



National Fire Protection Association

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MEMORANDUM

TO: NFPA Technical Committee on Special Operations Protective Clothing and Equipment

FROM: Stacey Van Zandt

DATE: April 8, 2011

SUBJECT: NFPA1951 ROC TC Letter Ballot (F2011)

The ROC letter ballot for NFPA 1951 is attached. The ballot is for formally voting on whether or not you concur with the committee's actions on the comments. Reasons must accompany all negative and abstention ballots.

Please do not vote negatively because of editorial errors. However, please bring such errors to my attention for action.

Please complete and return your ballot as soon as possible but no later than **Tuesday, April 26, 2011**. As noted on the ballot form, please return the ballot to Stacey Van Zandt either via e-mail to svanzandt@nfpa.org or via fax to 617-984-7056. You may also mail your ballot to the attention of Stacey Van Zandt at NFPA, 1 Batterymarch Park, Quincy, MA 02169.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachments: Comments
Letter Ballot

1951-1 Log #39 FAE-SCE
(Entire Document)

Final Action: Accept in Principle

Submitter: Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment,
Comment on Proposal No: 1951-1

Recommendation: The TCC advises the Technical Committee on Special Operations Protective Clothing and Equipment that a TCC task group has been formed to provide recommendations for the MIST permeation and the development of an inward leakage test. The objective is to harmonize MIST and permeation resistance test methods and to consider the inclusion of a total inward leakage test for current project standards that address CBRN protection.

The TCC instructs the Technical Committee on Special Operations Protective Clothing and Equipment to consider information provided by the task group for CBRN Test Methods pertaining to the criteria in Section 7.3.1.1 in NFPA 1951, and the test method in Section 8.4.4 in NFPA 1951 as follows:

- a) Provide detailed specifications for the PADs that meet test requirements for the uptake rate as set in the standard. These specifications should go beyond the current edition of ASTM F2588, which have not been validated to meet the uptake rate of 3.5 cm/min, ± 1.0 cm/min. ASTM is considering similar changes to the uptake rate specifications.
- b) Establish specific methodology for the determination of uptake rate.
- c) Provide a method for a pre-assessment of the exposure concentration in the chamber as determined by the measured uptake rate of the PADs.
- d) Remove the conflict in the test method for the exposure of the exterior PADs (15 minutes as indicated in the apparatus section versus 30 minutes in the procedure section)
- e) Provide more detailed specifications for the placement of PADs for measurement of chamber concentrations and for the placement of PAD on individual test subjects.
- f) Determine an approach to consistently set the inside Ct value for the determination of local protection factors.
- g) Establish limits for the time of analysis of exposed PADs.
- h) Investigate the accuracy and appropriateness of the body region hazard analysis as applied in the determination of systemic physiological protective dosage factor.
- i) Consider using the average systemic physiological protective dosage factor to determine pass fail performance for specific ensembles.

The TCC instructs the Technical Committee on Special Operations Protective Clothing and Equipment to consider information provided by the task group for CBRN Test Methods to update the permeation resistance test method in Section 8.4.5 in NFPA 1951 consistent with the latest research and laboratory test practices by undertaking the following actions:

- a) Remove the reference to ASTM F 739
- b) Base revised test procedures on recommendations provided in Technical Support Working Group (TSWG) report, Risk-Based Protective Clothing Material Permeation Criteria, dated March 31, 2010, in the following table.

*****Insert 1951_LCP1_Tb_TCC Note Here*****

The TCC instructs the Technical Committee on Special Operations Protective Clothing and Equipment to consider information provided by the task group for CBRN Test Methods related to the creation of criteria for determining the effect of the ensemble on the performance of the CBRN respirator by undertaking the following actions:

- a) Determine basis for applying a total inward leakage test to evaluate the ensemble-respirator interface.
- b) Investigate approaches for conducting inward leakage test that accommodates APR respirators.
- c) Investigate specific use of MIST evaluation test for monitoring inward leakage of MeS into facepiece during an abbreviated exercise protocol.

Substantiation: This is a direction from the Technical Correlating Committee on Technical Committee on Special Operations Protective Clothing and Equipment in accordance with 3.4.2 and 3.4.3 of the Regulations Governing Committee Projects.

Committee Meeting Action: Accept in Principle

Committee Statement: The technical committee accepted the comment in principle, and refers the reader to the following Logs:

For MIST, see Comment on 1951- 66 (Log #52)

For permeation, see Comment on 1951-29 (Log #42)

For whole ensemble inward leakage, the technical committee decided to hold this comment for further study.

1951-2 Log #4 FAE-SCE Final Action: Accept
(1.1.1)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-26

Recommendation: Move closing bracket after "technical rescue" to after "(CBRN)".

Substantiation: Editorial correction.

Committee Meeting Action: Accept

1951-3 Log #5 FAE-SCE Final Action: Accept
(1.1.4)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Change expression "technical rescue utility and technical rescue and recovery" to "utility technical rescue or rescue and recovery technical rescue".

Substantiation: Editorial correction of the names of these two kinds of protective ensembles, see 1.1.1.

Committee Meeting Action: Accept

1951-4 Log #3 FAE-SCE Final Action: Accept
(2.3.3)

Submitter: Marcelo M. Hirschler, GBH International

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

2.3.3 ASTM Publications

ASTM D 6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*, 2008 ~~1999~~.

No changes are proposed to any other standards.

Substantiation: This comment simply updates the date of an ASTM standard.

Committee Meeting Action: Accept

1951-5 Log #6 FAE-SCE Final Action: Accept
(3.3.38)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Add references to 3.3.13 and 3.3.123.

Substantiation: Editorial corrections to harmonize with format of 3.3.40 and 3.3.45 for example.

Committee Meeting Action: Accept

The technical committee notes that the same reference list that appears in 3.3.40 should also appear in 3.3.13 and 3.3.123.

**NFPA Technical Correlating Committee on
Fire and Emergency Service Protective Clothing and Equipment**

**NFPA 1951
Table for Log CP1**

Table of Recommended Changes to Permeation Resistance Test Method

| Test Parameter | Current Specification | Proposed Change |
|--|---|--|
| Referenced standards | ASTM F 739 | ASTM D 1777 for thickness measurement; ASTM D 3776 for unit area weight measurement |
| Test environment | None; however, testing to be performed at 32 ±1°C | All testing to be performed in separate test chamber that will be maintained at test conditions; specimens, chemicals, and test apparatus will be placed in chamber and required to be in place 24 hrs prior to testing |
| Test cell | Per ASTM F 739, alternative test cells permitted; no requirements for determining equivalency | Modified TOP 8-2-501 test cell with drawing specification for modified specimen plate to accommodate control of exposed surface area in saturated surface exposure tests; test cap to contain fitting for measuring integrity of test cell after specimen is mounted |
| Air flow requirements in collection side | Filtered air at rate of 1 ±0.1 Lpm at 80 ±5% RH | Balance air flow with challenge side for consistency and absence of pressure drop; measure temperature and relative humidity at test cell inlet; principal air flow system to be positioned inside environmental chamber |
| Specimen size | Varies with test cell | Standardized for TOP 8-2-501 test cell |
| Permeation specimen conditioning | 21 ±3°C and 65 ±5% RH (standard textile conditioning) | 32 ±1°C and 80 ±5% RH to be conducted inside test chamber; tolerance on temperature to be relaxed to ±2°C |
| Test cell sealing | None | Alternative gasketing material to be specified; O-rings and fittings must be assessed for compatibility with test chemical; Specific torque to be applied in sealing test cell |

| Test Parameter | Current Specification | Proposed Change |
|---|--|--|
| Test cell integrity check | None | Using fitting in test line cap, test cell to be pressurized with air to 2 psig with specimen in place with pressure drop measured after 1 minute (only 10% pressure drop permitted) |
| Liquid challenge conditions | Liquid applied at surface density of 10 g/m ² using appropriate number of 1- μ L droplets uniformly dispensed on material specimen surface | For each liquid chemical (including chemical warfare agents), nine (9) 1- μ L droplets will be applied in specific pattern on exposed specimen surface; time of 30 seconds will be required for opening test cell cap, dispensing droplets, and closing test cell cap. |
| Air flow on challenge side for open top test cell configuration | Filtered air at rate of 0.3 \pm 0.03 Lpm at 80 \pm 5% RH | Filtered air at rate of 0.3 \pm 0.03 Lpm at 80 \pm 5% RH, temperature conditioning with environmental chamber |
| Volatile liquid toxic industrial chemical challenge | None | Chemicals with vapor pressures of 5 mm Hg or greater at 25°C will be tested as vapors at the corresponding gas concentration in the respective standard |
| Collection technique | Combination of analytical technique and collection medium shall be selected to maximize sensitivity for the detection of the test chemical and represent actual occupational conditions as closely as possible | Test system collection efficiency evaluated using procedure to determine total test chemical collected; evaluation must be performed for each test chemical and verified periodically by laboratory |
| Analytical sensitivity | Test system must have detection limit that is one order of magnitude lower than prescribed permeation end point | Specification to be based on each individual chemical; good laboratory practice standards will be referenced for correct analytical procedures |
| Results reported | Breakthrough time Permeation rate (optional) Test parameters as part of report | Cumulative permeation Test parameters as part of report |
| Interpretation of results | Average of all results | Average of all results; however, if one or two test cells show no cumulative permeation, the standard-defined minimum detection limit will be used for no detectable permeation test results for purposes of averaging results |

1951-6 Log #7 FAE-SCE
(3.3.72)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
Comment on Proposal No: 1951-1
Recommendation: Change "incidents" to "ensembles or".
Substantiation: Editorial correction.
Committee Meeting Action: **Accept**

1951-7 Log #8 FAE-SCE
(3.3.91, 3.3.92, 3.3.93, 3.3.94, and 3.3.95)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
Comment on Proposal No: 1951-1
Recommendation: Change "The element of the certified" to "The certified element of the".
Substantiation: For rescue and recovery technical rescue protective ensembles there are no provisions for certifying the ensemble, only for certifying elements.
Committee Meeting Action: **Accept**

1951-8 Log #9 FAE-SCE
(3.3.123, 3.3.124, 3.3.125, 3.3.126, and 3.3.127)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
Comment on Proposal No: 1951-1
Recommendation: Change "The element of the certified" to "The certified element of the".
Substantiation: For utility technical rescue protective ensembles there are no provisions for certifying the ensemble, only for certifying elements.
Committee Meeting Action: **Accept**

1951-9 Log #45 FAE-SCE
(5.1.7)

Final Action: Accept in Principle

Submitter: Karen E. Lehtonen, LION

Comment on Proposal No: 1951-8

Recommendation: Revise text to read as follows:

5.1.7 The following information shall also be printed legibly on the product label, and all letters shall be at least 1.6 mm (1/16 in) high:

- (1) Manufacturer's name, identification, or designation
- (2) Manufacturer's address
- (3) Country of manufacture
- (4) Manufacturer's garment element identification number, lot number, or serial number
- (5) Month and year of manufacture (not coded)
- (6) Model name, number, or design
- (7) Size or size range
- (8)* Principle material(s) ~~Materials~~ of construction.

For gloves, at least the outer shell, moisture barrier, thermal liner, and wristlet shall be listed. Generic names of materials shall be used. The type of leather shall be listed. Additional materials that are used throughout the majority of the glove body shall also be listed on the label.

For footwear, at least the outer shell, moisture barrier and thermal liner shall be listed. General names of materials shall be used. Additional materials that are used throughout the majority of the boot shall also be listed on the boot label.

For garments, at least the identification of the fiber or material type of the outer shell and moisture barrier shall be listed.

For helmets, at least the general terminology for the shell material shall be used.

- (9) Cleaning precautions if applicable

5.1.8 For garments only, where the outer shell and moisture barrier are separable, each separable layer shall also have a label containing the information required in Section 5.1.7(4), (5), (6), (7) and (8).

5.1.9 Where the principle material of construction used in a garment is a component that is listed, the component name under which it is listed shall be used.

A.5.1.7(8)* For glove labels, examples of the type of leather that may be listed are cow leather, elk leather, etc. Any additional thermal liner that is used in the entire back of the glove shall be listed on the label. Elastic and similar materials should not be listed. Trade names may be added if desired.

For footwear labels, examples of an additional thermal layer that is used in the majority of the boot should be listed on the label. Zippers, eyelets, and similar should not be listed. Type of leather does not have to be listed. Trade names may be added if desired.

For helmet labels, examples of general terminology for shell material are as follows: thermoplastic, thermoplastic/leather, fiberglass composite, Kevlar composite, fiberglass composite/leather, etc.

Substantiation: The comment is submitted to clarify the intent of what should be included on the product label. These changes are being made in other ensemble standards as well and I believe they should be made in this document for consistency across the project.

This is not original material; its reference/source is as follows:

Some proposed language is taken from the task group work on NFPA 1971.

Committee Meeting Action: Accept in Principle

Revise the text in the preprint document to read as follows:

5.1.7 The following information shall also be printed legibly on the product label, and all letters shall be at least 1.6 mm (1/16 in) high:

- (1) Manufacturer's name, identification, or designation
- (2) Manufacturer's address
- (3) Country of manufacture
- (4) Manufacturer's garment element identification number, lot number, or serial number
- (5) Month and year of manufacture (not coded)
- (6) Model name, number, or design
- (7) Size or size range
- (8)* Principal material(s) ~~Materials~~ of construction.

For gloves, at least the outer layer, barrier layer, and wristlet shall be listed. Generic names of materials shall be used. The type of leather shall be listed. Additional materials that are used throughout the majority of the glove body shall also

be listed on the label.

For footwear, at least the outer layer and barrier layer shall be listed. General names of materials shall be used.

Additional materials that are used throughout the majority of the boot shall also be listed on the boot label.

For garments, at least the identification of the fiber or material type of the outer shell and moisture barrier shall be listed.

For helmets, at least the general terminology for the shell material shall be used.

(9) Cleaning precautions if applicable

5.1.8 For garments only, where the outer shell and moisture barrier are separable, each separable layer shall also have a label containing the information required in Section 5.1.7(4), (5), (6), (7) and (8).

5.1.9 Where the principle material of construction used in a garment is a component that is listed, the component name under which it is listed shall be used.

A.5.1.7(8)* For glove labels, examples of the type of leather that may be listed are cow leather, elk leather, etc. Any additional thermal liner that is used in the entire back of the glove shall be listed on the label. Elastic and similar materials should not be listed. Trade names may be added if desired. For footwear labels, examples of an additional thermal layer that is used in the majority of the boot should be listed on the label. Zippers, eyelets, and similar should not be listed. Type of leather does not have to be listed. Trade names may be added if desired. For helmet labels, examples of general terminology for shell material are as follows: thermoplastic, thermoplastic/leather, fiberglass composite, Kevlar composite, fiberglass composite/leather, etc.

Committee Statement: The technical committee accepted the comment in principle, and provided the clarifying amended text for principal materials of construction and labels as shown in the meeting action.

1951-10 Log #CC7 FAE-SCE
(6.1, 6.2, 6.11, 8.25, 8.26, 8.27 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-6

Recommendation: Revise the text in the preprint document as follows:

6.1.3.3, 6.2.3.3 The glove shall consist of a glove body and a wristlet or gauntlet shall be permitted to have an additional glove interface component at the end of the glove body.

6.1.3.3.3, 6.2.3.3.3 A one pound weight shall be attached to the end of the glove body, extended body or gauntlet glove interface component. The weight shall not be attached to a knitted wristlet glove interface component. The weight shall be applied evenly across the glove.

~~6.1.3.3.5, 6.2.3.3.5 A measurement shall be made down from the base of the finger crease between digit 2 and 3. This measurement shall be the palm length as specified below for the corresponding glove size. This point shall be the wrist crease.~~

6.1.3.3.5*, 6.2.3.3.5* Two points shall be marked on the back side of the glove. The location of the points shall be determined by measuring down the following distances from the finger crotch of digit two and from the finger crotch of digit three. The distances below are given according to glove size. See Table 6.1.3.3.5 and Table 6.2.3.3.5.

****Insert 1951_L#CC7_Table 6.1.3.3.5_R Here****

Insert 1951_L#CC7_Table 6.2.3.3.5_R (same table to appear twice in text) Here* ****

A. 6.1.3.3.5, 6.2.3.3.5 * The measurements given in Table 6.1.3.3.5 and Table 6.2.3.3.5 are palm lengths and are calculated by subtracting the median length of digit 3 from the median hand length found for each glove size in Tables 6.7.6.1 (a-e) of NFPA 1971-2007.

6.1.3.3.6, 6.2.3.3.6 A straight line shall be drawn on the back side of the glove using the two points. This line shall be drawn around the side edges of the glove.

6.1.3.3.7, 6.2.3.3.7 The glove shall be removed from the measurement board. A line shall be drawn on the palm side of the glove by connecting the lines from the side edges of the glove.

6.1.3.3.8, 6.2.3.3.8 The resulting straight line around the circumference of the glove shall be the location of the wrist crease.

~~6.1.3.3.6, 6.2.3.3.6~~ 6.1.3.3.9, 6.2.3.3.9 Gloves shall have a wristlet or gauntlet at the end of the glove body. The wristlet glove interface component shall allow the glove material to fit closely around the wearer's wrist. This wristlet or gauntlet or any other part of the glove that is present beyond the end of the glove body shall be known as the glove interface component. The portion of the glove beyond the wrist crease shall meet the performance requirements for the interface component as specified in 7.1.3, 7.2.3.

In preprint: Renumber existing 6.2.3.5 and 6.2.3.6 as 6.2.3.4 and 6.2.3.5.

6.2.3.6 Glove Sizes.

6.2.3.6.1 Gloves shall be available in all sizes from XS to XXL.

6.2.3.6.2 Gloves shall be available in at least two finger lengths for all sizes in 6.2.3.6.1.

In preprint: Renumber existing 6.1.3.5 and 6.1.3.6 as 6.1.3.4 and 6.1.3.5.

8.11.7.1 Specimens shall be taken from the palm area of the gloves representative of the glove body composite construction at the following glove areas as described in 8.1.14 and shall not include seams: A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B. Samples and specimens shall be permitted to be materials representative of those used in the construction of the glove. Specimens shall consist of the outer separable layer of the glove composite that is at least 50 percent of the total surface area.

8.25.7.1 Specimens shall be representative of glove body composite construction at the palm of the hand and at the palm side of the fingers; at the following glove areas as described in 8.1.X: A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P. (Delete remainder of paragraph).

8.27.7 Specific Requirements for Testing Glove Materials. Specimens be representative of the glove body composite construction at the following glove areas as described in 8.1.X: A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P. Where the specimen composites of the palm and palm side of the fingers are identical, only one representative composite shall be required to be tested.

8.26.7.1 Specimens shall be representative of the glove body composite construction at the following glove areas as described in 8.1.14 and shall not include seams: ~~A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B.~~ (Delete remainder of paragraph).

Substantiation: The wrist crease wording was altered slightly to provide an explanation of how to draw the line at the wrist crease. Editorial errors were corrected. More explanation given about glove body and glove interface component. Glove test areas moved from requirements section to test method section.

Committee Meeting Action: Accept

1951-11 Log #1 FAE-SCE
(6.1.1.10 and 6.2.1.11)

Final Action: Accept

Submitter: Kevin J. Canty, VELCRO USA INC.

Comment on Proposal No: 1951-18

Recommendation: Replace sections 6.1.1.10 and sections 6.2.1.11 with the following:

6.1.1.10 ~~Fastener tape shall meet the requirements of A-A-55126, Commercial Item Description, Fastener Tapes, Hook and Pile, Synthetic.~~

6.2.1.11 ~~Fastener tape shall meet the requirements of A-A-55126, Commercial Item Description, Fastener Tapes, Hook and Pile, Synthetic.~~

Proposed Text:

Fastener tape shall be tested for breaking strength as specified in CID A-A 55126B, Fastener Tapes, Hook and Loop, Synthetic, Test Method ASTM D 5034 (G-E or G-T)2/, and shall meet or exceed the minimum breaking strength requirements established for type 2, Class 1 and Class 4 tapes as set forth in that specification Table 1. Tapes in a 1" width shall be used as the basis for performance.

Fastener tape shall be tested for shear strength as specified in CID A-A 55126B, Fastener Tapes, Hook and Loop, Synthetic, Test Method AATCC 61, Test 3A, ASTM D5170 after 3 washings and shall meet or exceed the minimum shear strength requirements established for type 2, Class 1 and Class 4 tapes as set forth in the specification Table 1. Tapes in a 1" width shall be used as the basis for performance.

Fastener tape shall be tested for peel strength as specified in CID A-A 55126B, Fastener Tapes, Hook and Loop, Synthetic, Test Method AATCC 61, Test 3A, ASTM D 5169 after 3 washings and shall meet or exceed the minimum peel strength requirements established for type 2, Class 1 and Class 4 tapes as set forth in the specification Table 1. Tapes in a 1" width shall be used as the basis for performance.

Substantiation: Proposal 1951-18 (Log #CP32) is excluding hook and loop from FR testing, to be consistent with garments. The above text is also being proposed for NFPA 1971 and will establish minimum breaking, shear, and peel strength requirements for hook and loop products.

This is not original material; its reference/source is as follows:

Some input from Globe Firefighters Inc.

Committee Meeting Action: Accept

1951-12 Log #43 FAE-SCE
(6.1.1.12)

Final Action: Accept

Submitter: Karen E. Lehtonen, LION

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

~~Cargo Expandable~~ pockets, where provided shall have a means to drain water and shall have a means of being fastened in the closed position. This shall not apply to patch pockets which lie flat on the garment.

