism agent protection.

**8.33.1.2** Specific requirements for testing the CBRN barrier layer of garments, hoods, elastomeric interface material, and socks shall be as specified in 8.33.7.

**8.33.1.3** Specific requirements for testing the CBRN barrier layer of visors shall be as specified in 8.33.8.

**8.33.1.4** Specific requirements for testing the CBRN barrier layer of gloves shall be as specified in 8.33.9.

**8.33.1.5** Specific requirements for testing the CBRN barrier layer of footwear shall be as specified in 8.3.10.

**8.33.1.6** Specific requirements for testing the CBRN barrier layer's seams of garments, hoods, socks, visors, and gloves shall be as specified in 8.3.11.

**8.33.1.7** Specific requirements for testing elastomeric interface materials shall be specified in 8.33.12.

**8.33.2 Samples.**

**8.33.2.1** Samples for conditioning shall be as specified according to the specific requirements in 8.33.7, 8.33.8, 8.33.9, 8.33.10, 8.33.11, and 8.33.12, as appropriate.

**8.33.2.2** Samples shall be conditioned as specified according to the specific requirements in 8.33.7, 8.33.8, 8.33.9, 8.33.10, 8.33.11, and 8.33.12, as appropriate.

**8.33.2.3** Samples shall then be cut to the specimen size.

**8.33.2.4** All layers of the samples during conditioning shall be present and configured in the order and orientation as worn.

**8.33.3 Specimens.**

**8.33.3.1** Specimens shall be the CBRN barrier layer or the CBRN barrier layer's seam of the size required to fit the penetration test cell.

**8.33.3.2** At least three specimens shall be tested against each challenge chemical.

**8.33.3.3** Any outer shell or other composite layers normally worn over the specimen shall be permitted to be included on top of the specimen in the test. The outer shell or other composite layers shall be placed on the test specimen through the cell cap port after the test cell has been assembled.

**8.33.3.4** If the specimen is the outermost layer of the composite, then it shall be tested without any additional layers on top.

8.33.3.5 Any separable layers normally worn underneath the specimen shall not be permitted to be included in the test.

8.33.3.6 Specimens with nonuniform surfaces shall be permitted to be treated with an impermeable nonreactive sealant outside the area of the specimen exposed to the challenge chemical, in order to allow sealing of the test cell to a uniform surface of the specimen.

**8.33.4 Procedure.**

8.33.4.1 Penetration testing shall be conducted against liquid sulfuric acid, 93.1 percent, chemical abstract service (CAS) number CAS 7664-93-9, at specific gravity 1.84, 66° Baumé.

8.33.4.2 Penetration resistance shall be measured in accordance with ASTM F903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, Procedure C, using the following modifications:

- (1) All tests shall be conducted at 25°C ±3°C (77°F ±5°F) and 65 percent ±5 percent relative humidity.
- (2) The plexiglass shield shall be omitted from the test cell.
- (3) Use of blotting paper at the end of the test shall be permitted to assist in the visual observation of liquid penetration. Visually observed chemical on the blotting paper shall constitute failure of this test.
- (4) An observation to determine specimen penetration shall be made at the end of the 60-minute chemical contact period.

8.33.5 Report. The pass or fail results for each chemical tested and identification of location where penetration occurs, if discernible, shall be recorded and reported.

8.33.6 Interpretation. Observed liquid penetration at the end of the test for any specimen shall constitute failure.

**8.33.7 Specific Requirements for the CBRN Barrier Layer of Garments, Hoods, and Socks.**

8.33.7.1 Samples shall be conditioned by flexing as specified in 8.1.3 and shall be 200 mm × 280 mm (8 in. × 11 in.). Following flexing, one specimen shall be taken from the center of each sample subjected to flexing for penetration resistance testing.

8.33.7.2 Samples shall be conditioned by abrading as specified in 8.1.4 and shall be configured as specified in Figure 8.1.4. Following abrading, one specimen shall be taken from the center of each sample subjected to abrading for penetration resistance testing.