Substantiation: Since the definition of cargo pocket applies to any pocket on the exterior of the garment a drainage mechanism is required. Since these garments are used for multiple purposes there have been requests for patch pockets to house note pads, etc. which may need to stay dry. Requiring a drainage hole allows moisture inside the pocket which could harm the pocket contents. Drainage should remain required for any pocket that expands since it could hold water.

Committee Meeting Action: Accept

Table 6.1.3.3.5

| Glove Size | Palm Length (cm) | Palm Length (in) |
|-------------------|-------------------------|-------------------------|
| XS | 9.46-10.04 | 3.72-3.95 |
| S | 10.04-10.68 | 3.95-4.20 |
| M | 10.68-11.21 | 4.20-4.42 |
| L | 11.21-11.73 | 4.42-4.62 |
| XL | 11.73- 12.23 | 4.62-4.81 |
| XXL | 12.23 -12.71 | 4.81-5.0 |

Table 6.2.3.3.5

| Glove Size | Palm Length (cm) | Palm Length (in) |
|-------------------|-------------------------|-------------------------|
| XS | 9.46-10.04 | 3.72-3.95 |
| S | 10.04-10.68 | 3.95-4.20 |
| M | 10.68-11.21 | 4.20-4.42 |
| L | 11.21-11.73 | 4.42-4.62 |
| XL | 11.73- 12.23 | 4.62-4.81 |
| XXL | 12.23 -12.71 | 4.81-5.0 |

1951-13 Log #10 FAE-SCE
(6.1.3.3.1, Table 6.X, and 6.1.3.7.1)

Final Action: Accept in Part

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-6

Recommendation: 6.1.3.3.1 Add "at least" before "the wrist crease."

Table 6.x should give tolerances for the lengths required.

In 6.1.3.7.1 Utility gloves are required to have 6 sizes.

Modify Table 6.x accordingly. See Log #CP38.

Substantiation: Practical corrections.

Committee Meeting Action: **Accept in Part**

In the preprint document, revise 6.1.3.3.1 as follows:

Add "at least" before "the wrist crease."

Committee Statement: The technical committee accepted the comment on 6.1.3.3.1 and refers the reader to 1951-10 (Log #CC7) which addresses the other parts of the comment.

1951-14 Log #12 FAE-SCE
(6.1.4.4.3 and 6.2.4.4.3)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-11

Recommendation: Change "topline at all locations" to "topline excluding the gusset".

Substantiation: Allowing the topline to include the gusset means the protective requirements can end 2 in. below the bottom of the gusset which can be very low. See 6.2.4.4.1.

Committee Meeting Action: **Accept**

The technical committee notes that the comment references the preprint document in the print line.

1951-15 Log #46 FAE-SCE
(6.2.1.13)

Final Action: Accept

Submitter: Karen E. Lehtonen, LION

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

~~Cargo-Expandable~~ pockets, where provided shall have a means to drain water and shall have a means of being fastened in the closed position. This shall not apply to patch pockets which lie flat on the garment.

Substantiation: Since the definition of cargo pocket applies to any pocket on the exterior of the garment a drainage mechanism is required. Since these garments are used for multiple purposes there have been requests for patch pockets to house note pads, etc. which may need to stay dry. Requiring a drainage hole allows moisture inside the pocket which could harm the pocket contents. Drainage should remain required for any pocket that expands since it could hold water.

Committee Meeting Action: **Accept**

1951-16 Log #44 FAE-SCE
(6.2.1.17)

Final Action: Hold

Submitter: Karen E. Lehtonen, LION

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

Metal components of the garments shall not come in direct contact with the body. Coat hardware shall not penetrate through the outer shell and moisture barrier to come in contact with the wearers body when the coat is worn with the closures fastened, unless the hardware is completely covered by external closure flaps. Pant hardware shall not penetrate through the outer shell and moisture barrier to come in contact with the wearers body when the pant is worn with the closures fastened, unless the hardware is located on or above the waistline or hardware is completely covered by external closure flaps.

Substantiation: The hardware requirements should be consistent with that of other multi layer garment standards.

This allows for improved use and location of hardware items on the coat and pant.

This is not original material; its reference/source is as follows:

Proposed language is taken from NFPA 1971.

Committee Meeting Action: Hold

Committee Statement: The technical committee decided to hold this comment for further study.

1951-17 Log #11 FAE-SCE
(6.2.3.3.1 and Table 6.X)

Final Action: Accept in Part

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-6

Recommendation: 6.2.3.3.1 Add "at least" before "the wrist crease"

Table 6.x should give tolerances for the lengths required.

The table referred to in 6.2.3.3.6 should be different from the one in 6.1.3.3.5.

Substantiation: Practical corrections.

Committee Meeting Action: Accept in Part

In the preprint document, revise 6.2.3.3.1 as follows:

Add "at least" before "the wrist crease."

Committee Statement: The technical committee accepted the comment on 6.2.3.3.1 and refers the reader to 1951-10 (Log #CC7) which addresses the other parts of the comment.

1951-18 Log #CC2 FAE-SCE
(6.2.5.1)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,

Comment on Proposal No: 1951-13

Recommendation: Revise paragraph 6.2.5.1 in the preprint to read as follows.

This change restores this paragraph to the text of the 2007 edition of the standard.

6.2.5.1 Goggle elements shall meet ANSI Z87.1, Occupational and Educational Personal Eye and Face Protection Devices, requirements for Type G (Cover Goggle, No Ventilation), Type H (Cover Goggle, Indirect Ventilation), Type I (Cover Goggle, Direct Ventilation), Type J (Cup Goggle, Direct Ventilation), or Type K (Cup Goggle, Indirect Ventilation) Goggles.

Substantiation: The corresponding change for Rescue and Recovery Goggle Design Requirements was left out of the original proposal. Text indicated in the recommendation is identical to text in 6.2.5.1 in current edition of NFPA 1951.

Committee Meeting Action: Accept

1951-19 Log #13 FAE-SCE
(6.3.4.4)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-6

Recommendation: Delete "and 6.2.3.4".

Substantiation: Log #CP24 has removed 6.2.3.4 and included all relevant information in 6.2.3.3.

Committee Meeting Action: Accept

1951-20 Log #2 FAE-SCE
(7.1.1.9)

Final Action: Reject

Submitter: Patricia A. Freeman, Globe Manufacturing Company, LLC

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

7.1.1.9 Textile fabrics, linings, hardware, and other materials used in garment construction, including but not limited to padding, reinforcements, wristlets, collars, labels, hanger loops, buttons, and fasteners but excluding hook and pile fasteners not in direct contact with the skin, and excluding emblems, labels and patches, shall be individually tested for heat resistance in their original form as specified in Section 8.5, heat and Thermal Shrinkage Resistance Test, and shall not melt, drip, separate, or ignite; garment outer shells shall not char; and hardware items and closures shall remain functional.

Substantiation: In the 2007 edition of this standard, emblems, labels and patches are exempt from flame testing; however, they are still required to be tested for thermal resistance which requires third party certification. I have spoken to at least one member of the committee and they were not sure if this was by design or a committee oversight and so I am entering this comment for discussion. As long as the requirement for thermal testing remains in place, most departments will not be able to add these items due to the expense of the required testing for certification.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the comment because it is the committee's intent to not include emblems, labels and patches since these are single-layer garments.

1951-21 Log #14 FAE-SCE
(7.1.1.11)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Change "shall no corrosion" to "show no corrosion".

Substantiation: Editorial.

Committee Meeting Action: Accept

1951-22 Log #18 FAE-SCE
(7.1.3.2, 7.2.3.2, and 7.3.4.2)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-6

Recommendation: Change "under an applied force of 45 N (101bf) to "under an average applied force of 22 N (51bf).

Substantiation: This change makes the utility, rescue and recovery, and CBRN glove puncture resistance all the same. 22 N is what was originally required for CBRN in 7.3.4.19. The requirement for gloves in NFPA 1971 is 40 N, so 45 N seems too high here.

Committee Meeting Action: Accept

The technical committee notes that the comment references the preprint document in the print line.

1951-23 Log #CC9 FAE-SCE
(7.1.3.5, 7.2.3.5, 7.3.4.5, 8.29 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-16

Recommendation: Revise the text in the preprint document as follows:

7.1.3.5 Gloves shall be tested for grip as specified in Section 8.29, Grip Test, and shall ~~have a weight-pulling capacity not less than 90 percent of the barehand control values and shall not drop 30% from its peak value~~ not have a drop of more than 30 percent from the peak pull force value.

7.2.3.5 Gloves shall be tested for grip as specified in Section 8.29, Grip Test, and shall ~~have a weight-pulling capacity not less than 90 percent of the barehand control values and shall not drop 30% from its peak value~~ not have a drop of more than 30 percent from the peak pull force value.

7.3.4.5 Gloves shall be tested for grip as specified in Section 8.29, Grip Test, and shall ~~have a weight-pulling capacity not less than 90 percent of the barehand control values and shall not drop 30% from its peak value~~ not have a drop of more than 30 percent from the peak pull force value.

Delete the text of Section 8.29 in the preprint document, and replace with the following text:

8.29 Grip Test.

8.29.1 Application. This test method shall apply to protective gloves.

8.29.2 Sample Preparation.

8.29.2.1 Samples shall be whole glove pairs, sizes small and large, in new, as-distributed condition.

8.29.2.2 Samples shall be conditioned as specified in 8.1.2.

8.29.3 Specimens.

8.29.3.1 Specimens shall be whole glove pairs, sizes small and large.

8.29.3.2 At least three glove pairs each for small and large sizes shall be tested.

8.29.3.3 Glove pair specimens shall not receive special softening treatments prior to tests.

8.29.3.4 Specimens shall be tested for each material and construction combination.

8.29.3.5 Specimen glove pairs shall be tested after being conditioned for wet conditions as specified in 8.1.7.

8.29.4 Apparatus.

8.29.4.1 A pulling device. The pulling device shall be a 1 1/4 in. diameter fiberglass pole attached to an overhead calibrated force measuring device in such a fashion that pulls on the pole will be perpendicular to the ground and downward in direction. This pole shall be used until surface degradation occurs or for a maximum of 100 pulls.

8.29.4.2 An adjustable stand shall be used. The stand shall have a cushioned bar that can be positioned at chest height. The stand shall prevent the test subject from leaning forward during the grip trials.

8.29.5 Procedure.

8.29.5.1 Test subjects shall be selected such that their hand dimensions are as close as possible to those specified in accordance with manufacturing glove-sizing guidelines. At least three test subjects shall be selected for both size small and size large.

8.29.5.2 The gloves shall be conditioned by the wetting procedure specified in 8.1.7 before each set of three pulls by the test subject as described below.

8.29.5.3 The pulling device shall be wet conditioned before each individual pull by wiping with a damp rag.

8.29.5.4 The test subject shall then make three pulls on the pulling device with gloves with peak and minimum pull force values measured. Pulls shall be performed as described here. The test subject shall stand with feet together, firmly planted on the ground, and knees slightly bent. The stand shall be adjusted such that the cushioned bar is touching the test subject's chest. The stand shall prevent the test subjects forward movement during the pull. The test subject shall extend the arms in front of the body at shoulder height to grab the pulling device for pulling vertically down from the ceiling. The test subject shall stand in a comfortable pulling position with the arms bent at an angle of approximately 90 degrees and in any case the arms shall not be completely extended or touching the body. The test subject shall grasp the pulling device with hands next to each other. Thumbs shall not overlap the fingers. The test subject shall pull the rope or pole with as much pulling force as possible in a smooth, steady, swift, and non-jerking action. The test subject shall not bend the knees further or pull down with body weight during the pull. The test subject shall continuously pull on the pulling device for a minimum of 5 +1/-0 sec. The test subject shall continue to pull until the test facilitator observes a peak pulling force and instructs the test subject to end the pull.

8.29.6 Report.

8.29.6.1 The peak pull force value for each individual pull shall be recorded and reported.

8.29.6.2 The minimum pull force value occurring after the peak pull force value shall be recorded and reported.

8.29.6.3 The percentage drop between the peak pull force value and the minimum pull force value shall be calculated, recorded, and reported.

8.29.7 Interpretation.

8.29.7.1 The individual percentage drop between the peak pull force value and the minimum pull force value shall be used to determine pass or fail performance.

8.29.7.2 Failure during any pull shall constitute failure of the test.

Substantiation: This change to the proposal is based on the research that was completed by NC State in conjunction with the Glove Research Project at the NFPA Research Foundation and will remove the variability of the previous test method

Committee Meeting Action: Accept

1951-24 Log #CC12 FAE-SCE
(7.1.3.7, 7.2.3.7, 7.3.4.7 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-18

Recommendation: In the preprint document, add the word “external” in front of the added word “labels” in the proposal in 7.1.3.7, 7.2.3.7, and 7.3.4.7.

Substantiation: This comment clarifies that the inclusions are for external labels as opposed to internal.

Committee Meeting Action: Accept

1951-25 Log #CC14 FAE-SCE
(7.1.3.14, 7.2.3.18, 7.3.4.21, 8.49.2.2, 8.49.4.1 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-20

Recommendation: Delete the text in the preprint document of paragraphs 7.1.3.16, 7.2.3.18, and 7.3.4.21, and replace with the following text:

7.1.3.16, 7.2.3.18 and 7.3.4.21. Gloves shall be tested for grip function as specified in Section 8.49, Torque Test, and shall have an average percent of bare-handed control not less than 80 percent.

Revise the following paragraphs in the preprint document as follows:

8.49.2.2 Sample glove pairs shall be preconditioned as specified in ~~8.1.9~~ 8.1.2.

~~8.49.3.5 Specimen gloves shall be tested after being conditioned for wet conditions as specified in 8.1.7.~~

8.49.4.1 Torque testing shall be evaluated with the use of an 1 inch diameter solid acrylic cylinder with diameter 1 inches securely centered on a calibrated digital torque meter capable of measuring up to 88.5 lb-in (10.00 N-m).

~~8.49.5.5 Wet conditioned specimen gloves shall be tested on a wet acrylic cylinder. Gloves shall be subjected to wet conditioning as specified in 8.1.8. The cylinder shall be wet conditioned between attempts by wiping with a damp rag.~~

Substantiation: The requirement statement is reworded to match the NFPA format, and is changing the preconditioning for consistency based on work done by NCSU after the ROP meeting.

Committee Meeting Action: Accept

1951-26 Log #CC16 FAE-SCE
(7.1.4.6, 7.2.4.6, 7.3.5.8, 8.37 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-22

Recommendation: Revise the text in the preprint document as follows:

7.1.4.6 Footwear ~~soles~~ shall be tested for slip resistance as specified in Section 8.37, Slip Resistance Test, and shall have a ~~static~~ coefficient of friction of ~~0-20~~ 0.45 or greater.

7.2.4.6 Footwear ~~soles~~ shall be tested for slip resistance as specified in Section 8.37, Slip Resistance Test, and shall have a ~~static~~ coefficient of friction of ~~0-20~~ 0.45 or greater.

7.3.5.8 Footwear ~~soles~~ shall be tested for slip resistance as specified in Section 8.37, Slip Resistance Test, and shall have a ~~static~~ coefficient of friction of ~~0-20~~ 0.45 or greater.

Delete sections 8.37.4, 8.37.5 and 8.37.6 in the preprint document, and add the following new text:

8.37.4 Procedure. Slip resistance shall be performed in accordance with DIN EN ISO 13287, Personal Protective Equipment – Footwear – Test Method for Slip Resistance, in the following configurations:

a.) Footwear shall be tested both in the forepart and heel positions.

b.) Footwear shall be tested in the wet condition. The wet condition shall be achieved using distilled or de-ionized water. The water shall be applied to thoroughly wet the testing surface and make a pool at least as wide and long as the test portion of the footwear in the area of initial contact.

c.)* Footwear shall be tested on a quarry tile surface that meets the following specifications:

i.) Flat unglazed clay quarry tile that is wider than the test specimen and long enough to allow a sliding distance of at least 75mm without crossing a joint.

ii.) is sufficiently flat to allow it to be secured on the mounting table such that no movement occurs between the tile and mounting table during the test.

iii.) has a ribbed profile or directional marking on the underside to identify the direction in which the tile should be aligned (with the ribs parallel to the sliding direction).

iv.) conforms to the values specified in Table 8.37.4 when calibrated by the Slider 96 method.

v.)* Calibration of the tiles shall be checked after every 10 tests or prior to each day of testing whichever is the less frequent, to ensure that they are not being worn smooth or otherwise damaged.

****Insert 1951 LCC16 Tbl 8.37.4 R Here****

8.37.5 Report.

8.37.5.1 The coefficient of friction of each specimen shall be reported.

8.37.5.2 The average coefficient of friction of all specimens for each configuration shall be calculated, recorded, and reported.

8.37.6 Interpretation. The average coefficient of friction for each configuration shall be used to determine pass/fail performance.

A.8.37.4(c) A suitable tile is available from SATRA, reference STM 603 Quarry Tile.

A.8.37.4(c)(v) However, if experience shows that the friction properties of the test floor are not strongly influenced by repeated testing then calibration intervals may be extended.

Substantiation: The stainless steel plate is being removed to maintain more simplicity of this test. The testing is substantially more complex and requires significantly more whole boot samples than the current method. The stainless plate was removed to make the transition to this test method less burdensome to manufacturers and to allow some time to adjust to this new method. The surfactant condition was changed to a plain water condition so that the basic conditions of the footwear slip industry would be recorded. The dry condition was eliminated because wet condition is worst case. The sole position was changed to the forepart condition because the forepart condition is more critical and more accurately reflects shoe position for actual slipping. The test method was changed from SATRA to DIN EN ISO for consistency with other standards in the project. The test method itself is the same. Requirement is being changed based on information learned about minimum slip requirements necessary for standing and testing performed.

Committee Meeting Action: Accept

Table 8.37.4

| | <u>Dry CoF</u> | <u>Wet CoF</u> |
|-----------------|----------------|----------------|
| <u>Miniumum</u> | <u>0.57</u> | <u>0.36</u> |
| <u>Maximum</u> | <u>0.63</u> | <u>0.42</u> |

1951-27 Log #CC3 FAE-SCE
(7.1.4.10, 7.2.4.10, 8.32 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-44

Recommendation: Revise the text of the preprint document as indicated:

7.1.4.10 Footwear shall be individually tested for flame resistance as specified in Section 8.32, Flame Resistance Test 4, shall not have an afterflame of more than ~~2-0~~ 5.0 seconds, shall not melt or drip, and shall not exhibit any burn-through.

7.2.4.10 Footwear shall be individually tested for flame resistance as specified in Section 8.32, Flame Resistance Test 4, shall not have an afterflame of more than ~~2-0~~ 5.0 seconds, shall not melt or drip, and shall not exhibit any burn-through.

8.32.4.1 The test apparatus shall consist of a fuel pan, movable shutter(s), specimen holder, n-heptane, ignition source, and ~~stopwatch~~ timing device.

8.32.4.1.2 The movable shutter(s) shall be located at a height of 255 mm (10 in.) +/- 13mm (¹/₂ in.) above the surface of the water and n-heptane fluid as measured before ignition. The shutter(s) shall be of a size sufficient to cover the surface area of the fuel pan and shall be capable of being fully retracted or fully extended within 1 sec.

8.32.4.1.3 The specimen holder shall be capable of suspending the specimen over the flame in a manner such that the flames will not be impeded and specimen contact is minimized holder does not impede the flames.

8.32.5.5 The specimen shall be mounted in the specimen holder as follows:

- a.) The toe shall be at a ~~5 +/- 1~~ 7.5 +/- 2.5 degree angle above the heel
- b.) The height of the lowest edge of the specimen shall be 305 mm (12 in.) +0/-25mm (+0/-1 in.) from the surface of the water and n-heptane fluid as measured before ignition
- c.) The heel toe axis of the specimen shall be parallel with the 457 mm side of the fuel pan.

8.32.5.8 The shutter(s) shall be positioned above the flame.

8.32.5.9 The specimen shall be positioned above the shutter(s) over the approximate center of the flame area.

8.32.5.10 The shutter(s) shall be retracted and specimen flame exposure shall commence not longer than 1 minute 15 seconds from ignition.

8.32.5.11 The specimen shall be exposed to the flame for 12 +/- 0.2 seconds.

8.32.5.12 Following flame exposure, the shutter(s) shall be repositioned above the flame.

Substantiation: Based on the additional testing has been performed since the ROP meeting, the task group on footwear is suggesting that the requirement for afterflame be changed from 2 seconds to 5 seconds. This will make the requirement consistent with helmets and faceshields. In addition this test is more severe than the current method because it is applying a larger scale flame and evaluating a whole boot as opposed to discrete areas of the boot. This increase in severity of the test makes an adjustment in the requirement appropriate. Also, test details and tolerances were added for clarification and consistency.

Committee Meeting Action: Accept

1951-28 Log #CC4 FAE-SCE
(7.1.4.18, 7.2.4.18 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-10
Recommendation: Revise the text in the preprint document as follows:

Delete the following sections:

7.3.5.4
7.3.5.7
7.3.5.2
7.3.5.21

~~6.1.4.13 Footwear shall meet the requirements as specified in ASTM F2413, *Performance Requirements for Protective (Safety) toe cap Footwear*, for Impact, Compression, Metatarsal, and Puncture Resistant Footwear with the following exception:~~

~~a.) Flex Resistance to Cracking shall not be evaluated:~~

~~6.2.4.14 Footwear shall meet the requirements as specified in ASTM F2413, *Performance Requirements for Protective (Safety) toe cap Footwear*, for Impact, Compression, Metatarsal, and Puncture Resistant Footwear with the following exception:~~

~~a.) Flex Resistance to Cracking shall not be evaluated:~~

7.1.4.18 Footwear shall meet the performance requirements as specified in ASTM F2413, *Performance Requirements for Protective (Safety) toe cap Footwear*, for Impact, Compression, Metatarsal, and Puncture Resistant Footwear with the exception that Flex Resistance to Cracking shall not be evaluated.

7.2.4.18 Footwear shall meet the performance requirements as specified in ASTM F2413, *Performance Requirements for Protective (Safety) toe cap Footwear*, for Impact, Compression, Metatarsal, and Puncture Resistant Footwear with the exception that Flex Resistance to Cracking shall not be evaluated.

7.3.5.X Footwear shall meet the performance requirements as specified in ASTM F2413, *Performance Requirements for Protective (Safety) toe cap Footwear*, for Impact, Compression, Metatarsal, and Puncture Resistant Footwear with the exception that Flex Resistance to Cracking shall not be evaluated.

Substantiation: The technical committee is proposing to place this requirement in Chapter 7 rather than Chapter 6 because it is the performance requirements that are desired, rather than design and labeling requirements.

Committee Meeting Action: Accept

1951-29 Log #42 FAE-SCE
(7.3.1.3, and 8.4.5)

Final Action: Accept in Principle

Submitter: Paul Dacey, W L Gore & Associates

Comment on Proposal No: 1951-23

Recommendation: {In NFPA 1971, replace para 7.20.1.3 with the following:

- In NFPA 1994 Replace para 7.1.2.1, 7.1.2.8.1, 7.1.3.2, 7.1.4.2 and create new para 7.1.1.6 with the following:
- In NFPA 1994, replace para , 7.2.2.1, 7.2.2.9.1, 7.2.3.2 and 7.2.4.2 and create new para 7.2.1.6 with the following:
- In NFPA 1951, replace para 7.3.1.3 with the following:
- In NFPA 1991, replace Para 7.2.2, 7.2.3, 7.2.4, 7.2.10, 7.2.11, 7.2.12, 7.3.2, 7.3.3, 7.3.4, 7.3.7, 7.3.8, 7.3.9, 7.4.2, 7.4.3, 7.4.4, 7.5.2, 7.5.3, 7.5.4 with the following new para 7.1.10:

The following numbering is correct for NFPA 1951 document only}

7.3.1.3 Each ensemble element's CBRN barrier layer and the CBRN barrier layer's seams shall be tested for permeation resistance as specified in Section 8.45 and shall meet the following performance criteria:

1. For permeation testing of the liquid chemical warfare agent sulfur mustard, distilled [HD, or bis (2- chloroethyl) sulfide, CAS 505-60-2], the average cumulative permeation in one hour shall not exceed $4.0 \mu\text{g}/\text{cm}^2$.
2. For permeation testing of the liquid chemical warfare agent Soman [GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-64-0], the average cumulative permeation in one hour shall not exceed $1.25 \mu\text{g}/\text{cm}^2$.
3. For permeation testing of the liquid toxic industrial chemical dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g}/\text{cm}^2$.
4. For permeation testing of the chemical gas acrolein (allyl aldehyde, CAS 107-02-8), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g} / \text{cm}^2$.
5. For permeation testing of the chemical gas acrylonitrile (VCN, cyanoethylene, CAS 107-13-1), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g} / \text{cm}^2$.
6. For permeation testing of the chemical gas ammonia (NH_3 , CAS 7664-41-7), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g} / \text{cm}^2$.
7. For permeation testing of the chemical gas chlorine (Cl_2 , CAS 7782-50-5), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g} / \text{cm}^2$.

{In the NFPA 1971 Standard, replace Section 8.67 with the following:

In the NFPA 1994 Standard, replace Section 8.7 with the following:

In the NFPA 1951 Standard, replace Section 8.45 with the following:

In the NFPA 1991 Standard, replace Section 8.6.4.2 with the following new method:

The following numbering is correct for NFPA 1951 document only}

8.45 Chemical Permeation Resistance Test

8.45.1 Application

8.45.1.1 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.

8.45.1.2 Specific requirements for testing the CBRN barrier layer of garments, hoods, and booties shall be as specified in 8.45.10.

8.45.1.3 Specific requirements for testing the CBRN barrier layer of visors shall be as specified in 8.45.11.

8.45.1.4 Specific requirements for testing the CBRN barrier layer of gloves shall be as specified in 8.45.12.

8.45.1.5 Specific requirements for testing the CBRN barrier layer of footwear shall be as specified in 8.45.13.

8.45.1.6 Specific requirements for testing the CBRN barrier layer's seams of garments, hoods, booties, visors, and gloves shall be as specified in 8.45.14.

8.45.2 Samples

8.45.2.1 Samples for conditioning shall be as specified according to the specific requirements in 8.45.10, 8.45.11, 8.45.12, 8.45.13, and 8.45.14 as appropriate.

8.45.2.2 Samples shall be conditioned as specified according to the specific requirements in 8.45.10, 8.45.11, 8.45.12, 8.45.13, and 8.45.14 as appropriate.

8.45.2.3 Samples shall then be cut to the specimen size.

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

8.45.3 Specimens

8.45.3.1 Specimens shall be the CBRN barrier layer or the CBRN barrier layer's seam of the size required to fit the permeation test cell.

8.45.3.2 A minimum of three specimens shall be tested against each challenge chemical.

8.45.3.3 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. Place the outer shell or other composite layers on the test specimen through the cell cap port after the test cell has been assembled.

8.45.3.4 If the specimen is the outer most layer of the composite then it shall be tested without any additional layers on top.

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

8.45.3.6 Specimens with non-uniform 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.

8.45.3.7 Following any sample preparation, the specimens shall be conditioned at a temperature of 32°C +/- 1°C (90°F, +/- 2°F) and at a relative humidity of 80 percent, +/- 5 percent, for at least twenty-four hours prior to testing in accordance with paragraph 8.45.7.1.1.

8.45.4 Apparatus

8.45.4.1 A thickness gauge suitable for measuring thicknesses to the nearest 0.02 mm (or the nearest 0.001 in.), as specified in ASTM D1777, shall be used to determine the thickness of each test specimen.

8.45.4.2 An analytical balance readable and reproducible to +/- 0.5 mg, as specified in ASTM D3776 shall be used to determine the weight per unit area of each test specimen.

8.45.4.3 A controlled environmental chamber shall be used to maintain the test cell, air flow control system, and reagent chemicals within +/- 1.0°C (+/- 2.0°F) of the test temperature and +/- 5 percent of the test relative humidity. The controlled environment chamber shall be sized so that it can be used for conditioning test materials, test cells when not in use, challenge chemicals, and other test apparatus prior to testing, as well as holding the test cells horizontally during use while connected to the air delivery system with manifold and to the effluent sampling mechanism.

8.45.4.4 The test cell shall be a two-chambered aluminum alloy cell for contacting the specimen with the challenge chemical on the specimen's normal outside surface and for flowing a collection medium on the specimen's normal inside surface, conforming to diffusion test cell part # TOP 8-2-501 from Aero-Space Tooling & Machining, 2190 West 1700 South, Salt Lake City, UT 84104, with the following modifications:

(a) The cell cap shall have a smooth solid surface facing the test specimen, i.e. no opening ports for cell integrity testing.

(b) Ports for testing the integrity of the assembled test cell shall be mounted on the inlet fittings on both the upper body and lower body of the test cell.

8.45.4.5* An air delivery system and manifold shall be used to provide oil-free, conditioned air to the test cell/fixtures at a rate of 2 standard liters per minute (SLPM) per test cell/fixture with a temperature precision of +/- 0.2°C and a relative humidity precision of +/- 5 percent. The manifold is designed to deliver 0.3 L/min for the challenge side of the test cell and 1 L/min for the collection side of the test cell and maintain at the test temperature. All parts of the air delivery system and manifold must be chemically inert and non-absorptive to the challenge chemical.

8.45.4.6* An analytical system shall be used to evaluate the amount of challenge chemical in the effluent air streams from the collection side of the test cell and shall be selected to provide the ability to measure the challenge chemical at 0.1 µg/cm² over the test exposure period. The analytical system shall be permitted to include a bubbler tube, solid sorbent, or real time chemical analyzer. Effluent sampling shall be permitted to be taken discretely or cumulatively; however the selected analytical system shall be able to determine all of the challenge chemical permeating through the specimen in 60 minutes.

8.45.4.7 A vacuum pump capable of creating vacuum of at least 5 inches water column shall be used for testing the integrity of the assembled test cell.

8.45.4.8 A manometer or pressure gage capable of measuring pressures or vacuums to 10 inches water column, with an accuracy of 5 percent of scale, shall be used for testing the integrity of the assembled test cell.

8.45.5 Supplies

8.45.5.1 Syringe needles, capable of delivering one-microliter droplets, +/- 1%, of the challenge chemical, shall be used for dispensing liquid challenge chemical onto the surface of the specimen in the test cell.

8.45.5.2* Replacement O-rings shall be available for use in the permeation test cell.

8.45.5.2.1* If unknown, the compatibility of the O-ring material with the challenge chemical shall be verified before use.

8.45.5.2.2 If an O-ring shows any signs of chemical degradation in the form of softening, hardening, swelling, deterioration, or loss of shape, or function, an O-ring of different material shall be used that does not show chemical degradation.

8.45.5.3* An inert impermeable surrogate material shall be used as a negative control during validation tests.

8.45.6 Chemicals

8.45.6.1 The following challenge chemicals shall be tested as liquids:

- (1) Liquid chemical warfare agents
 - (a) Sulfur mustard, distilled [HD, or bis (2- chloroethyl) sulfide, CAS 505-60-2]
 - (b) Soman [GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-64-0]
- (2) Liquid toxic industrial chemical
 - (a) Dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1)

8.45.6.2 Process for Determining the Mass of Liquid Chemical Challenge Applied

8.45.6.2.1 Prior to assembling the test cell and conducting the test, the mass of the applied challenge chemical shall be determined using the following procedure.

8.45.6.2.2* The challenge chemical shall be applied to an inert impermeable surrogate specimen in the pattern described in 8.45.7.4.

8.45.6.2.3 After application, the inert impermeable surrogate specimen shall be visually inspected to verify that the liquid chemical challenge was correctly applied.

8.45.6.2.4 The inert impermeable surrogate specimen with the applied liquid chemical challenge shall be placed in a closed large vial containing a known volume of solvent compatible with the following analysis procedure.

8.45.6.2.5 The large vial with solvent and impermeable surrogate specimen with the applied liquid challenge chemical shall be agitated for at least 1 hour to ensure complete extraction of the challenge chemical.

8.45.6.2.6 After agitation the solvent vial shall be removed and submitted for analysis of the liquid challenge chemical using a procedure capable of detecting 1.0 µg of the liquid challenge chemical.

8.45.6.2.7 Using the mass of the liquid challenge chemical detected in the extraction procedure and the exposed area of the test specimen defined by the test cell, the exposure concentration shall be 10 g/m² (+1.0 / -0.0 g/m²).

8.45.6.2.8 The number of one-microliter liquid droplets shall be adjusted to conform to the 10 g/m² (+1.0 / -0.0 g/m²) concentration requirement.

8.45.6.3* The following challenge chemicals shall be tested as gases or vapors in dry air or nitrogen.

- (1) Ammonia (NH₃, CAS 7664-41-7)
- (2) Chlorine (Cl₂, CAS 7782-50-5)
- (3) Acrolein (allyl aldehyde, CAS 107-02-8)
- (4) Acrylonitrile (VCN, cyanoethylene, CAS 107-13-1)

8.45.7 Procedures**8.45.7.1 Preconditioning**

8.45.7.1.1 The challenge chemicals, test specimen, test equipment, and test cell assembly shall be placed in the environmental chamber for a minimum of twenty-four hours at 32°C, +/- 1°C (90°F, +/- 2°F) and at a relative humidity of 80 percent, +/- 5 percent, prior to testing.

8.45.7.2 Test Cell Assembly

INSERT FIGURE: Use figure 8.7.5.2.1 Permeation Cell Assembly from Risk-Based Protective Clothing Material Permeation Criteria: Final Report prepared by International Personnel Protection, Inc. dated February 19, 2010.

8.45.7.2.1 The test cell shall be assembled in the environmental chamber at 32°C, +/- 1°C (90°F, +/- 2°F) and at a relative humidity of 80 percent, +/- 5 percent.

8.45.7.2.2 An O-ring shall be placed on the lower body of the test cell.

8.45.7.2.3 The sample support plate shall be placed on O-ring #1 and O-ring #2 shall be placed in the groove on the sample support plate.

8.45.7.2.4 The specimen shall be removed from the conditioning location in the environmental chamber and shall be placed on top of the sample support plate with O-ring #3 placed over the specimen.

8.45.7.2.5 With the upper body of the test cell upside down, O-ring #4 shall be placed in the upper body of the test cell and the compression plate shall be positioned over O-ring #4.

8.45.7.2.6 The upper body of the test cell with O-ring #4 and the compression plate, shall be inverted, aligned with the lug posts, and joined with the lower body of the test cell.

8.45.7.2.7 Using the four cell sealing lugs, the cell halves shall be clamped together and 51.8 cm-kp (45 in-lbs) of torque shall be applied to each lug to ensure a proper cell seal.

8.45.7.2.8 O-ring #5 shall be inserted into the groove around the agent challenge port in the upper body of the test cell and the cell cap shall be screwed into place.

8.45.7.2.9 The integrity of the test cell assembly shall be verified using the procedure in 8.45.7.3.

8.45.7.2.10 Each test cell shall be labeled with the challenge chemical to be used in it.

8.45.7.3 Verification of Test Cell Integrity

8.45.7.3.1 Test cell integrity shall be performed in the environmental chamber at 32°C, +/- 1°C (90°F, +/- 2°F) and at a relative humidity of 80 percent, +/- 5 percent.

8.45.7.3.2 Valves on the outlet ports of the upper and lower body of the test cell shall be closed.

8.45.7.3.3 Both the upper and lower body inlet ports of the test cell shall be connected to a manometer.

8.45.7.3.4 Both inlet ports shall be connected to a vacuum and the test cell upper body and test cell lower body shall be depressurized to 75 mm (3 inch) water column pressure.

8.45.7.3.5 If the test cell pressure drops below 50 mm (2 inch) of water column within 2 minutes, the test cell shall be reassembled according to the steps in 8.45.7.2.

8.45.7.3.6 Only test cells that have passed this integrity test shall be used for testing.

8.45.7.4 Determination of Procedure for Applying Liquid Challenge Chemicals

8.45.7.4.1 The liquid chemical challenge concentration shall be $10 \text{ g/m}^2 (+1.0 / -0.0 \text{ g/m}^2)$.

8.45.7.4.1.2 The number of one-microliter droplets shall be permitted to vary depending on the density of the liquid chemical challenge. Eight droplets shall be applied evenly spaced around the perimeter. The remaining droplets shall be placed in the center, if more than one droplet is required in the center, then the droplets shall be spaced 8.1 mm (1/3 in) apart. For seams, the droplets in the center shall be spaced along the seam juncture.

8.45.7.4.1.3 A mechanical or automated device shall be permitted for uniformly dispensing the droplets onto the surface of the specimen.

8.45.7.4.1.4 Prior to testing any liquid chemical, a quality control trial shall be conducted to verify that the application process delivers $10 \text{ g/m}^2 (+1.0 / -0.0 \text{ g/m}^2)$ using the procedures in 8.45.6.2

8.45.7.5 Procedure for Liquid Chemical Challenge

8.45.7.5.1 The test cell shall be mounted horizontally and connected to the air delivery system in the environmental chamber at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent. All connections shall be secured.

8.45.7.5.2 The calibrated analytical detection system shall be assembled and initiated according to its instructions.

8.45.7.5.2.1 If bubblers are used, each bubbler shall be filled with the proper collection solvent using a calibrated pipette or equivalent device; the collection solvent shall incorporate an internal standard so adjustments can be made for solvent evaporation/water condensation during sampling.

8.45.7.5.2.2 If solid sorbent tubes are to be used, each sorbent tube shall be cleaned by heating and purging; the absence of any residual chemical shall be verified by the appropriate analysis technique.

8.45.7.5.3 The air delivery shall be flowing filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, to the collection side of the test cell at least 15 minutes prior to the application of the challenge chemical.

8.45.7.5.4 With the cell cap removed, one-microliter droplets shall be placed through the agent challenge port of the test cell on the specimen's outer surface within 20 seconds, according to the procedure determined in 8.45.7.4

8.45.7.5.5 After placing the liquid challenge chemical on the specimen in the test cell, the cell cap shall be sealed within 5 seconds.

8.45.7.5.5.1 For testing of Class 2 ensemble materials, (this paragraph should be used in NFPA 1971 and 1994 and 1991) the filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, shall be flowed only to the collection side of the test cell a rate of 1.0 LPM, ± 0.1 LPM. No air shall be flowed across the challenge side of the test cell.

8.45.7.5.5.2 For testing of Class 3 ensemble materials, (this paragraph should be used in NFPA 1951 and 1994) the filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, shall be flowed to the challenge side of the test cell at a rate of 0.3 LPM, ± 0.03 LPM, and to the collection sides of the test cell at a rate of 1.0 LPM, ± 0.1 LPM.

8.45.7.5.6 The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes, $\pm 1.0 / -0$ minutes.

8.45.7.5.7 The collection media for the challenge chemical shall be analyzed using an appropriate analytical procedure.

8.45.7.5.8 At least one test shall be conducted with a specimen, but without the challenge chemical, as a negative control.

8.45.7.5.9* At least one test shall be conducted with an inert impermeable surrogate specimen as a negative control.

8.45.7.5.10 The results from tests accompanied by unsuccessful negative controls shall not be used and the test shall be repeated.

8.45.7.6 Procedure for Gas or Vapor Challenge Chemicals

8.45.7.6.1 The test cell shall be mounted horizontally and connected to the air delivery system in the environmental chamber at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent. All connections shall be secured.

8.45.7.6.2 The air delivery shall be connected and flowing 1 LPM of filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, to the collection side of test cell at least 15 minutes prior to the initiation of any gas or vapor challenge chemical.

8.45.7.6.3 The calibrated analytical detection system shall be assembled and initiated according to its instructions.

8.45.7.6.4 The initiation of the test shall occur when the gas or vapor challenge chemical is introduced into the challenge side of the test cell.

8.45.7.6.4.1 The supply of the gas or vapor challenge chemical shall be sufficient to maintain the gas or vapor challenge chemical concentration during the exposure period of 60 minutes + 1.0 / -0.0 minutes.

8.45.7.6.4.2 The gas or vapor challenge chemical shall be at a temperature of 32°C, +/- 1°C (90°F, +/- 2°F).

8.45.7.6.4.3 For testing of Class 2 ensemble materials, (this paragraph should be used in NFPA 1971 and 1994 and 1991) the concentration of the gas or vapor challenge chemical shall be 350 ppm, + 35 / -0 ppm.

8.45.7.6.4.4 For testing of Class 3 ensemble materials, (this paragraph should be used in NFPA 1951 and 1994) the concentration of the gas or vapor challenge chemical shall be 40 ppm, +10 / -0 ppm.

8.45.7.6.5 The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes, +1.0 / -0 minutes.

8.45.7.6.6 The collection media for the challenge chemical shall be analyzed using an appropriate analytical procedure.

8.45.7.6.7 At least one test shall be conducted with the specimen, but without the challenge chemical, as a negative control.

8.45.7.6.8* At least one test shall be conducted with an inert surrogate specimen as a negative control.

8.45.7.6.9 The results from tests accompanied by unsuccessful negative controls shall not be used and the test shall be repeated.

8.45.7.7 Test conclusion, test cell cleaned, and specimen disposal

8.45.7.7.1 At the conclusion of the test, the test cell shall be purged and the air delivery and analytical system shall be shut down.

8.45.7.7.2 Each cell shall be disassembled one at a time.

8.45.7.7.3 The tested specimen shall be inspected for degradation or other obvious abnormalities; these observations shall be recorded with the test results.

8.45.7.7.4 Disposal of tested specimens and other supplies shall be handled according to local, state, federal or other applicable regulations.

8.45.7.7.5 Each component of the test cell shall be rinsed with acetone or other appropriate solvent to remove residual chemicals.

8.45.7.7.6 The cell shall be allowed to air dry in a clean area for 24 hours before reuse.

8.45.8 Report

8.45.8.1 The cumulative permeation in one hour shall be calculated, recorded, and reported in $\mu\text{g}/\text{cm}^2$ for each specimen for each challenge chemical.

8.45.8.1.1 If no challenge chemical is detected at the end of the 60 minute test period, then the cumulative permeation shall be recorded and reported as less than the minimum detectable mass per unit area for the specific chemical being tested.

8.45.8.2 The average cumulative permeation shall be calculated and reported by averaging the results from all specimens for each challenge chemical.

8.45.8.2.1 For the calculation of average cumulative permeation, if the results of one or more of the specimens tested is less than the minimum detectable cumulative permeation then use the minimum detectable cumulative permeation as the result for those specimens.