8.33.7.3 Preconditioning one sample to both flexing and abrading shall be permitted prior to penetration resistance testing.

**8.33.8 Specific Requirements for Testing the CBRN Barrier Layer of Visors.**

8.33.8.1 Samples for conditioning shall be visor materials.

**8.33.9 Specific Requirements for Testing the CBRN Barrier Layer of Gloves.**

8.33.9.1 Samples for conditioning shall be whole gloves.

**8.33.10 Specific Requirements for Testing the CBRN Barrier Layer of Footwear.**

8.33.10.1 This test shall apply to all types of footwear configurations.

8.33.10.2 Where the footwear incorporates a sock or overboot constructed of garment material, the garment material flex fatigue resistance test as specified in 8.1.3 shall be permitted to be substituted for this test.

8.33.10.3 Upper samples for conditioning shall be whole footwear items.

8.33.10.4 Footwear upper samples shall be conditioned by abrading as specified in 8.1.4.

8.33.10.5 Following abrasion, only one test specimen for chemical penetration resistance testing shall be taken from each sample subjected to abrasion.

8.33.10.6 The chemical penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test specimen and the center of the abraded specimen coincide.

**8.33.11 Specific Requirements for Testing the CBRN Barrier Layer's Seams of Garments, Hoods, Socks, Visors, and Gloves.**

8.33.11.1 Samples for conditioning shall be 600 mm (23 1/2 in.) lengths of prepared seam or cut from ensembles.

8.33.11.2 Seam specimens shall be prepared from seam samples that have a minimum of 75 mm (3 in.) of material on each side of the seam center.

8.33.11.3 Penetration test specimens shall be cut such that the exact seam center divides the specimen in half.

8.33.11.4 Seam specimens shall be prepared representing each type of seam found in the garment, or shall be taken from each type of seam found in the garment, including as a minimum the garment-to-garment material seams and the garment-to-visor material seams.

8.33.11.5 Seam specimens shall be taken from the gauntlet portion of the glove where an external seam is used in the construction of the glove.

**8.33.12 Specific Requirements for Testing Elastomeric Interface Materials.**

8.33.12.1 Samples shall not be subjected to conditioning by flexing or abrasion.

8.33.12.2 Specimens shall be taken from elastomeric interface sheet material or formed elastomeric interface items that are representative of the elastomeric interface material nominal thickness.

**Substantiation:** Sulfuric acid was added as a new chemical as part of the Class 1 battery for chemical permeation testing. However, the current chemical permeation resistance procedures specified in the standard do not permit the analysis of a relatively nonvolatile chemical with air collection at the specified air flow. While other chemicals could be substituted, the proposal for removing sulfuric acid addresses the problem of performing a test where the chemical cannot be efficiently collected in air. Instead, liquid penetration resistance testing is recommended where the ensemble element materials and seams are evaluated against full strength sulfuric acid with the observation of liquid penetration through the fabric. This represents a more likely mechanism of how sulfuric acid would be presented as a hazard to the wearer of a protective ensemble. The same procedures for liquid penetration resistance as now specified in NFPA 992 have been adapted as part of the proposed changes. Additional changes are needed to remove sulfuric acid where it appears in other portions of the standard, particularly within Appendix A.

**Emergency Nature:** The NFPA Standard contains an error or an omission that was overlooked during the regular revision process.

In specifying new chemicals as part of the Class 1 ensemble element chemical permeation testing requirements, the Technical Committee overlooked how sulfuric acid would be collected due to its relative low volatility. The inclusion of sulfuric acid as a permeation test chemicals using the current permeation test procedures represents an error in the standard.

*Anyone may submit a comment by the closing date indicated above. Please identify the TIA number forward to the Secretary, Standards Council. [SUBMIT A COMMENT](#)*