8.45.8.2.2 For the calculation of average cumulative permeation, if the results of all the specimens tested are less than the minimum detectable cumulative permeation then the average cumulative permeation is reported as the minimum detectable cumulative permeation.

8.45.8.3 Report the thickness and weight per unit area of each specimen.

8.45.8.4 Report any observations of degradation or other abnormalities at the conclusion of the testing of each specimen.

8.45.9 Interpretation

8.45.9.1 The average cumulative permeation for each challenge chemical shall be used to determine pass or fail performance.

8.45.10 Specific Requirements for the CBRN Barrier layer of Garments, Hoods, and Booties.

{For NFPA 1951 see the existing text in Section 8.45.7 of the 2007-edition Standard}

{For NFPA 1971 see the existing text in Section 8.67.7 of the 2007-edition Standard}

{For NFPA 1991 see the existing text in Section 8.6.7 of the 2005-edition Standard}

{For NFPA 1994 see the existing text in Section 8.7.7 of the 2007-edition Standard}

8.45.11 Specific Requirements for Testing the CBRN Barrier Layer of Visors

{There is no specific text given for visors in NFPA 1951, 1971, or 1991}

{For NFPA 1994 see the existing text in Section 8.7.8 of the 2007-edition Standard}

8.45.12 Specific Requirements for Testing the CBRN Barrier Layer of Gloves

{For NFPA 1951 see the existing text in Section 8.45.9 of the 2007-edition Standard}

{For NFPA 1971 see the existing text in Section 8.67.9 of the 2007-edition Standard}

{For NFPA 1991 see the existing text in Section 8.6.8 of the 2005-edition Standard}

{For NFPA 1994 see the existing text in Section 8.7.9 of the 2007-edition Standard}

8.45.13 Specific Requirements for Testing the CBRN Barrier Layer of Footwear

{For NFPA 1951 see the existing text in Section 8.45.10 of the 2007-edition Standard}

{For NFPA 1971 see the existing text in Section 8.67.10 of the 2007-edition Standard}

{For NFPA 1991 see the existing text in Section 8.6.9 of the 2005-edition Standard}

{For NFPA 1994 see the existing text in Section 8.7.10 of the 2007-edition Standard}

8.45.14 Specific Requirements for Testing the CBRN Barrier Layer's seams of Garments, Hoods, Booties, Visors, and Gloves

{For NFPA 1951 see the existing text in Section 8.45.8 of the 2007-edition Standard}

{For NFPA 1971 see the existing text in Section 8.67.8 of the 2007-edition Standard}

{For NFPA 1991 see the existing text in Section 8.6.10 of the 2005-edition Standard}

{For NFPA 1994 see the existing text in Section 8.7.11 of the 2007-edition Standard}

Annex:

A.8.45.4.5 It is essential that the air delivery system provide precise flow to each test cell and achieve the specified temperature and humidity conditions. This delivery is controlled by the conditioning of the incoming air to achieve the temperature and humidity conditions before reaching each test cell and is monitored by separate flow meters or controllers for each test cell.

A.8.45.4.6 The performance requirement is based on a cumulative measurement; however discrete measurements can be used to determine this. These discrete measurements must be able to account for all of the permeating challenge chemical. This means that the frequency of the discrete sampling must be almost continuous, at least sampling once per minute, preferably sampling two to four times per minute, or more.

The efficacy of the selected sampling and analysis approach should be validated for each challenge chemical through the use of procedures where a known amount of the challenge chemical, representative of a cumulative permeation close to the minimum requirement, is injected into the collection medium of a trial test. The selected sampling and analytical approach should be able to demonstrate a mass recovery of 95% or better to be considered a valid part of the procedures.

A.8.45.5.2 Viton[®] O-rings have been found to be compatible with the challenge chemicals.

A.8.45.5.2.1 One procedure to determine the compatibility of O-ring material with the challenge chemicals would be to place the O-rings in contact with the challenge chemical for a period of 4 hours. Remove the O-ring from contact with the challenge chemical and observe for any physical changes or signs of degradation.

A.8.45.5.3 Aluminum foil with a thickness of 1/32nd of an inch has been found to be acceptable.

A.8.45.6.2.2 Aluminum foil with a thickness of 1/32nd of an inch has been found to be acceptable.

A.8.45.6.3 It is recommended that the concentrations for the gases be achieved by ordering prepared gas mixtures at the prescribed concentration.

A.8.45.7.5.9 Aluminum foil with a thickness of 1/32nd of an inch has been found to be acceptable.

A.8.45.7.6.8 Aluminum foil with a thickness of 1/32nd of an inch has been found to be acceptable.

Substantiation: This revised requirement and test method will, if adopted, harmonize the permeation resistance performance requirements for CWs and TICs in NFPA 1951, NFPA 1971, NFPA 1991, and NFPA 1994. Currently, they all try to do the same thing with slightly different words and format. This comment updates the procedures to conform with current best practices, corrects many editorial mistakes, and aligns the formatting in all 4 documents.

This is not original material; its reference/source is as follows:

Risk-Based Protective Clothing Material Permeation Criteria: Final Report prepared by International Personnel Protection Inc. dated February 19, 2010.

Committee Meeting Action: Accept in Principle

The technical committee notes that the print line references the preprint document.

Replace paragraph 7.3.1.3 with the following:

7.3.1.3 Each ensemble element's CBRN barrier layer and the CBRN barrier layer's seams shall be tested for permeation resistance as specified in Section 8.45 and shall meet the following performance criteria:

1. For permeation testing of the liquid chemical warfare agent sulfur mustard, distilled [HD, or bis (2- chloroethyl) sulfide, CAS 505-60-2], the average cumulative permeation in one hour shall not exceed 4.0 $\mu\text{g}/\text{cm}^2$.

2. For permeation testing of the liquid chemical warfare agent Soman [GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-64-0], the average cumulative permeation in one hour shall not exceed 1.25 $\mu\text{g}/\text{cm}^2$.

3. For permeation testing of the liquid toxic industrial chemical dimethyl sulfate (DMS, sulfuric acid dimethyl ester, CAS 77-78-1), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g}/\text{cm}^2$.

4. For permeation testing of the chemical gas acrolein (allyl aldehyde, CAS 107-02-8), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g}/\text{cm}^2$.

5. For permeation testing of the chemical gas acrylonitrile (VCN, cyanoethylene, CAS 107-13-1), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g}/\text{cm}^2$.

6. For permeation testing of the chemical gas ammonia (NH_3 , CAS 7664-41-7), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g}/\text{cm}^2$.

7. For permeation testing of the chemical gas chlorine (Cl_2 , CAS 7782-50-5), the average cumulative permeation in one hour shall not exceed $6.0 \mu\text{g}/\text{cm}^2$.

Delete Section 8.45 in the preprint and replace with the following:

8.45 Chemical Permeation Resistance Test

8.45.1 Application

8.45.1.1 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.

8.45.1.2 Specific requirements for testing the CBRN barrier layer of garments, hoods, and booties shall be as specified in 8.45.10.

8.45.1.3 Specific requirements for testing the CBRN barrier layer of visors shall be as specified in 8.45.11.

8.45.1.4 Specific requirements for testing the CBRN barrier layer of gloves shall be as specified in 8.45.12.

8.45.1.5 Specific requirements for testing the CBRN barrier layer of footwear shall be as specified in 8.45.13.

8.45.1.6 Specific requirements for testing the CBRN barrier layer's seams of garments, hoods, booties, visors, and gloves shall be as specified in 8.45.14.

8.45.2 Samples

8.45.2.1 Samples for conditioning shall be as specified according to the specific requirements in 8.45.10, 8.45.11, 8.45.12, 8.45.13, and 8.45.14 as appropriate.

8.45.2.2 Samples shall be conditioned as specified according to the specific requirements in 8.45.10, 8.45.11, 8.45.12, 8.45.13, and 8.45.14 as appropriate.

8.45.2.3 Samples shall then be cut to the specimen size.

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

8.45.3 Specimens

8.45.3.1 Specimens shall be the CBRN barrier layer or the CBRN barrier layer's seam of the size required to fit the permeation test cell.

8.45.3.2 A minimum of three specimens shall be tested against each challenge chemical.

8.45.3.3 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. Place the outer shell or other composite layers on the test specimen through the cell cap port after the test cell has been assembled.

8.45.3.4 If the specimen is the outer most layer of the composite then it shall be tested without any additional layers on top.

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

8.45.3.6 Specimens with non-uniform 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.

8.45.3.7 Following any sample preparation, the specimens shall be conditioned at a temperature of $32^\circ\text{C} \pm 1^\circ\text{C}$ ($90^\circ\text{F} \pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, for at least twenty-four hours prior to testing in accordance with paragraph 8.45.7.1.1.

8.45.4 Apparatus

8.45.4.1 A controlled environmental chamber shall be used to maintain the test cell, air flow control system, and reagent chemicals within $\pm 1.0^\circ\text{C}$ ($\pm 2.0^\circ\text{F}$) of the test temperature and ± 5 percent of the test relative humidity. The controlled environment chamber shall be sized so that it can be used for conditioning test materials, test cells when not in use, challenge chemicals, and other test apparatus prior to testing, as well as holding the test cells horizontally during use while connected to the air delivery system with manifold and to the effluent sampling mechanism.

8.45.4.2 The test cell shall be a two-chambered cell for contacting the specimen with the challenge chemical on the specimen's normal outside surface and for flowing a collection medium on the specimen's normal inside surface, which meets the test cell requirements for the Liquid Challenge/Vapor Penetration (L/V) Test Cell specified in TOP 8-2-501 and shown in Figure 8.45.4.2 (1), and with the following additional specifications:

- (1) The test cell is configured to separately permit flow across the challenge side and the collection side, and to allow the challenge side to be exposed for the placement of challenge chemical.
- (2) The sample support plate and compression plate shall be modified as shown in Figure 8.45.4.2 (2), Figure 8.45.4.2 (3), and Figure 8.45.4.2 (4), to permit the O-rings to be closer to the exposed surface area of the specimen.
- (3) The cell cap shall have a smooth solid surface facing the test specimen, i.e. no opening ports for cell integrity testing.
- (4) Ports for testing the integrity of the assembled test cell shall be mounted on the inlet fittings on both the upper body and lower body of the test cell.

****Insert the following Figures:****

8.45.4.2 (1) Liquid Challenge/Vapor Penetration (L/V) Test Cell (from Log 51 Figure 8.45.4.1.4 Liquid Challenge/Vapor Penetration (L/V) Test Cell).

8.45.4.2 (2) Modifications to Sample Support Plate and Compression Plate (from Log 51 Figure 8.45.4.1.4(2)-1 Modifications to Sample Support Plate and Compression Plate).

8.45.4.2 (3) Specific Modifications to Compression Plate (from Log 51 Figure 8.45.4.1.4(2)-2 Specific Modifications to Compression Plate).

8.45.4.2 (4) Specific Modifications to Sample Support Plate (from Log 51 Figure 8.45.4.1.4(2)-3 Specific Modifications to Sample Support Plate).

8.45.4.3 An air delivery system and manifold shall be used to provide oil-free, conditioned air to the test cell/fixtures at a rate of 2 standard liters per minute (SLPM) per test cell/fixture with a temperature precision of +/- 0.2°C and a relative humidity precision of +/- 5 percent. The manifold is designed to deliver 0.3 L/min for the challenge side of the test cell and 1 L/min for the collection side of the test cell and maintain at the test temperature. All parts of the air delivery system and manifold must be chemically inert and non-absorptive to the challenge chemical.

8.45.4.4 An analytical system shall be used to evaluate the amount of challenge chemical in the effluent air streams from the collection side of the test cell and shall be selected to provide the ability to measure the challenge chemical at 0.1 µg/cm² over the test exposure period. The analytical system shall be permitted to include a bubbler tube, solid sorbent, or real time chemical analyzer. Effluent sampling shall be permitted to be taken discretely or cumulatively; however the selected analytical system shall be able to determine all of the challenge chemical permeating through the specimen in 60 minutes.

8.45.4.5* A vacuum pump capable of creating vacuum of at least 5 inches water column shall be used for testing the integrity of the assembled test cell.

8.45.4.6 A manometer or pressure gage capable of measuring pressures or vacuums to 10 inches water column, with an accuracy of 5 percent of scale, shall be used for testing the integrity of the assembled test cell.

8.45.5 Supplies

8.45.5.1 Syringe needles, capable of delivering one-microliter droplets, +/- 1%, of the challenge chemical, shall be used for dispensing liquid challenge chemical onto the surface of the specimen in the test cell.

8.45.5.2* Replacement O-rings shall be available for use in the permeation test cell.

8.45.5.2.1* If unknown, the compatibility of the O-ring material with the challenge chemical shall be verified before use.

8.45.5.2.2 If an O-ring shows any signs of chemical degradation in the form of softening, hardening, swelling, deterioration, or loss of shape, or function, an O-ring of different material shall be used that does not show chemical degradation.

8.45.5.3* An inert impermeable surrogate material shall be used as a negative control during validation tests.

8.45.6 Chemicals

8.45.6.1 The following challenge chemicals shall be tested as liquids:

(1) Liquid chemical warfare agents

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

(b) Soman [GD, or O-Pinacolyl methylphosphonofluoridate, CAS 96-64-0]

(2) Liquid toxic industrial chemical

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

8.45.6.2 Process for Determining the Mass of Liquid Chemical Challenge Applied

8.45.6.2.1 Prior to assembling the test cell and conducting the test, the mass of the applied challenge chemical shall be determined using the following procedure.

8.45.6.2.2* The challenge chemical shall be applied to an inert impermeable surrogate specimen in the pattern described in 8.45.7.4.

8.45.6.2.3 After application, the inert impermeable surrogate specimen shall be visually inspected to verify that the liquid chemical challenge was correctly applied.

8.45.6.2.4 The inert impermeable surrogate specimen with the applied liquid chemical challenge shall be placed in a closed large vial containing a known volume of solvent compatible with the following analysis procedure.

8.45.6.2.5 The large vial with solvent and impermeable surrogate specimen with the applied liquid challenge chemical shall be agitated for at least 1 hour to ensure complete extraction of the challenge chemical.

8.45.6.2.6 After agitation the solvent vial shall be removed and submitted for analysis of the liquid challenge chemical using a procedure capable of detecting 1.0 mg of the liquid challenge chemical.

8.45.6.2.7 Using the mass of the liquid challenge chemical detected in the extraction procedure and the exposed area of the test specimen defined by the test cell, the exposure concentration shall be 10 g/m^2 (+1.0 / -0.0 g/m^2).

8.45.6.2.8 The number of one-microliter liquid droplets shall be adjusted to conform to the 10 g/m^2 (+1.0 / -0.0 g/m^2) concentration requirement.

8.45.6.3* The following challenge chemicals shall be tested as gases or vapors in dry air or nitrogen.

- (1) Ammonia (NH_3 , CAS 7664-41-7)
- (2) Chlorine (Cl_2 , CAS 7782-50-5)
- (3) Acrolein (allyl aldehyde, CAS 107-02-8)
- (4) Acrylonitrile (VCN, cyanoethylene, CAS 107-13-1)

8.45.7 Procedures

8.45.7.1 Preconditioning

8.45.7.1.1 The challenge chemicals, test specimen, test equipment, and test cell assembly shall be placed in the environmental chamber for a minimum of twenty-four hours at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, prior to testing.

8.45.7.2 Test Cell Assembly

****Insert Figure 8.45.5.2.1 Permeation Cell Assembly from the Log 51 Include and renumber here as 8.45.7.2.

(Courtesy Risk-Based Protective Clothing Material Permeation Criteria: Final Report prepared by International Personnel Protection, Inc. dated February 19, 2010) Here****

8.45.7.2.1 The test cell shall be assembled in the environmental chamber at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent.

8.45.7.2.2 An O-ring shall be placed on the lower body of the test cell.

8.45.7.2.3 The sample support plate shall be placed on O-ring #1 and O-ring #2 shall be placed in the groove on the sample support plate.

8.45.7.2.4 The specimen shall be removed from the conditioning location in the environmental chamber and shall be placed on top of the sample support plate with O-ring #3 placed over the specimen.

8.45.7.2.5 With the upper body of the test cell upside down, O-ring #4 shall be placed in the upper body of the test cell and the compression plate shall be positioned over O-ring #4.

8.45.7.2.6 The upper body of the test cell with O-ring #4 and the compression plate, shall be inverted, aligned with the lug posts, and joined with the lower body of the test cell.

8.45.7.2.7 Using the four cell sealing lugs, the cell halves shall be clamped together and 51.8 cm-kG (45 in-lbs) of torque shall be applied to each lug to ensure a proper cell seal.

8.45.7.2.8 O-ring #5 shall be inserted into the groove around the agent challenge port in the upper body of the test cell and the cell cap shall be screwed into place.

8.45.7.2.9 The integrity of the test cell assembly shall be verified using the procedure in 8.45.7.3.

8.45.7.2.10 Each test cell shall be labeled with the challenge chemical to be used in it.

8.45.7.3 Verification of Test Cell Integrity

8.45.7.3.1 Test cell integrity shall be performed in the environmental chamber at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent.

8.45.7.3.2 Valves on the outlet ports of the upper and lower body of the test cell shall be closed.

8.45.7.3.3 Both the upper and lower body inlet ports of the test cell shall be connected to a manometer.

8.45.7.3.4 Both inlet ports shall be connected to a vacuum and the test cell upper body and test cell lower body shall be depressurized to 75 mm (3 inch) water column pressure.

8.45.7.3.5 If the test cell pressure drops below 50 mm (2 inch) of water column within 2 minutes, the test cell shall be reassembled according to the steps in 8.45.7.2.

8.45.7.3.6 Only test cells that have passed this integrity test shall be used for testing.

8.45.7.4 Determination of Procedure for Applying Liquid Challenge Chemicals

8.45.7.4.1 The liquid chemical challenge concentration shall be $10 \text{ g/m}^2 (+1.0 / -0.0 \text{ g/m}^2)$.

8.45.7.4.1.2 The number of one-microliter droplets shall be permitted to vary depending on the density of the liquid chemical challenge. Eight droplets shall be applied evenly spaced around the perimeter. The remaining droplets shall be placed in the center, if more than one droplet is required in the center, then the droplets shall be spaced 8.1 mm (1/3 in) apart. For seams, the droplets in the center shall be spaced along the seam juncture.

8.45.7.4.1.3 A mechanical or automated device shall be permitted for uniformly dispensing the droplets onto the surface of the specimen.

8.45.7.4.1.4 When testing any liquid chemical, a quality control trial shall be conducted to verify that the application process delivers $10 \text{ g/m}^2 (+1.0 / -0.0 \text{ g/m}^2)$ using the procedures in 8.45.6.2

8.45.7.5 Procedure for Liquid Chemical Challenge

8.45.7.5.1 The test cell shall be mounted horizontally and connected to the air delivery system in the environmental chamber at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent. All connections shall be secured.

8.45.7.5.2 The calibrated analytical detection system shall be assembled and initiated according to its instructions.

8.45.7.5.2.1 If bubblers are used, each bubbler shall be filled with the proper collection solvent using a calibrated pipette or equivalent device; the collection solvent shall incorporate an internal standard so adjustments can be made for solvent evaporation/water condensation during sampling.

8.45.7.5.2.2 If solid sorbent tubes are to be used, each sorbent tube shall be cleaned by heating and purging; the absence of any residual chemical shall be verified by the appropriate analysis technique.

8.45.7.5.3 The air delivery shall be flowing filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, to the collection side of the test cell at least 15 minutes prior to the application of the challenge chemical.

8.45.7.5.4 With the cell cap removed, one-microliter droplets shall be placed through the agent challenge port of the test cell on the specimen's outer surface within 20 seconds, according to the procedure determined in 8.45.7.4.

8.45.7.5.5 After placing the liquid challenge chemical on the specimen in the test cell, the cell cap shall be sealed within 5 seconds.

8.45.7.5.5.1 The filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, shall be flowed to the challenge side of the test cell at a rate of 0.3 LPM, ± 0.03 LPM, and to the collection sides of the test cell at a rate of 1.0 LPM, ± 0.1 LPM.

8.45.7.5.6 The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes, $\pm 1.0 / -0$ minutes.

8.45.7.5.7 The collection media for the challenge chemical shall be analyzed using an appropriate analytical procedure.

8.45.7.5.8 At least one test shall be conducted with a specimen, but without the challenge chemical, as a negative control.

8.45.7.5.9* At least one test shall be conducted with an inert impermeable surrogate specimen as a negative control.

8.45.7.5.10 The results from tests accompanied by unsuccessful negative controls shall not be used and the test shall be repeated.

8.45.7.6 Procedure for Gas or Vapor Challenge Chemicals

8.45.7.6.1 The test cell shall be mounted horizontally and connected to the air delivery system in the environmental chamber at 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent. All connections shall be secured.

8.45.7.6.2 The air delivery shall be connected and flowing 1 LPM of filtered air at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$) and at a relative humidity of 80 percent, ± 5 percent, to the collection side of test cell at least 15 minutes prior to the initiation of any gas or vapor challenge chemical.

8.45.7.6.3 The calibrated analytical detection system shall be assembled and initiated according to its instructions.

8.45.7.6.4 The initiation of the test shall occur when the gas or vapor challenge chemical is introduced into the challenge side of the test cell.

8.45.7.6.4.1 The supply of the gas or vapor challenge chemical shall be sufficient to maintain the gas or vapor challenge chemical concentration during the exposure period of 60 minutes $\pm 1.0 / -0.0$ minutes.

8.45.7.6.4.2 The gas or vapor challenge chemical shall be at a temperature of 32°C , $\pm 1^\circ\text{C}$ (90°F , $\pm 2^\circ\text{F}$).

8.45.7.6.4.3 The concentration of the gas or vapor challenge chemical shall be 40 ppm, $\pm 10 / -0$ ppm.

8.45.7.6.4 The challenge chemical in the effluent air stream shall be collected, measured, and analyzed using either discrete or cumulative methods for 60 minutes, $\pm 1.0 / -0$ minutes.

8.45.7.6.5 The collection media for the challenge chemical shall be analyzed using an appropriate analytical procedure.

8.45.7.6.6 At least one test shall be conducted with the specimen, but without the challenge chemical, as a negative control.

8.45.7.6.7 At least one test shall be conducted with an inert surrogate specimen as a negative control.

8.45.7.6.8* The results from tests accompanied by unsuccessful negative controls shall not be used and the test shall be repeated.

8.45.7.7 Test conclusion, test cell cleaned, and specimen disposal

8.45.7.7.1 At the conclusion of the test, the test cell shall be purged and the air delivery and analytical system shall be shut down.

8.45.7.7.2 Each cell shall be disassembled one at a time.

8.45.7.7.3 The tested specimen shall be inspected for degradation or other obvious abnormalities; these observations shall be recorded with the test results.

8.45.7.7.4 Disposal of tested specimens and other supplies shall be handled according to local, state, federal or other applicable regulations.

8.45.7.7.5 Each component of the test cell shall be rinsed with acetone or other appropriate solvent to remove residual chemicals.

8.45.7.7.6 The cell shall be allowed to air dry in a clean area for 24 hours before reuse.

8.45.8 Report

8.45.8.1 The cumulative permeation in one hour shall be calculated, recorded, and reported in $\mu\text{g}/\text{cm}^2$ for each specimen for each challenge chemical.

8.45.8.1.1 If no challenge chemical is detected at the end of the 60 minute test period, then the cumulative permeation shall be recorded and reported as less than the minimum detectable mass per unit area for the specific chemical being tested.

8.45.8.2 The average cumulative permeation shall be calculated and reported by averaging the results from all specimens for each challenge chemical.

8.45.8.2.1 For the calculation of average cumulative permeation, if the results of one or more of the specimens tested is less than the minimum detectable cumulative permeation then use the minimum detectable cumulative permeation as the result for those specimens.

8.45.8.2.2 For the calculation of average cumulative permeation, if the results of all the specimens tested are less than the minimum detectable cumulative permeation then the average cumulative permeation is reported as the minimum detectable cumulative permeation.

8.45.8.3 Report any observations of degradation or other abnormalities at the conclusion of the testing of each specimen.

8.45.9 Interpretation

8.45.9.1 The average cumulative permeation for each challenge chemical shall be used to determine pass or fail performance.

8.45.10 Specific Requirements for the CBRN Barrier layer of Garments, Hoods, and Booties.

8.45.10 Specific Requirements for Testing Garment, Hood, and Bootie Materials.

8.45.10.1 Samples for conditioning shall be at least 380 mm (15 in.) square and shall consist of all layers of the composite arranged in the order used in the construction of the garment, hood, or bootie.

8.45.10.2 Composite samples prepared as described in 8.45.10.1 shall be tested after being twice subjected to the following conditioning.

(1) Specimens shall first be subjected to the procedure specified in 8.1.9.

(2) Specimens shall then be conditioned as specified in 8.1.2.

(3) Specimens shall then be conditioned as specified in 8.1.8.

8.45.10.3 The composite sample, including the CBRN barrier layer, that was conditioned in 8.45.7.2 shall be trimmed to a sample size of 300 mm \times 280 mm (12 in. \times 11 in.). The trimmed composite samples shall be subject to flexing conditioning as specified in 8.1.11 with the 280 mm (11 in.) direction parallel with the compression action of the machine. The trimmed samples shall be mounted such that the outer layer is visible with all layers in their normal "as worn" orientation.

8.45.10.4 Following flexing, samples of the CBRN barrier layer shall be removed from the flexed, trimmed composite sample, cut to the dimensions specified in 8.45.7.3 with the long dimension of the sample parallel to the 280 mm (11 in.) dimension.

8.45.10.5 The layers in the flexed, trimmed composite sample adjacent to the CBRN barrier layer shall be retained for use as the abrasants.

8.45.10.6 The CBRN barrier layer samples prepared as specified as 8.45.10.4 and the other samples retained as specified in 8.45.10.5 shall be subjected to abrasion as specified 8.1.12.

8.45.10.7 Following abrading, the permeation test specimen shall be taken from the center of the abraded sample so

that the center of the permeation test and the center of the abraded sample coincide.

8.45.10.8 Use of exterior layers with the CBRN barrier layer specimen shall be permitted. Exterior layer specimens shall be removed from the composite samples that are conditioned as specified in 8.45.10.2.

8.45.10.9 The specimens shall be oriented in the permeation test cell with the exterior surfaces facing the challenge chemical.

8.45.10.10 Specimens shall be tested for permeation resistance as specified in 8.45.2 through 8.45.6.

8.45.11 Specific Requirements for Testing the CBRN Barrier Layer of Gloves

8.45.11.1 This test shall apply to all types of glove configurations.

8.45.11.2 Samples for conditioning shall be whole gloves.

8.45.11.3 Glove samples shall be subjected to the following sequence a total of two times prior to permeation testing.

- (1) Specimens shall first be subjected to the procedure specified in 8.1.9.
- (2) Specimens shall then be conditioned as specified in 8.1.2.
- (3) Specimens shall then be conditioned as specified in 8.1.8.

8.45.11.4 Following the conditioning specified in 8.45.11.3,

conditioned gloves shall be donned by a test subject and subjected to flexing by the test subject clenching his or her hands into a fist a total of 3000 times over a period not greater than 60 minutes. Test subjects shall be selected so that their hand dimensions are as close as possible to the middle of the range for hand length and hand circumference as specified in 6.1.3.4 and A.6.1.3.6.

8.45.11.5 Following the flexing in 8.45.11.4, specimens for permeation resistance testing shall be taken from the CBRN barrier layer of the flexed glove. Where the CBRN layer includes seams, specimens shall include seams that bisect the specimens.

8.45.11.6 Use of exterior layers with the CBRN barrier layer specimen shall be permitted. Exterior layer specimens shall be removed from the composite samples that are conditioned as specified in 8.45.9.2.

8.45.11.7 Specimens shall be tested for permeation resistance as specified in 8.45.2 through 8.45.6.

8.45.12 Specific Requirements for Testing the CBRN Barrier Layer of Footwear

8.45.12.1 This test shall not apply to footwear configurations that include booties that are subjected to the procedures in 8.45.7 and 8.45.8.

8.45.12.2 Samples for conditioning shall be whole footwear items.

8.45.12.3 Footwear samples shall be subjected to the following sequence a total of two times prior to permeation testing.

- (1) Samples shall first be conditioned as specified in 8.1.8.
- (2) Samples shall then be conditioned by flexing 500,000 cycles in accordance with Appendix B of FIA 1209, *Whole*

1951-30 Log #16 FAE-SCE
(7.3.2.18)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: In last line change "barrier layer and barrier layer seams" to "outer shell" and "outer shell seams".
Add 7.3.2.13 to list of required paragraphs.

Substantiation: Editorial correction. Addition of 7.3.2.13 is an outer shell requirement missing from list.

Committee Meeting Action: Accept

The technical committee notes that the comment references the preprint document in the print line.

1951-31 Log #15 FAE-SCE
(7.3.3.12)

Final Action: Reject

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Delete 7.3.3.12.

Substantiation: This requirement is redundant with 7.3.1.3.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the comment as the information is not redundant.

1951-32 Log #17 FAE-SCE
(7.3.4.18 and 7.3.5.22)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-14

Recommendation: Change "distance of not less than 25 mm (1 in.)" to "distance of not less than 20 mm (0.8 in.)".

Substantiation: Match requirement with base composite requirement in 7.3.5.2 and in 7.3.4.1. See Log #CP8.

Committee Meeting Action: Accept

The technical committee notes that the comment references the preprint document in the print line.

1951-33 Log #19 FAE-SCE
(7.3.6,8.1.9, 8.1.12, and 8.1.14)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-26

Recommendation: Make heading bold. 8.1.13 missing.

Substantiation: Editorial.

Committee Meeting Action: Accept

The technical committee notes that the comment references the preprint document in the print line.

EDITORIAL NOTE: Section 8.1.10 from the 2007 edition of the standard is missing from the preprint. The text of that section should be inserted before section 8.1.10 in the preprint. Section 8.1.10 in the preprint should then be renumbered 8.1.11, and the subsequent section renumbered accordingly.

1951-34 Log #47 FAE-SCE
(Chapter 8)

Final Action: Accept in Principle

Submitter: Steven D. Corrado, Underwriters Laboratories Inc.

Comment on Proposal No: 1951-26

Recommendation: Helmet test methodology should be revised to be consistent with that of NFPA 1971.

Substantiation: At the time of comment submission, work is ongoing by the NFPA 1971 Task Group on Helmets, Footwear, and Gloves. Test methodology in NFPA 1971 and 1951 should be consistent.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment on 1951-41 (Log #CC1).

1951-35 Log #48 FAE-SCE
(Chapter 8)

Final Action: Accept in Principle

Submitter: Steven D. Corrado, Underwriters Laboratories Inc.

Comment on Proposal No: 1951-10

Recommendation: Footwear test methodology should be revised to be consistent with that of NFPA 1971.

Substantiation: At the time of comment submission, work is ongoing by the NFPA 1971 Task Group on Helmets, Footwear, and Gloves. Test methodology in NFPA 1971 and 1951 should be consistent.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment on 1951-51 (Log #CC5) and 1951-26 (Log #CC16).

1951-36 Log #49 FAE-SCE
(Chapter 8)

Final Action: Accept in Principle

Submitter: Steven D. Corrado, Underwriters Laboratories Inc.

Comment on Proposal No: 1951-6

Recommendation: Glove test methodology should be revised to be consistent with that of NFPA 1971.

Substantiation: At the time of comment submission, work is ongoing by the NFPA 1971 Task Group on Helmets, Footwear, and Gloves. Test methodology in NFPA 1971 and 1951 should be consistent.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment on 1951-41 (Log #CC1), 1951-10 (Log #CC7) and 1951-61 (Log# CC8).

1951-37 Log #40 FAE-SCE
(8.1, 8.1.1)

Final Action: Accept in Principle

Submitter: Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment,

Comment on Proposal No: 1951-26

Recommendation: The TCC instructs the Technical Committee on Special Operations Protective Clothing and Equipment to review this proposal and the work conducted by the Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment helmet task group.

Substantiation: This is a direction from the Technical Correlating Committee on Special Operations Protective Clothing and Equipment in accordance with 3.4.2 and 3.4.3 of the Regulations Governing Committee Projects.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment on 1951-41 (Log #CC1).

1951-38 Log #CC10 FAE-SCE
(8.1.7 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,

Comment on Proposal No: 1951-27

Recommendation: Delete the text in the preprint of section 8.1.7, and replace with the following:

8.1.7 Wet Conditioning Procedure for Whole Gloves.

8.1.7.1 Test subjects shall be selected such that their hand dimensions are as close as possible to those specified in accordance with manufacturing glove-sizing guidelines.

8.1.7.2 The wrist crease location shall be marked as described in 6.1.3.3 on each specimen around the entire glove +0/-3 mm (+0/-0.25 in.). Then, in the same manner, the water height line shall also be marked on each specimen 25 mm (1 in.) +0/-3 mm (+0/-0.25 in.) below (towards the fingers) the location of the wrist crease around the entire glove.

8.1.7.3 The test subject shall don the test specimen gloves.

8.1.7.4 The test subject shall immerse the donned specimens straight down into two containers of water at a temperature of 21°C, ±3°C (70°F, ±5°F) to the water height line for 15 secs +1.5/-0 sec.

8.1.7.5 The glove specimens shall be tested within 1 min.

Substantiation: The wetting procedure was modified slightly to remove requirement for stool and to reduce the water height due to the reduction in the length requirement of the glove body.

Committee Meeting Action: Accept

1951-39 Log #20 FAE-SCE
(8.1.9.1 through 8.1.9.14)

Final Action: Accept in Principle

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Change garment, gloves, glove pouches, hoods and CBRN material to "the sample". Harmonize the instructions so all samples are conditioned the same.

Substantiation: Having slightly different instructions for all these items makes for a lot of redundancy in these paragraphs.

Committee Meeting Action: Accept in Principle

Delete section 8.1.9 in the preprint and replace with the following:

8.1.9 Washing and Drying Procedures for Whole Garments, Gloves, Glove Pouches, and CBRN Materials.

8.1.9.1 Samples shall be washed and dried alternately for a total of ten washing and ten drying cycles.

8.1.9.2 Samples shall be washed and dried with all closures fastened.

8.1.9.3 A front-loading washer/extractor shall be used for washing the samples.

8.1.9.4 The wash load shall be two-thirds the rated capacity of the washer. If ballast is needed to reach two-thirds capacity, 7.5 osy Nomex ballast shall be used. Two-thirds of the rated capacity shall not be exceeded.

8.1.9.5 The wash cycle procedure in Table 8.1.9.4 shall be followed.

8.1.9.6 A tumble dryer with a dry stack temperature of 38 degrees C to 49 degrees C (100 degrees F to 120 degrees F) measured 20 minutes into the drying cycle shall be used for drying the samples.

8.1.9.7 Samples shall be removed from the dryer after 60 minutes of tumble drying, except CBRN material samples shall be removed after 20 minutes. At the conclusion of the final drying cycle the sample shall be allowed to dry completely for at least 48 hours in accordance with paragraph 8.1.2.

Committee Statement: The technical committee accepted the comment in principle, and provided the clarifying amended text for washing and drying as shown in the meeting action.

1951-40 Log #21 FAE-SCE
(8.1.10 and 8.1.11)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Change "specimen" to "sample" throughout.

Substantiation: Samples are the subject of conditioning.

Committee Meeting Action: Accept

1951-41 Log #CC1 FAE-SCE Final Action: Accept
(8.1.12, 8.5.11.4, 8.18.5.1.1, 8.18.5.2.1, 8.19.5.1, 8.20.5.1, 8.21.5.1.1, 8.21.5.1.2, 8.21.5.2.2, Preprint)

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-26

Recommendation: Delete the following paragraphs in the preprint document:

8.1.12
8.1.12.1
8.1.12.2
A.8.1.12

Add new text as follows:

8.1.12 Helmet Positioning

8.1.12.1 The helmet shall be seated firmly on the applicable test headform in accordance with the Helmet Positioning Index (HPI).

8.1.12.2 The HPI shall be the vertical distance, as specified by the helmet manufacturer, from the lowest point of the front lateral midpoint of the helmet shell aligned with the midsagittal plane, to the basic plane of an ISO size J headform conforming to the nominal dimensions in Figure 8.23.4.1, with the helmet firmly positioned on the headform.

8.1.12.3 When positioning the helmet for testing on headforms other than the ISO size J, the basic plane used for the HPI positioning shall be located 130 mm below and parallel to the crown of the headform and shall be marked on the headform.

Revise text as follows:

8.5.11.4 Sample helmets shall be positioned according to the HPI as described in 8.1.13 on the thermal headform conforming to the dimensions in Figure 8.5.11.4.

8.18.5.1.1 The helmet shall be ~~seated~~ positioned according to the HPI as described in 8.1.X on the ISO J headform specified in Figure 8.23.4.1 according to the manufacturer's positioning index, as specified in the manufacturer's instruction for the specific helmet.

8.18.5.2.1 The helmet shall be ~~seated~~ positioned according to the HPI as described in 8.1.X on the ISO J headform specified in Figure 8.23.4.1 according to the manufacturer's positioning index, as specified in the manufacturer's instruction for the specific helmet.

8.19.5.1 Specimen helmets shall be positioned ~~as described in 8.1.13~~ according to the HPI as described in 8.1.13 on the headform. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. ~~Where an internal faceshield is an integral part of the structural integrity of the helmet, it shall be deployed as far as possible without interfering with the test equipment.~~ Helmets shall be subjected to the environmental conditions specified in 8.1.2, 8.1.4, 8.1.5, and 8.1.6 prior to each impact and within the specified time after being removed from conditioning.

8.20.5.1 The environmentally conditioned helmet shall be positioned according to the HPI as described in 8.1.13 on the ~~rigidly mounted~~ test headform and secured by the helmet retention system or by other means that will not interfere with the test. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance. The helmet shall be positioned so that the penetration striker shall impact perpendicular to the helmet. The helmet shall be adjusted to a size sufficient to properly fit on the headform with the horizontal center plane parallel and within 5 degrees of the reference plane. The front-to-back centerline of the shell shall be within 13 mm (0.5 in.) of the midsagittal plane of the headform. ~~Where an internal faceshield is an integral part of the structural integrity of the helmet, it shall be deployed as far as possible without interfering with the test equipment.~~

8.21.5.1.1 The helmet shall be positioned according to the HPI as described in 8.1.13 on the ISO size J headform specified in Figure 8.23.4.1. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the most amount of clearance.

8.21.5.1.2 The dielectric test plane specified in Figure 8.21.5.1.2 shall be marked on the shell of the helmet. The dielectric test plane shall be the plane that passes through the point located 85 mm above the basic plane, where the basic plane and the midsagittal plane intersect at the front of the headform, and the point located 60 mm above the basic plane, where the basic plane and the midsagittal plane intersect at the rear of the headform.

8.21.5.2.2 The specimen shall then be ~~mounted~~ positioned according to the HPI as described in 8.1.13 on the modified ISEA size 7 aluminum headform, with chin strap firmly secured to the headform by means of the conductive terminal junction bolt. Where the crown clearance of the helmet is adjustable, the helmet shall be mounted with the least amount of clearance.

Substantiation: The proposed language meets the intent of the original language but uses a different method of achieving this goal. This method was preferred because of its simplicity and because it does not depend on helmet positioning.

Committee Meeting Action: Accept

1951-42 Log #CC11 FAE-SCE
(8.1.14 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-29

Recommendation: Delete the text of section 8.1.14 in the preprint, and replace with the following:

8.1.14* Glove Test Areas.

8.1.14.1 Glove test shall be as described below and shown in Figure 8.1.14.1. Glove Test Area abbreviations shall be as follows: P=Palm; B=Back; S=Side.

A-P.) Palm side of hand from finger crotch line to $\frac{1}{3}$ of the way down (grasp area)

B-P.) Palm side of hand from $\frac{1}{3}$ of the way down (grasp area) to the wrist crease

C-P.) Palm side of hand from the wrist crease to 50 mm (2 in.) past the wrist crease

D-P.) Palm side of thumb

E-P.) Palm side of tip of thumb

F-P.) Palm side of index finger

G-P.) Palm side of fingertip of index finger

H-P.) Palm side of non-index fingers

I-P.) Palm side of fingertip of non-index fingers

A-PS.) Sides of hand adjacent to section A-P

B-PS.) Outside of hand adjacent to section B-P

C-PS.) Sides of hand adjacent to section C-P

D-PS.) Outside of thumb adjacent to section D-P

E-PS.) Inside of thumb adjacent to section D-P

F-PS.) Outside of index finger adjacent to section F-P

H-PS.) In between fingers adjacent to sections F-P and H-P

I-PS.) Outside of and adjacent to the smallest finger

A-B.) Back side of hand from finger crotch line to $\frac{1}{3}$ of the way down (knuckle area)

B-B.) Back side of hand from $\frac{1}{3}$ of the way down (knuckle area) to the wrist crease

C-B.) Back side of hand from the wrist crease to 50 mm (2 in.) past the wrist crease

D-B.) Back side of thumb

E-B.) Back side of tip of thumb

F-B.) Back side of index finger

G-B.) Back side of fingertip of index finger

H-B.) Back side of non-index fingers

I-B.) Back side of fingertip of non-index fingers

A-BS.) Sides of hand adjacent to section A-B

B-BS.) Outside of hand adjacent to section B-B

C-BS.) Sides of hand adjacent to section C-B

D-BS.) Outside of thumb adjacent to section D-B

E-BS.) Inside of thumb adjacent to section D-B

F-BS.) Outside of index finger adjacent to section F-B

H-BS.) In between fingers adjacent to sections F-B and H-B

I-BS.) Outside of and adjacent to the smallest finger

****Insert 1951_LCC11_ Fig 8.1.14.1_Rec Here****

Add a new Annex item as follows:

A.8.1.14 When a glove is 2 dimensional rather than 3 dimensional (the glove in Figure A.8.1.14 is 3 dimensional),

then the same methodology should be applied to the 2 dimensional glove. For example, if there are requirements for the sides of the fingers, then the area of the glove that would cover the sides of the fingers should be considered for these requirements even though the glove does not have forchettes. When wearing a correctly sized glove and laying the gloved hand completely flat on an even, flat surface, the portion of the glove that comes in contact with the even, flat surface should be considered the palm test areas of the glove. The layers immediately above the palm areas should be considered the areas next to the palm areas. The finger sides should include the interior side areas of the small, ring, middle, and index fingers for a glove, that are hidden from sight, as observed both from the glove palm and glove back sides, when an individual wearing a correctly sized glove has his or her fingers completely closed.

The back area is intended to include all parts of the glove that are not defined as the palm area or the side areas. The layers immediately beneath the back areas should be considered the side areas next to the back areas.

Substantiation: This comment further divides test areas of gloves to provide more options for testing and for future use.

Committee Meeting Action: Accept

1951-43 Log #26 FAE-SCE **Final Action: Accept**
(8.2.2.2, 8.4.3.1, 8.5.2.2, 8.7.2.2, 8.8.2.2, 8.9.2.2, 8.13.2.2, 8.16.2.2, and 8.17.2.2)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Add "except CBRN garment and material samples shall be conditioned as specified in 8.1.9 followed by 8.1.2."

Substantiation: The correct laundering preconditioning for CBRN garments and materials is in 8.1.9, not 8.1.3.

Committee Meeting Action: Accept

1951-44 Log #23 FAE-SCE **Final Action: Accept**
(8.2.2.2 and 8.2.2.3)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Change to "8.2.2.2 Samples shall be conditioned as specified in 8.2.8, 8.2.9, or 8.2.10. Delete 8.2.2.3.

Substantiation: The conditioning required in 8.2.2.2 is redundant with 8.2.8.4, 8.2.9.4, and 8.2.10.4

Committee Meeting Action: Accept

The technical committee notes that the comment references the preprint document in the print line.

1951-45 Log #24 FAE-SCE **Final Action: Reject**
(8.2.8.4)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

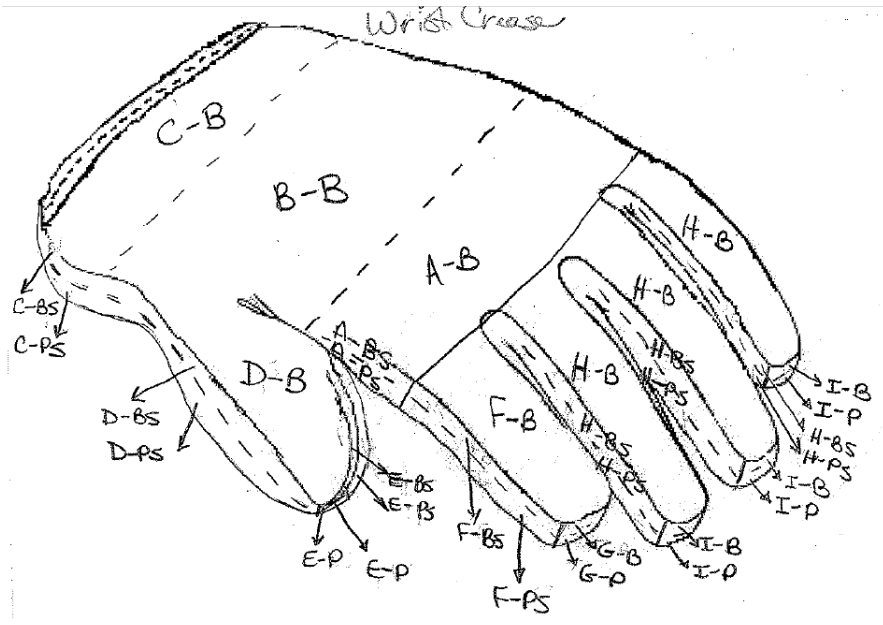
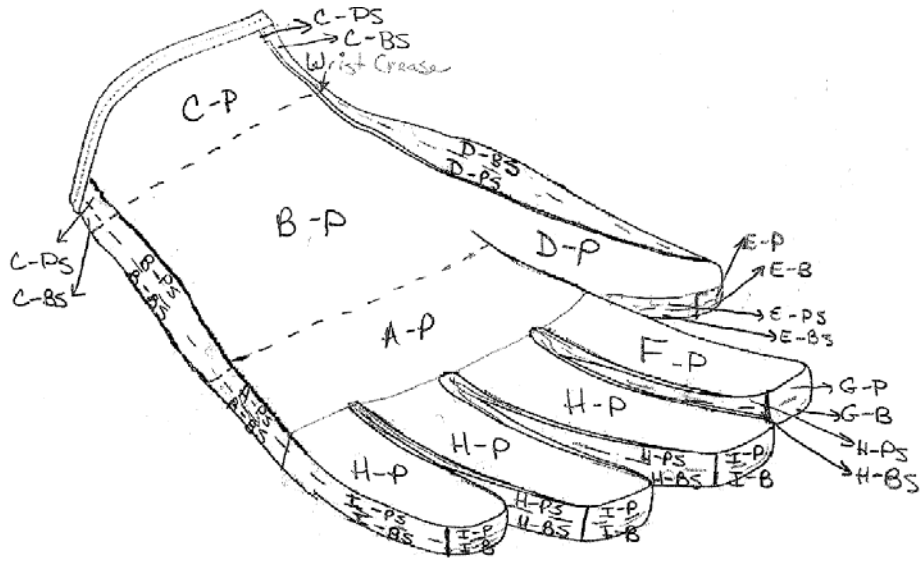
Recommendation: Revise text to read as follows:

8.2.8.4 Samples shall be conditioned as specified in 8.1.2. Other samples shall be conditioned as specified in 8.1.3, followed by 8.1.2.

Substantiation: Samples are the subject of conditioning.

Committee Meeting Action: Reject

Committee Statement: The technical committee believes the current language as written in the standard is correct.



NFPA 1951 Log CC 11 Figure 8.1.14.1

1951-46 Log #CC13 FAE-SCE

Final Action: Accept

(8.2.9, 8.16.8, 8.17.8, 8.24.8, 8.24.9, 8.24.10, 8.25.7, 8.26.7, 8.27.7, Preprint)

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,

Comment on Proposal No: 1951-30

Recommendation: Add new text to the end of section 8.1 in the preprint document as follows:

8.1.X Pouch Construction for Glove Composite Samples One

8.1.X.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test. However, for the test specified in 8.2, the pouch size shall not be reduced.

8.1.X.2 The pouch shall be made of two glove composite swatches.

8.1.X.3 The two glove composites shall be of the same materials and construction.

8.1.X.4 The two glove composite swatches shall be constructed to simulate the actual layers of the glove body or glove interface component as appropriate, arranged in proper order.

8.1.X.5 Each of the two glove composite swatches shall be stitched on all four sides using the same thread as used in the glove construction.

8.1.X.6 The two glove composite swatches shall then be sewn together, inner liner to inner liner, or inside to inside for single layer composites, on three sides using the same thread as used in the glove construction.

8.1.X.7 The two glove composite swatches and resulting pouch shall be permitted to not be stitched or have reduced stitching if a laundering preconditioning is not required to be performed on the composite samples.

8.1.Y Pouch Construction for Glove Composite Samples Two

8.1.Y.1 The pouch shall be 200 mm × 200 mm (8 in. × 8 in.). A smaller pouch size shall be permitted provided that the resulting test specimens are of sufficient size for the test.

8.1.Y.2 The pouch shall be made of two glove composite swatches.

8.1.Y.3 The two glove composites shall be permitted to be made of the same materials and construction. The two glove body composites shall be permitted to be representative of either the palm or the back of the glove.

8.1.Y.4 The two glove composite swatches shall be constructed to simulate the actual layers of the glove body, arranged in proper order.

8.1.Y.5 Where the moisture barrier material seam is being tested, the moisture barrier layer shall contain a seam. The seam shall run within 25 mm (1 in.) of the center and shall extend across the entire width of the specimen.

8.1.Y.6 Each of the two glove composite swatches shall be stitched on all four sides using the same thread as used in the glove construction.

8.1.Y.7 The two glove composite swatches shall then be sewn together, inner liner to inner liner, on three sides using the same thread as used in the glove construction.

Delete the text in the preprint of sections 8.2.9, 8.16.8, 8.17.8, 8.24.8, 8.24.9, 8.24.10, 8.25.7, 8.26.7, 8.27.7, and add the new text as indicated below:

8.2.9 Specific Requirements for Testing Glove Body Composites.

8.2.9.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.2.9.2 Specimens shall be representative of each glove body composite construction. All variations in composite construction, including number of layers and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), and the reinforcement layer(s) is the same as one or more of the base composite layers, the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases: 1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly 2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

8.2.9.3 Specimens shall be tested both before and after preconditioning as specified in 8.1.2 and then conditioned as specified in 8.1.9.

8.2.9.4 After conditioning, the glove composite pouch and stitching shall be cut to form specimens measuring 175 mm × 175 mm (7 in. × 7 in.) for testing.

8.2.9.4.1 Specimens shall not be stitched to hold individual layers together during testing.

8.2.9.5 Testing shall be performed as specified in 8.2.2 through 8.2.7.

8.16.8 Specific Requirements for Testing Glove Materials.

8.16.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.16.8.2 Specimens shall be representative of the glove moisture barrier and moisture barrier seams. Three specimens shall be tested.

8.16.8.3 The glove moisture barrier layers shall be removed from the multilayer composite samples after all preconditioning has been completed and shall become the glove barrier test specimen.

8.16.8.4 Specimens for testing shall be the barrier layer only.

8.16.8.5 Where the moisture barrier material is continuous through the glove body, only the barrier seams shall be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

8.17.8 Specific Requirements for Testing Glove Materials.

8.17.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.17.8.2 Specimens shall be representative of the glove moisture barrier and moisture barrier seams. Three specimens shall be tested.

8.17.8.3 The glove moisture barrier layers shall be removed from the multilayer composite samples after all preconditioning has been completed and shall become the glove barrier test specimen.

8.17.8.4 Specimens for testing shall be the barrier layer only.

8.17.8.5 Where the moisture barrier material is continuous through the glove body, only the barrier seams shall be tested. The test cell shall include both the moisture barrier material and the moisture barrier seam. The seam shall be located in the approximate center of the test cell.

8.24.8 Specific Requirements for Testing Glove Body Composites.

8.24.8.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.24.8.2 Specimens shall be representative of each glove body composite construction.

8.24.8.3 After conditioning, the pouch and necessary stitching shall be cut to form 50 mm x 150 mm (2 in. x 6 in.) specimens for testing.

8.24.8.4 If a proposed glove body construction has stitched-through seams, three additional specimens containing these seams shall be tested. The seam shall be in the direction of the 150 mm (6.0 in.) dimension.

8.24.9 Specific Requirements for Testing Protective Glove Interface Component- Other than Wristlet Composites.

8.24.9.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.24.9.2 Specimens shall be representative of the glove interface component composite construction.

8.24.9.3 After conditioning, the necessary stitching shall be cut to form 50 mm x 150 mm (2 in. x 6 in.) specimens for testing.

8.24.10 Specific Requirements for Testing Protective Wristlet Glove Interface Components.

8.4.10.1 Samples for conditioning shall include wristlet material.

8.24.10.2 Specimens shall be representative of the wristlet glove interface component composite construction.

8.24.10.3 After conditioning, the material shall be cut to form 50 mm x 150 mm (2 in. x 6 in.) specimens for testing.

8.25.7 Specific Requirement for Testing Gloves.

8.25.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.25.7.2 Specimens shall be representative of glove body composite construction at the following glove areas as described in 8.1.14: A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P. All variations in composite construction, including number of layers and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), and the reinforcement layer(s) is the same as one or more of the base composite layers, the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases: 1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly 2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

8.25.7.3 Glove specimens shall be tested before and after being subjected to the procedure specified in 8.1.9.

8.25.7.4 After conditioning, the pouch and necessary stitching shall be cut to form specimens for testing.

8.26.7 Specific Requirements for Testing Glove Materials.

8.26.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.26.7.2 Specimens shall be representative of glove body composite construction at the following glove areas as described in 8.1.14: A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P, A-B, B-B, D-B, E-B, F-B, G-B, H-B, I-B. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases: 1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly 2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as

is used in the actual glove construction.

8.26.7.3 After conditioning, the pouch and necessary stitching shall be cut to form specimens for testing.

8.26.7.4 Cut resistance testing shall be performed under a load of 200 g.

8.27.7 Specific Requirements for Testing Glove Materials.

8.27.7.1 Samples for conditioning shall be in the form of a pouch as described in 8.1.X.

8.27.7.3 Specimens shall be representative of glove body composite construction at the following glove areas as described in 8.1.14: A-P, B-P, D-P, E-P, F-P, G-P, H-P, I-P. All variations in composite construction and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases: 1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly 2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

8.27.7.3 After conditioning, the pouch and necessary stitching shall be cut to form specimens for testing.

Substantiation: This comment was submitted to put this text into section 8.1 to avoid redundant wording throughout standard. Also, it allows swatches/pouches to not be stitched if the conditioning does not involve laundering. The comment also creates a section in 8.1 for the viral/liquid penetration pouches in the same format as well for the same reason of simplification. The comment also reorganizes sections 8.16.8, 8.17.8, 8.24, 8.25, 8.26 and 8.27.

Committee Meeting Action: **Accept**

1951-47 Log #22 FAE-SCE
(8.2.9.2, 8.2.9.3, 8.7.2.3, 8.8.2.3, 8.11.3.1, and 8.14.3.1)

Final Action: **Accept**

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Change "specimen" to "sample".

Substantiation: Samples are the subject of conditioning.

Committee Meeting Action: **Accept**

In the sections noted in the print line (refers to preprint document), replace all instances of "specimens" with "samples."

1951-48 Log #CC6 FAE-SCE
(8.2.9.2, 8.25.7.1 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-32

Recommendation: Revise text in the preprint document as follows:

8.2.9.2 Specimens shall be representative of each glove body composite construction. All variations in composite construction, including number of layers and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), and the reinforcement layer(s) is the same as one or more of the base composite layers, the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases: 1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly 2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

8.25.7.1 Specimens shall be representative of each glove body composite construction at the palm of the hand and at the palm side of the fingers. All variations in composite construction, including number of layers and the order of layering of composite materials shall constitute a new composite and shall be tested separately. Where a composite is identical to another composite except for additional reinforcement layer(s), and the reinforcement layer(s) is the same as one or more of the base composite layers, the composite with no reinforcement layers shall be representative of the composite with reinforcement layer(s). Specimens shall not include seams except in the following cases: 1) Ridged areas or similar where stitching is used to create specific performance characteristics rather than for glove assembly 2) When there are size constraints of a material making it necessary to allow stitching in order to create the sample size required. Stitching shall be of the same type as is used in the actual glove construction.

Substantiation: This comment adds allowance to test base composite in place of composites which contain additional layers of base composite materials.

Committee Meeting Action: Accept

1951-49 Log #25 FAE-SCE
(8.2.9.4)

Final Action: Reject

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Revise text to read as follows:

8.2.9.4 Samples shall be conditioned as specified in 8.1.2. Other samples shall be conditioned as specified in 8.1.9, followed by 8.1.2.

Substantiation: Samples are the subject of conditioning.

Committee Meeting Action: Reject

Committee Statement: The technical committee believes the current language as written in the standard is correct.

1951-50 Log #CC17 FAE-SCE
(8.5.13 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,

Comment on Proposal No: 1951-11

Recommendation: Delete paragraphs 8.5.13.13 and 8.5.13.15 in the preprint document, and replace with the following text:

8.5.13.13 After flexing, the footwear specimen shall be marked with a water height line that is 2 inches below the top line excluding the gusset.

8.5.13.15 The footwear specimen shall then be placed in a container that allows its immersion in tap water, treated with a dye and surfactant that achieves a surface tension of 35 dynes/cm + or - 5 dynes/cm, to within 0.5 inches of the water height line.

Substantiation: This comment will ensure that the boots are evaluated for water penetration resistance commensurate with the height of the boot.

Committee Meeting Action: Accept

1951-51 Log #CC5 FAE-SCE
(8.5.13.9)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,

Comment on Proposal No: 1951-35

Recommendation: Revise paragraph 8.5.13.9 as follows:

8.5.13.9 Following removal from the oven, the specimen shall be allowed to cool at room temperature for not less than 5 minutes, +15/-0 seconds. The test specimen shall be examined inside and outside for evidence of melting, separation, or ignition, within 10 minutes, +15/-0 seconds, after removal from the oven. Separation for footwear in this test shall be recorded and reported if it is at least 1.4mm in length or height or width x 18mm in any orientation.

Substantiation: The proposed changes further clarify the fail criteria to cover more situations.

Committee Meeting Action: Accept

1951-52 Log #38 FAE-SCE
(8.6.4 and 8.6.5)

Final Action: Reject

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Change "ASTM F 1868" to ASTM F 1868-02".

Substantiation: The new revision of ASTM F1868 introduces new techniques for handling composites that distort dimensionally during the test. This revision alters the standard values on which NFPA's performance requirements are based, introduces a bias in handling materials, and may allow materials which previously failed to pass.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the comment, as the standard cannot reference an outdated standard.

1951-53 Log #50 FAE-SCE
(8.6.5)

Final Action: Reject

Submitter: Holly Blake, WL Gore & Associates

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

8.6.5* Testing shall be conducted in accordance with ASTM F 1868, Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate, using Part C, with the following modifications:

- (1) The specimen shall be placed on the test plate with the side normally facing the human body toward the test plate.
- (2) For multiple layers, arrange the layers in the order and orientation as worn.
- (3) Smooth each layer by hand to eliminate wrinkles or bubbles in each layer and, if necessary, secure the edges.
- (4) * Once the test is started, no further adjustments to the specimen shall be made.

* Annex 8.6.5 These modifications shall be used instead of Note 6 in ASTM F 1868 Part C.

Substantiation: The new revision of ASTM F 1868 has introduced new techniques via Note 6 for handling composites that distort dimensionally during the test. The standard values of performance in Total Heat Loss testing are dependent on the test parameters and procedures. By modifying the testing and handling techniques of the specimen, Note 6 has the unintended consequence of modifying standard values. It can allow material systems that previously failed the requirements to pass. Furthermore, the instructions are biased and unclear. For example, in a multi-layer composite, it is difficult to determine, which layer, if any, is not laying flat per Note 6. By preferentially re-smoothing one or more of the layers in one composite, and not all layers, or not all composites, Note 6 introduces bias. It is unclear when to implement Note 6 or which parts of Note 6. When is a flat specimen no longer flat? It also introduces a bias by assuming materials only change dimensionally under the conditions of the test, and therefore preferentially attempts to correct for only this one effect. A uniform handling of the specimens is needed as this comment recognizes.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the comment, and believes that the current ASTM method is an accepted practice.

1951-54 Log #30 FAE-SCE
(8.14.5.4)

Final Action: Accept in Principle

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Change "485°C" to "250°C"

Substantiation: 485°F is equal to 250°C making this an editorial correction.

Committee Meeting Action: Accept in Principle

Revise text to read:

8.14.5.4 ...to ~~within 485°C~~ 245°C...

Committee Statement: The technical committee accepted the comment in principle, and provided the amended text with the temperature conversion as shown in the meeting action.

1951-55 Log #31 FAE-SCE
(8.19.2.2 and 8.20.2.2)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Revise 8.19.2.2 Separate samples...".

8.20.2.2 Separate samples...".

Substantiation: It is unclear whether one set or separate sets of samples receives the sequence of conditionings.

Committee Meeting Action: Accept

1951-56 Log #32 FAE-SCE Final Action: Accept
(8.24.3.3)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
 Comment on Proposal No: 1951-1
 Recommendation: Change "8.24.2.3 and 8.24.2.4" to "8.24.2.2 and 8.24.2.3".
 Substantiation: Editorial.
 Committee Meeting Action: Accept
 The technical committee notes that the comment references the preprint document in the print line.

1951-57 Log #33 FAE-SCE Final Action: Hold
(8.24.6.4)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
 Comment on Proposal No: 1951-1
 Recommendation: Rewrite 8.24.6.4 Observations of melting, dripping, or hole formation in any layer, other than the outer layer, shall be reported for each specimen.
 Substantiation: Presumably a 4 in. char length hole is allowed in the outer layer, so the requirement for no hole formation must be for the other layers.
 Committee Meeting Action: Hold
 Committee Statement: The technical committee decided to hold this comment for further study.

1951-58 Log #34 FAE-SCE Final Action: Accept in Principle
(8.26.2.1, 8.26.2.2, 8.27.2.1, and 8.27.2.2)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
 Comment on Proposal No: 1951-30
 Recommendation: The text of 8.26.2.1 and 8.27.2.1 is missing in the preprint.
 The text of 8.26.2.1 and 8.27.2.1 of the preprint should be 8.26.2.2 and 8.27.2.2.
 Substantiation:
 Committee Meeting Action: Accept in Principle
 In the preprint document, add a new 8.26.2.1 as follows:
 8.26.2.1 Samples shall be as specified in 8.26.7, 8.26.8, or 8.26.9.
 Renumber current 8.26.2.1 in preprint as 8.26.2.2 as follows:
 8.26.2.2 Samples shall be conditioned as specified in 8.1.2.
 In the preprint document, add a new 8.27.2.1 as follows:
 8.27.2.1 Samples shall be as specified in 8.27.7, 8.27.8, or 8.27.9.
 Renumber current 8.27.2.1 in preprint as 8.27.2.2 as follows:
 8.27.2.2 Samples shall be conditioned as specified in 8.1.2.
 Committee Statement: The technical committee accepted the comment in principle, reinserted the missing text from the 2007 edition of the standard.

1951-59 Log #35 FAE-SCE Final Action: Accept
(8.27.4)

Submitter: Daniel J. Gohlke, W. L. Gore and Associates
 Comment on Proposal No: 1951-1
 Recommendation: Add "Test Method A" to end.
 Substantiation: There are several procedures in ASTM F 1342. The method of interest should be identified.
 Committee Meeting Action: Accept

1951-60 Log #CC15 FAE-SCE
(8.28 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-15

Recommendation: Revise text in the preprint document as follows:

8.28.2.2 Samples shall be conditioned as specified in ~~8.1.9~~, followed by conditioning as specified in 8.1.2.

8.28.6.2 The average percent of barehand control for all test subjects shall be calculated, recorded, and reported for each size.

8.28.7 Interpretation. The average percent of barehand control for ~~all test subjects~~ size small and size large shall be used to determine pass or fail performance.

Substantiation: This comment eliminates the laundering condition and averaging per size is consistent with other similar tests within the project.

Committee Meeting Action: Accept

1951-61 Log #CC8 FAE-SCE
(8.31.4, 8.31.5 Preprint)

Final Action: Accept

Submitter: Technical Committee on Special Operations Protective Clothing and Equipment,
Comment on Proposal No: 1951-43

Recommendation: Revise the text in the preprint document as follows:

8.31.4.1* A water-markable glove shall cover all areas of the tester's hand. The water-markable glove shall be constructed of a fabric that is easily water marked to determine leakage. ~~The water markable glove shall be a seamless continuous knit glove.~~

A.31.4.1 The water markable glove should be thin, snug fitting, ~~medium or dark-colored~~, show liquid contact easily, and the fabric should not have any surface treatment.

8.31.4.2 Water used for integrity testing shall be at a temperature of 20°C, ±3°C (68°F, ±5°F) and treated with a nonfoaming surfactant to lower its surface tension to 35 dynes/cm, ±5 dynes/cm.

Add new paragraphs as follows:

8.31.4.3 The following equipment shall be used for the test procedure:

1.) A clear container(s) for submerging gloved hand(s).

2.) A stopwatch.

~~8.31.5.2 The wrist crease location shall be marked on test specimen gloves as described in 6.1.3.3 after the conditioning described in 8.1.10. In the same manner, the water height line shall also be marked on test specimen gloves 25 mm (1 in.) +0/-3 mm below the location of the wrist crease as described in 6.1.3.3 and 6.2.3.3 around the entire glove after the conditioning described in 8.31.2.2.~~

~~8.31.5.3 The test subject shall don the glove specimen over the water-markable glove.~~

~~8.31.5.4 The test subject shall immerse the glove specimen to within 25 mm (1 in.) of the top of the body of the glove specimen for 5 minutes in 20°C, ±3°C (68°F, ±5°F) water. The test subject shall flex the glove specimen in a fist-clenching motion every 10 seconds.~~

~~8.31.5.5 The glove specimen shall be removed from the test subject's hand, and the water markable glove shall be inspected for water marks.~~

8.31.5.2 After the conditioning described in 8.31.2.2, the wrist crease location shall be marked as described in 6.1.3.3 on each specimen around entire glove +0/-3 mm (+0/-0.25 in.). Then, in the same manner, the maximum water height line shall also be marked on each specimen 25 mm (1 in.) +0/-3 mm (+0/-0.25 in.) below (towards the fingers) the location of the wrist crease around the entire glove. Then, in the same manner, the minimum water height line shall also be marked on each specimen 25 mm (1 in.) +0/-3 mm (+0/-0.25 in.) below (towards the fingers) the location of the wrist crease around the entire glove.

8.31.5.3 The test subject shall don the specimen(s) over the water markable glove(s).

8.31.5.4 The test subject shall then immerse the donned specimen(s) straight down into the surfactant treated water to between the minimum and maximum water height lines for 5 minutes +30/-0 sec. An observer shall be present to ensure that the specimen(s) is not immersed beyond the maximum water height line. If the test subject immerses the specimen(s) beyond the maximum water height line, the specimen(s) shall be retested after air drying and conditioning as specified in 8.1.2. The test subject shall flex the specimen in a gentle, complete fist closing motion every 10 seconds with each fist closing motion taking 10 seconds, +/- 2 seconds to complete. A complete fist closing motion shall be when the ends of the glove fingertips make contact with the palm surface of the glove.

8.31.5.5 The specimen(s) shall then be removed from the test subject's hand, and the water markable glove(s) shall be inspected for water marks.

Substantiation: Further modifications are being proposed after additional discussions after the 1971 ROP meeting. The original intent of the original proposal is still being met, which was to reduce wicking issues, but the technical committee believes the method outlined here will provide the most repeatability and test effectiveness.

Committee Meeting Action: Accept

1951-62 Log #36 FAE-SCE
(8.31.4.1 and A.8.31.4.1)

Final Action: Accept in Principle

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-43

Recommendation: 8.31.4.1 and A.8.31.4.1 Use original existing text instead.

Substantiation: There does not appear to be an advantage to changing the description of the water markable glove. The existing indicator gloves apparently work well, and it is uncertain (to me at least) that a change to a knit glove will be as good.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment in 1951-61 (Log #CC8).

1951-63 Log #41 FAE-SCE
(8.32.4.1)

Final Action: Accept in Principle

Submitter: Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment,

Comment on Proposal No: 1951-44

Recommendation: The TCC instructs the Technical Committee on Special Operations Protective Clothing and Equipment to review the proposed test method in Section 8.32 for safety hazards and reproducibility.

Substantiation: This is a direction from the Technical Correlating Committee on Special Operations Protective Clothing and Equipment in accordance with 3.4.2 and 3.4.3 of the Regulations Governing Committee Projects.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment in 1951-27 (Log #CC3).

1951-64 Log #28 FAE-SCE
(8.4.2)

Final Action: Accept in Principle

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Rewrite 8.1.4 Sample Preparation

8.4.2.1 Samples shall be as specified in 8.4.8, 8.4.9, 8.4.10, or 8.4.11.

8.4.2.2 Samples shall be conditioned as specified in 8.1.3, followed by 8.1.2.

Substantiation: This harmonizes the format for sample preparation and Specimens with all the other methods.

Committee Meeting Action: Accept in Principle

In the preprint document, delete section 8.4.2 Samples, and replace with the following:

8.4.2 Sample Preparation

8.4.2.1 Samples shall be as specified in 8.4.8, 8.4.9, 8.4.10, or 8.4.11.

8.4.2.2 Samples shall be conditioned as specified in 8.1.2. Other samples shall be conditioned as specified in 8.1.3 followed by 8.1.2.

Committee Statement: The technical committee accepted the comment in principle, and provided the clarifying amended text related to sample preparation as shown in the meeting action.

1951-65 Log #29 FAE-SCE
(8.4.3)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Rewrite 8.4.3 Specimens

8.4.3.1 Specimens shall consist of a 75 mm and 305 mm (3 in. x 12 in.) rectangle with the long dimension parallel to either the warp direction, machine or course, or the filling direction, cross machine, or wales of the material.

8.4.3.2 Each individual layer of multilayer material systems or composites shall be separately tested.

Substantiation: This harmonizes the format for Sample Preparation and Specimens with all the other methods.

Committee Meeting Action: Accept

1951-66 Log #52 FAE-SCE
(8.44)

Final Action: Accept in Principle

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

Insert Include 1951_L52_F2011_Include_R

Substantiation: Errors have been identified in the MIST evaluation procedures that create problems with the conduct and reproducibility of the test. A task group assigned by the Technical Correlating Committee has been established to resolve these issues with efforts including the conduct of experiments to assist with the identification of improvements. The proposed changes reflect these changes.

In addition, the footwear conditioning requirements are being harmonized with those used in permeation testing.

Committee Meeting Action: Accept in Principle

Delete Section 8.44.4, and replace with the following text:

8.44.4 Apparatus.

8.44.4.1 Test Facility.

8.44.4.1.1 The test facility shall include areas for dressing, a first stage undressing area adjacent and accessible to the chamber, and a second stage undressing area adjacent and accessible to the first stage undressing area.

8.44.4.1.2 The test shall be conducted in a sealed chamber with a minimum volume of sufficient dimensions to permit free movement of the test subject(s) when fully dressed in the ensemble.

8.44.4.1.3 More than one test subject shall be permitted in the chamber at the same time, provided that they can complete all tasks completely in the appropriate time period and that they have an unobstructed direct path to the wind stream.

8.44.4.1.4 The test chamber shall have a temperature of 25°C, ±2°C, relative humidity of 55 percent, ±10 percent, and a nominal wind speed of 0.9 to 2.2 m/sec (2 to 5 mph). The average wind speed shall be 1.6 m/sec, ±0.2 m/sec (3.5 mph, ±0.5 mph).

8.44.4.2 Test Chemical and Analytical Equipment.

8.44.4.2.1 The test simulant shall be methyl salicylate (MeS; C₈H₈O₂) CAS #119-36-8, more commonly known as oil of wintergreen. The MeS minimum purity shall be 95 percent. Vapor doses shall be measured using Passive Adsorbent Dosimeters (PADs).

8.44.4.2.2 The standard concentration of MeS in the vapor chamber shall be 100 mg/m³, ±15 mg/m³, as measured by a real-time infrared analysis of the chamber air or other validated real-time analytical technique.

8.44.4.2.3 Infrared readings shall be taken every 60 seconds to verify compliance with the concentration requirement, and an air sample shall be taken at least every 10 minutes for validation of infrared readings.

8.44.4.2.4 Every step shall be taken to avoid generation of liquid aerosol.

8.44.4.2.5 The sensitivity of the analytical technique used for the measurement of MeS in the PADs shall provide a detection limit of 30 ng MeS per PAD. The analytical technique shall have an upper limit of quantification of 31,500 ng.

8.44.4.3* Passive Adsorbent Dosimeters (PADs).

8.44.4.3.1 The test shall be conducted using Passive Adsorbent Dosimeters (PADs) that affix directly to the skin of the test subjects with the following characteristics.

(1) The PADs shall be a foil packet, which contains an adsorbent material covered by a high-density polyethylene film that acts as a pseudo-skin barrier.

(2) The PADs shall have an uptake rate of shall be 1.0 cm/min to 4.5 cm/min.

8.44.4.4 Test Subjects.

8.44.4.4.1 All test subjects shall be medically and physically suitable to perform these tests without danger to themselves. A medical certificate for each test subject shall have been issued within 12 months prior to testing.

8.44.4.4.2 Test subjects shall be familiar with the use of chemical protective ensembles and with the selected CBRN SCBA.

Delete paragraph 8.44.5.9.4, and replace with the following text:

8.44.5.9.4* Where an adhesive is used on the back of the PAD, each PAD shall be backed with aluminum foil, placed in individual sealed glass vials with a nonadsorbent lid liner, and stored in a refrigerated environment sufficiently cold to prevent migration of the MeS from the adhesive and shall not be removed from the environment for more than 15 minutes before processing.

Delete existing A.8.44.5.9.4, and replace with the following:

A.8.44.5.9.4 To determine if the temperature is low enough to prevent migration of the MeS from the adhesive, 12 pads are exposed simultaneously to an atmosphere of 1 to 10 mg/m³ of MeS for 30 minutes. After 15 minutes, 4 pads are extracted or thermally analyzed, 4 pads are each placed in separate sealed jars which are packed in dry ice and 4 pads are each placed in separate sealed jars and refrigerated at the intended storage temperature. After 24 hours, the 4 PADs packed in dry ice and the 4 PADs refrigerated should be extracted or thermally analyzed. The average amount of MeS observed on each of the 3 sets of 4 PADs should be statistically equivalent.

Delete section 8.44.6, and replace with the following text:

8.44.6 PAD Qualification and Analysis.

8.44.6.1 The uptake rate for each lot of PADs shall be determined in accordance with 8.2.6.2 using a minimum of 7 PADs selected randomly from the lot.

8.44.6.2* PAD uptake rate shall be measured by exposing the PADs to a concentration of MeS ranging from 1 to 10 mg/m³ for a period under conditions of 25°C ± 2°C (77°F ± 4°F) and a relative humidity of 55 percent ± 10 percent for a period of 30 minutes, +5/-0 minutes.

8.44.6.3 Processing of the PADs samples shall be performed within 24 hours of exposure. Where liquid extraction of the PADs samples is performed, the liquid extracts shall be permitted to be stored at 4°C (39°F) for up to 2 days before analysis.

8.44.6.4 The average MeS vapor exposure concentration and the actual time of exposure shall be used to determine the uptake rate from the following equation:

$$u = m / ACt$$

where:

u = the uptake rate in cm/min

m = the total mass of MeS measured on the PAD in mg

A = the average active area of the PAD in cm²

Ct = the exposure vapor dosage in mg/min/cm³.

8.44.6.5 For the test results to be considered valid for a given ensemble, no more than one PAD from each of the body region locations tested (i.e., no more than one PADS out of the four replicates for any particular region) shall be permitted to be lost to analysis over the course of the four test subjects.

Revise the following text as indicated:

8.44.7.1 ~~The arithmetic mean for the calibrated uptake rate shall be used to calculate the dosage measured by each PADS (Ct_{inside,i}) from the same equation based on the measured mass taken up by the PADS. Finally, the protection factor at each PADS location *i* inside the ensemble shall be calculated using the following equation: shall be determined using the average uptake rate determined for the PAD lot used in the evaluation of a specific ensemble using the following equation:~~

$$PFI = Ct_{outside} + Ct_{inside,i}$$

$$Ct_{inside,i} = m_i / u_{avg} A$$

where:

Ct_{inside,i} = the MeS vapor dosage at the specific PAD in mg/min/cm³

m_i = the total mass of MeS measured on the specific PAD in mg

u_{avg} = the average uptake of the PAD lot in cm/min

A = the average active area of the PA in cm²

Add a new paragraph as follows:

8.44.7.1.1 The protection factor at each PAD location shall be calculated using the following equation:

$$PF_i = C_{outside}^t / C_{inside,i}^t$$

where the $C_{outside}^t$ shall be determined from the measured chamber vapor dosage of the individual trial over the entire exposure. The value for $C_{outside}^t$ shall be the average of the chamber MS concentration readings taken during the course of the test subject exposure period.

Add a new paragraph as follows:

8.44.7.1.2 Where the measured total mass of MeS for a given PAD falls below 30 ng , the value of 30 ng shall be used for that specific PAD.

Revise the following paragraph:

8.44.7.3.1 The average $PPDF_{sys}$ for all specimens tested shall be calculated ~~and reported~~.

Delete sections 8.44.8 and 8.44.9, and replace with the following:

8.44.8 Report.

8.44.8.1 The individual specimen and average local $PPDF_i$ values for each PAD location shall be recorded and reported.

8.44.8.2 The $PPDF_{sys}$ value for each specimen and the average $PPDF_{sys}$ value for the ensemble tested shall be recorded and reported.

8.44.8.3 A spreadsheet shall be prepared that shows all test measurements and calculations including at least the following:

- (1) The MeS vapor exposure concentration for PAD lot qualification
- (2) The exposure time for used for PAD lot qualification
- (3) The measured MeS mass on each PAD used for PAD lot qualification
- (4) Each individual and the average PAD uptake rate
- (5) The measured MeS mass on each PAD using in the dressing room, stage 1 undressing room, and stage 2 undressing room.
- (6) The measured MeS mass on each PAD placed on the test subject
- (7) The calculated vapor dosage for each PAD placed on the test subject

8.44.9 Interpretation. The average local $PPDF_i$ values at each PAD location and the average $PPDF_{sys}$ value for each specimen shall be used to determine pass or fail performance.

Add new Annex items as follows:

A.8.44.4.3 PADs meeting these requirements that use an adhesive-backed foil packet measuring 25 mm × 35 mm × 0.02 mm, using a Tenax TA adsorbent that is covered by a high-density polyethylene film and having an active surface sampling area of a PAD shall be 3.5 cm², ±0.6 cm.

A.8.44.6.2 A convenient approach for measurement of PAD uptake rates under these conditions is to use a small scale chamber or permeation test cell and system where the air flow rate is controlled at a low rate (100 mL per minute) under the specified temperature and humidity conditions.

Committee Statement: The technical committee accepted the comment in principle, and provided text that has been provided by an ASTM task group on MIST since the time the comment was submitted.

7.3.1.1* The entire ensemble shall be tested for overall inward leakage as specified in Section 8.44, Man-In-Simulant Test (MIST), and shall have an average local physiological protective dosage factor (PPDF_i) value at each PAD location for the four ensembles tested of no less than 360.0 and an average systemic physiological protective dosage factor (PPDF_{sys}) value for each the four tested ensembles no less than 361.0.

8.44.2.4 Where the ensemble garment element does not include booties and the chemical/CBRN barrier material is incorporated into footwear, the footwear, shall be conditioned by flexing for ~~1,000,000~~ 500,000 cycles in accordance with Appendix B of FIA 1209, *Whole Shoe Flex*.

8.44.4 Apparatus.

8.44.4.1 ~~The test lab chamber and procedures shall be validated against the Test Operations Procedure (TOP 10-2-022), *Man In Simulant Test (MIST) – Chemical Vapor Testing of Chemical/Biological Protective Suits*, September 2001.~~

8.44.4.1 Test Facility.

~~8.44.4.3~~ **8.6.4.1.1** The test facility shall include areas for dressing, a first stage undressing area adjacent and accessible to the chamber, and a second stage undressing area adjacent and accessible to the first stage undressing area.

~~8.44.4.4~~ **8.6.4.1.2** The test shall be conducted in a sealed chamber with a minimum volume of sufficient dimensions to permit free movement of the test subject(s) when fully dressed in the ensemble.

~~8.44.4.5~~ **8.6.4.1.3** More than one test subject shall be permitted in the chamber at the same time, provided that they can complete all tasks completely in the appropriate time period and that they have an unobstructed direct path to the wind stream.

~~8.44.4.6~~ **8.6.4.1.4** The test chamber shall have a temperature of 25°C, ±2°C, relative humidity of 55 percent, ±10 percent, and a nominal wind speed of 0.9 to 2.2 m/sec (2 to 5 mph). The average wind speed shall be 1.6 m/sec, ±0.2 m/sec (3.5 mph, ±0.5 mph).

8.44.4.2 Test Chemical and Analytical Equipment.

~~8.44.4.2~~ **8.6.4.2.1** The test stimulant shall be methyl salicylate (MeS; C₈H₈O₈) CAS #119-36-8, more commonly known as oil of wintergreen. The MeS minimum purity shall be 95 percent. Vapor doses shall be measured using Passive Adsorbent Dosimeters (PADs).

~~8.44.4.7~~ **8.6.4.2.2** The standard concentration of MeS in the vapor chamber shall be 100 mg/m³, ±15 mg/m³, as measured by a real-time infrared analysis of the chamber air or other validated real-time analytical technique.

~~8.44.4.8~~ **8.6.4.2.3** Infrared readings shall be taken every 60 seconds to verify compliance with the concentration requirement, and an air sample shall be taken at least every 10 minutes for validation of infrared readings.

~~8.44.4.9~~ **8.6.4.2.4** Every step shall be taken to avoid generation of liquid aerosol.

8.6.4.2.5 The sensitivity of the analytical technique used for the measurement of MeS in the PADs shall provide for a detection limit of 3 mg-min/m³ (approximately 30 ng MS per PAD). In order to achieve the required maximum PF_i under the standard test conditions in this method (4.5 cm² PADS for 30 minutes at 100 ± 15 mg/m³ MeS concentration), the ratio of the analytical mass limit of quantification to uptake rate must be less than 7.5 ng-min/cm. The analytical technique shall have an upper end dose limit of quantification of a minimum of 2000 mg, min/m³

8.44.4.3* Passive Adsorbent Dosimeters (PADs).

~~8.44.4.14~~ The test shall be conducted using Passive Adsorbent Dosimeters (PADs) that affix directly to the skin of the test subjects with the following characteristics. ~~The PADS used in~~

ensemble certification shall be the same type of dosimeter that was used during the validation of the MIST test lab.

(1) The PADs shall be an adhesive-backed foil packet measuring $25\text{ mm} \times 35\text{ mm} \times 0.02\text{ mm}$, which contains an adsorbent material covered by a high-density polyethylene film that acts as a pseudo-skin barrier. The active surface sampling area of a PAD shall be 3.5 cm^2 , $\pm 0.6\text{ cm}$, and its

(2) The PADs shall have an uptake rate of shall be 3.5 cm/min , $\pm 1\text{ cm/min}$. The four-chamber PADs shall be used to calibrate the lot of PADs used in the test.

~~8.44.4.10~~ For the test, a minimum of four PADs shall be placed inside the chamber at defined positions for a known duration.

~~8.44.4.10.1~~ PADS shall be the item that is placed on skin of human test subject and in different chamber locations.

~~8.44.4.10.2~~ The PADS placed inside the test chamber shall be from the same lot as the dosimeters worn by the test subject and shall be used to calibrate the PADS lot used in the analysis.

~~8.44.4.11~~ The exposure time for the chamber PADS shall be 15 minutes, $+5/-0$ minutes, in length.

8.44.4.4 Test Subjects.

~~8.44.4.12~~ 8.44.4.4.1 All test subjects shall be medically and physically suitable to perform these tests without danger to themselves. A medical certificate for each test subject shall have been issued within 12 months prior to testing.

~~8.44.4.13~~ 8.44.4.4.2 Test subjects shall be familiar with the use of chemical protective ensembles and with the selected CBRN SCBA.

~~8.44.5.9.4~~ Where an adhesive is used on the back of the PADs, each PADS shall be backed with aluminum foil, placed in individual sealed glass vials with a nonadsorbent lid liner, and stored in a refrigerated environment [4°C (38°F)] and shall not be removed from the environment for more than 15 minutes before processing.

8.44.6 PAD Qualification and Analysis.

~~8.44.6.1*~~ The sensitivity of the analytical technique shall provide for a detection limit of 3 mg/min/m^3 (approximately 30 ng MS per PADS). The analytical technique shall be linear up to at least a dose of 2000 mg/min/m^3 with a coefficient of variation on replicate spiked dosimeter samples of less than 15 percent uptake rate for each lot of PADs shall be determined in accordance with 8.44.6.2 using a minimum of 7 PADs selected randomly from the lot.

~~8.44.6.2*~~ PAD uptake rate shall be measured by exposing the PADs to a concentration of MeS ranging from 1 to 10 mg/m^3 for a period under conditions of $32^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($90^{\circ}\text{F} \pm 5^{\circ}\text{F}$) and a relative humidity of 80 percent ± 5 percent for a period of 15 minutes, $+5/-0$ minutes.

~~8.44.6.2~~ 8.44.6.3 Processing of the PADs samples shall be performed within 24 hours of exposure. Where liquid extraction of the PADs samples is performed, samples shall be permitted to be stored at 4°C (39°F) for up to 7 days before analysis.

~~8.44.6.3~~ 8.44.6.4 Each lot of PADs used for testing shall be calibrated to determine its uptake rate. PADs shall be calibrated by placing at least four PADs from each representative lot within the chamber for 30 minutes, $+5/-0$ minutes during the MIST test. The chamber PADs exposure time shall be set such that the PADS dosage does not exceed the linear range of the analytical technique. The average of the chamber MeS vapor exposure concentration and the actual time of exposure shall be used to determine the uptake rate from the following equation:

$$m = uACt$$

$$u=m/Act$$

where:

u =the uptake rate in cm^3/min

m =the total mass of MeS measured on the PAD in mg

~~u =the uptake rate in cm^3/min~~

A =the average active area of the PAD in cm^2

Ct =the ~~chamber exposure~~ vapor dosage in $\text{mg}/\text{min}/\text{cm}^3$.

~~8.44.6.4~~ **8.44.6.5** For the test results to be considered valid for a given ensemble, no more than one PAD from each of the body region locations tested (i.e., no more than one PADS out of the four replicates for any particular region) shall be permitted to be lost to analysis over the course of the four test subjects.

~~8.44.7.1~~ The arithmetic mean for the calibrated uptake rate shall be used to calculate the dosage measured by each PADS ($Ct_{\text{inside},i}$) from the same equation based on the measured mass taken up by the PADS. Finally, the protection factor at each PADS location i inside the ensemble shall be calculated using the following equation: shall be determined using the average uptake rate determined for the PAD lot used in the evaluation of a specific ensemble using the following equation:

$$Ct_{\text{inside},i}=m_i/u_{\text{avg}}A$$

where:

$Ct_{\text{inside},i}$ =the MeS vapor dosage at the specific PAD in $\text{mg}/\text{min}/\text{cm}^3$

m_i =the total mass of MeS measured on the specific PAD in mg

u_{avg} =the average uptake of the PAD lot in cm^3/min

A =the average active area of the PA in cm^2

~~8.44.7.1.1~~ The protection factor at each PAD location shall be calculated using the following equation:

$$PF_i=Ct_{\text{outside}}/Ct_{\text{inside},i}$$

Where the Ct_{outside} shall be determined from the measured chamber vapor dosage of the individual trial over the entire exposure. The value for Ct_{outside} shall be the average of the chamber MS concentration readings taken during the course of the test subject exposure period.

~~8.44.7.1.2~~ Where the measured total mass of MeS for a given PAD falls below 0.03 mg, the value of 0.03 mg shall be used for that specific PAD.

~~8.44.7.3.1~~ The average $PPDF_{\text{sys}}$ for all specimens tested shall be calculated and reported.

8.44.8 Report.

8.44.8.1 The individual specimen and average local $PPDF_i$ values for each PAD location shall be recorded and reported.

8.44.8.2 The $PPDF_{\text{sys}}$ value for each specimen and the average $PPDF_{\text{sys}}$ value for the ensemble tested shall be recorded and reported.

8.44.8.3 A spreadsheet shall be prepared that shows all test measurements and calculations including at least the following:

- (1) The MeS vapor exposure concentration for PAD lot qualification
- (2) The exposure time used for PAD lot qualification
- (3) The measured MeS mass on each PAD used for PAD lot qualification
- (4) Each individual and the average PAD uptake rate
- (5) The measured MeS mass on each PAD using in the dressing room, stage 1 undressing room, and stage 2 undressing room

(6) The measured MeS mass on each PAD placed on the test subject

(7) The calculated vapor dosage for each PAD placed on the test subject

8.44.9 Interpretation. The average local $PPDF_i$ values at each PAD location and the average $PPDF_{sys}$ value for each specimen shall be used to determine pass or fail performance.

A.8.44.4.3 PADs meeting these requirements that use an adhesive-backed-foil packet measuring $25\text{ mm} \times 35\text{ mm} \times 0.02\text{ mm}$, using a Tenax TA adsorbent that is covered by a high-density polyethylene film and having an active surface sampling area of a PAD shall be 3.5 cm^2 , $\pm 0.6\text{ cm}$ are available from M&C Specialties, 90 James Way, Southampton, PA 18966, tel: 215-322-1600 (“Natick Sampler,” Part Number 037-002101-113).

A.8.44.6.2 A convenient approach for measurement of PAD uptake rates under these conditions is to use a small scale chamber or permeation test cell and system where the air flow rate is controlled at a low rate (100 mL per minute) under the specified temperature and humidity conditions.

1951-67 Log #51 FAE-SCE
(8.45)

Final Action: Accept in Principle

Submitter: Jeffrey O. Stull, International Personnel Protection, Inc.

Comment on Proposal No: 1951-1

Recommendation: Revise text to read as follows:

8.45 Chemical Permeation Resistance Test.

8.45.1 Application.

8.45.1.1 This method shall apply to the CBRN barrier layer and seams used in elements and ensembles for CBRN terrorism agent protection.

8.45.1.2 Specific requirements for testing the garment and hood CBRN barrier layer shall be as specified in ~~8.45.7~~ 8.45.8.

8.45.1.3 Specific requirements for testing the garment and hood CBRN barrier layer seams shall be as specified in ~~8.45.8~~ 8.45.9.

8.45.1.4 Specific requirements for testing the glove CBRN barrier layer and seams shall be as specified in ~~8.45.9~~ 8.45.10.

8.45.1.5 Specific requirements for testing footwear CBRN barrier layer shall be as specified in ~~8.45.10~~ 8.45.11.

8.45.2 Sample Preparation. Specimens shall then be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F), and at a relative humidity of 80 percent, ±5 percent, for at least ~~4~~24 hours prior to permeation testing.

8.45.2 Specimens.

8.45.3.1 A minimum of three specimens of each material shall be tested against each chemical.

8.45.3.2 The CBRN barrier layers shall be tested for chemical permeation resistance.

8.45.3.3 The CBRN barrier layer plus any outer shell or other composite layers normally worn over the CBRN barrier layer shall be permitted to be tested for chemical permeation resistance. Separable layers worn underneath the CBRN barrier layer shall not be tested with the CBRN layer.

8.45.3.4 If the CBRN barrier layer is the outermost layer in the composite, then it shall be tested for chemical permeation resistance without additional layers on top.

8.45.3.5 The thickness and the weight of the CBRN barrier material specimens shall be determined in accordance with ASTM D1777 and ASTM D3776, respectively.

8.45.4 Procedures: Apparatus, Supplies, and Chemicals.

~~8.45.4.1~~ Specimens shall be tested for permeation resistance for not less than 60 minutes, against the chemicals specified in ~~8.45.4.2~~ and ~~8.45.4.3~~ in accordance with ASTM F 739, *Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact*, with the following modifications:

(1) The test cells shall be designed to accommodate the introduction of liquid chemicals in a safe manner.

(2) The testing mode shall be open loop and the collection media shall be filtered air at a temperature of 32°C ±3°C (90°F ±5°F) and a relative humidity of 80 percent ±5 percent, flowed through the collection chamber of the test cell at a rate of 1 Lpm ±0.1 Lpm.

(3) Analytical methods used shall be sensitive to concentrations of at least one order of magnitude lower than the required end points.

(4) Where cumulative permeation end points are not specified in this standard, a permeation rate of 0.1 ig/cm²/min, as defined by ASTM F 739, *Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact*, shall be used.

~~8.45.4.2~~ The following liquid chemicals shall be tested:

(1) Liquid chemical warfare agents

(a) Distilled sulfur mustard [HD, bis (2-chloroethyl) sulfide], 505-60-2, at 32°C ±1°C (90°F ±2°F)

(b) Soman (GD, o-pinacolyl methylphosphonofluoridate), 96-64-0, at 32°C ±1°C (90°F ±2°F)

(2) Liquid toxic industrial chemicals

(a) Acrolein (allyl aldehyde), 107-02-8, at 32°C ±1°C (90°F ±2°F)

(b) Acrylonitrile (VCN, cyanoethylene), 107-13-1, at 32°C ±1°C (90°F ±2°F)

(c) Dimethyl sulfate (DMS, sulfuric acid dimethyl ester), 77-78-1, at 32°C ±1°C (90°F ±2°F)

~~8.45.4.3~~ The following gases shall be tested:

(1) Ammonia (7664-41-7), at 32°C ±1°C (90°F ±2°F)

(2) Chlorine (Cl₂, 7782-50-5), at 32°C ±1°C (90°F ±2°F)

~~8.45.4.4 Class 2 Elements.~~

~~8.45.4.4.1 For Class 2 elements, the gas concentration shall be 350 ppm +35 ppm/-0 ppm.~~

~~8.45.4.4.2 For Class 2 elements, the liquid concentration density shall be 10 g/m² +1 g/m²/-0 g/m².~~

~~8.45.4.4.3* The liquid drops shall be applied as nominal 1 μl drops uniformly distributed over the test area of the specimen surface. Where a seam, closure, or fixture is included, at least one drop shall be applied to each critical juncture, such as the seam edge.~~

~~8.45.4.4.4 The test cell shall be assembled in the closed-top configuration.~~

~~8.45.4.5 Class 3 Elements.~~

~~8.45.4.5.1 For Class 3 elements, the gas concentration shall be 40 ppm +10 ppm/-0 ppm, and the cell shall be assembled in closed-top configuration.~~

~~8.45.4.5.2 For Class 3 elements, the liquid concentration density shall be 10 g/m² +1 g/m²/-0 g/m².~~

~~8.45.4.5.3 Drops shall be applied as nominal 1 μl drops uniformly distributed over the test area of the specimen surface. Where a seam, closure, or fixture is included, at least one drop shall be applied to each critical juncture, such as the seam edge.~~

~~8.45.4.5.4 For the liquid chemicals specified in 8.45.4.2, the test cell shall be assembled in the open-top configuration with 0.3 Lpm ±0.03 Lpm of filtered air controlled at 80 percent ±5 percent, relative humidity (RH) flowing through the top of the cell. With the open-top configuration, the test cell washer shall be allowed to be sealed by an impermeable nonreactive sealant.~~

8.45.4.1 Apparatus.

8.45.4.1.1 A thickness gauge suitable for measuring thicknesses to the nearest 0.02 mm (or the nearest 0.001 in.), as specified in ASTM D1777, shall be used to determine the thickness of each protective clothing material specimen tested.

8.45.4.1.2 An analytical balance readable and reproducible to ±0.5 mg, as specified in ASTM D3776, shall be used to determine weight per unit area of each test specimen.

8.45.4.1.3 A controlled environmental chamber shall be used to maintain the test cell, air flow control system, and reagent chemicals within ±1.0°C of the test temperature and ±5% of the test relative humidity. The controlled environmental chamber shall be sized so that it can be used for conditioning test materials, test cells when not in use, challenge chemicals, and other test apparatus prior to testing.

8.45.4.1.4* The test cell shall be a two-chambered stainless steel cell for contacting the specimen with the challenge chemical on the specimen's normal outside surface and with a collection medium on the specimen's normal inside surface, which meets the test cell requirements for the Liquid Challenge/Vapor Penetration (L/V) Test Cell specified in TOP 8-501 and shown in Figure 8.45.4.1.4 and with the following additional specifications:

(1) The test cell is configured to separately permit flow across the challenge side and the collection side, and to allow the challenge side to be exposed for the placement of challenge chemical.

(2) The sample support plate and compression plate indicated in Figure 8.45.5.2.1 shall be modified as show in Figures 2 8.45.4.1.4(2)-1, 2 8.45.4.1.4(2)-2, and 2 8.45.4.1.4(2)-3, to permit the O-rings to be closer to the exposed surface area of the specimen.

(3) The cap of the test cell shall be modified to permit the attachment of a manometer or pressure gauge meeting the requirements of 8.45.4.1.9.

*****Insert Figure 8.45.4.1.4 Here*****

*****Insert Figure 8.45.4.1.4(2)-1 Here*****

*****Insert Figure 8.45.4.1.4(2)-2 Here*****

*****Insert Figure 8.45.4.1.4(2)-3 Here*****

8.45.4.1.5 Equipment shall be placed within the controlled environmental chamber to position the test cells horizontally and permit connection with the air delivery system and manifold.

8.45.4.1.6* An air delivery system and manifold shall be used to provide oil-free, conditioned air to the test

cells/fixtures at a rate of 1 standard L/min (slpm) per test cell/fixture with a temperature precision of $\pm 0.2^{\circ}\text{C}$ and relative humidity precision of ± 5 percent. The manifold shall be designed to deliver 1 L/min for the collection side of the test cell and maintain the test temperature. All parts of the air delivery system and manifold shall be chemically inert and non-absorptive to the challenge chemical.

8.45.4.1.7* An analytical system shall be used to evaluate the amount of challenge chemical in the effluent air streams from the collection side of the test cell and shall be selected to provide the ability to measure the chemical at $0.1 \mu\text{g}/\text{cm}^2$ over the test exposure period. The analytical system shall be permitted to include a bubbler tube, solid sorbent, or real time chemical analyzer. Samples shall be permitted to be taken continuous, discretely, or cumulatively; however, the selected analytical system shall capture all challenge chemical emitted in the effluent air stream.

8.45.4.1.8 A vacuum pump capable of creating vacuum of at least 5 inches water column shall be used for testing the integrity of the assembled test cell.

8.45.4.1.9 A manometer or digital pressure gauge capable of measuring pressures or vacuums to 10 inches water column, with an accuracy of 5% scale, shall be used for testing the integrity of the assembled test cell.

8.45.4.2 Supplies.

8.45.4.2.1 Syringe needles, capable of delivering $1 \mu\text{L} \pm 1\%$ droplets of challenge chemical, shall be used for dispensing liquid chemicals onto the surface of the specimens in the test cell.

8.45.4.2.2 Replacement O-rings shall be available for use in the permeation test cell.

8.45.4.2.2.1 If unknown, the compatibility of the O-ring material shall be verified before using the O-rings by placing the O-ring in contact with the chemical for a period of 4 hours and observing any physical changes to the O-ring within 10 minutes after the O-ring is removed from contact with the chemical.

8.45.4.2.2.2 If an O-ring shows any signs of chemical degradation in the form of softening, hardening, swelling, deterioration, or loss of shape, or function, an O-ring of different material shall be used that does not show chemical degradation.

8.45.4.2.3 Aluminum foil shall be used for the control and validation tests.

8.45.4.3 Chemicals.

8.45.4.3.1 The following chemicals shall be tested as liquids:

(1) Liquid chemical warfare agents

(a) Distilled sulfur mustard [HD; bis (2-chloroethyl) sulfide], 505-60-2

(b) Soman (GD; o-pinacolyl methylphosphonofluoridate), 96-64-0

(2) Liquid toxic industrial chemical

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

8.45.4.3.2* The following chemicals gases shall be tested as gases or vapors in dry air or nitrogen:

(1) Ammonia (NH_3 , 7664-41-7)

(2) Chlorine (Cl_2 ; 7782-50-5)

(3) Acrolein (allyl aldehyde), 107-02-8

(4) Acrylonitrile (VCN, cyanoethylene), 107-13-1

8.45.5 Procedures.

8.45.5.1 Test Set Up.

8.45.5.1.1 The test cell holders and the air delivery system manifolds shall be installed in the environmental chamber and shall be prepared to receive the loaded test cells.

8.45.5.1.2 The analytical detection system shall be assembled and calibrated.

8.45.5.1.2.1 If bubblers are used, each bubbler shall be filled with the proper collection solvent using a calibrated pipetter or equivalent device; the collection solvent shall incorporate an internal standard so adjustments can be made for solvent evaporation/water condensation during sampling.

8.45.5.1.2.2 If solid sorbent tubes are to be used, each sorbent tube shall be cleaned by heating and purging; the absence of any residual chemical shall be verified by the appropriate analysis technique. Checks should also be made to determine that the flow rate through the test cells are not affected by the differential pressure through the sorbent tubes.

8.45.5.1.3 Each test cell shall be labeled.

8.45.5.1.4 All liquid chemicals shall be placed in the environmental chamber for a minimum of 24 hours prior to testing.

8.45.5.1.5 The air delivery system shall be turned on and shall be operated at $32.2 \pm 2^{\circ}\text{C}$ ($90 \pm 3^{\circ}\text{F}$) and 80 ± 5 percent relative humidity for a minimum of 30 minutes to achieve environmental equilibrium before swatch loading.

8.45.5.2 Test Cell Assembly.

8.45.5.2.1 The test cell shall be assembled 24 hours before specimen conditioning in the environmental chamber as shown in Figure 8.45.5.2.1.

8.45.5.2.2 An O-ring shall be placed on the lower body of test cell.

8.45.5.2.2.1 The testing of seams and other non-uniform profile specimens shall require special O-rings to ensure that test cell integrity is maintained.

8.45.5.2.3 The sample support plate shall be placed on O-ring 1 and O-ring 2 shall be placed in the groove on the sample support plate.

8.45.5.2.4 The specimen shall be removed from the conditioning location in the environmental chamber and shall be placed in the depression of the sample support plate with O-ring 3 placed over the specimen.

8.45.5.2.5 O-ring 4 shall be placed in the upper body of the test cell and the compression plate shall be positioned over O-ring 4.

8.45.5.2.6 O-ring 4 shall be inverted and the upper body shall be aligned with the lower body.

8.45.5.2.7 Using the four cell sealing lugs, the cell halves shall be clamped together and 51.8 cm-kg (45 in lbs) of torque shall be applied to each lug to ensure a proper cell seal.

8.45.5.2.8 O-ring 5 shall be inserted into the groove around the agent challenge port in the upper body of the test cell and the cell cap shall be screwed into place.

8.45.5.2.9 For semipermeable fabrics the integrity of the seal between O-ring 5 and the cell cap shall be visually inspected and the procedure in 8.45.5.3 shall be used to verify the test cell seal.

8.45.5.2.10 For impermeable fabrics tested in dual mode, the procedures in 8.45.5.4 shall be used to verify test cell seal.

8.45.5.3 Verification of Test Cell Integrity (Permeable and Semipermeable Fabrics).

8.45.5.3.1 All ports shall be sealed except for the outlet port.

8.45.5.3.2 The cell shall be depressurized to 75 mm (3 in.) water column pressure by opening the valve slightly and watching the manometer.

8.45.5.3.3 When the pressure inside the test cell drops by 75 mm (3 in.) water column pressure, the valve shall be closed and the manometer shall be monitored for 2 minutes.

8.45.5.3.4 A 25 mm (1 in.) drop in water column pressure shall be considered failure to seal.

8.45.5.3.5 If a test cell fails, the procedures in 8.45.5.2 for assembling the cell shall be repeated to reseal the cell.

8.45.5.3.6 Only cells that have passed this test shall be used for testing.

*****Insert Figure 8.45.5.2.1 Here*****

8.45.5.4 Verification of Test Cell Integrity (Impermeable Fabrics).

8.45.5.4.1 Before applying chemical challenge, each test cell shall be subjected to a vacuum of 75 mm (3 in.) water column pressure in the bottom chamber of the cell as measured by a manometer.

8.45.5.4.2 The pressure shall be maintained for 2 minutes.

8.45.5.4.3 The pressure drop shall be observed at 2 minutes.

8.45.5.4.4 Test cells shall be considered to have an adequate seal if the pressure drop is less than a 25 mm (1 in.) drop in water column pressure.

8.45.5.4.5 If a pressure drop of 25 mm (1 in.) drop in water column pressure or greater is observed, the procedures in 8.45.5.2 for assembling the cell shall be repeated to reseal the cell.

8.45.5.3.6 Only cells that have passed this test shall be used for testing.

8.45.5.5 Application of Liquid Chemical Challenge.

8.45.5.5.1 Eight 1—L droplets shall be placed evenly spaced around a 25.4 mm (1—in) diameter circle on the upper specimen surface and two 1—L droplets shall be placed 8.1 mm (1/3-in) apart in the center of the specimen. For seams, the two droplets shall be placed on the seam juncture.

8.45.5.5.1.1 A mechanical or automated device shall be permitted for uniformly dispensing the droplets onto the surface of the specimen.

8.45.5.5.2 Prior to any test with a new chemical, a quality control trial shall be conducted to verify the challenge level delivery process using the procedures in 8.45.5.6.

8.45.5.6 Verification of Liquid Chemical Challenge Method.

8.45.5.6.1 For 10 1- μ L droplets, the mass \pm 1 μ g shall be determined using the density of the challenge chemical.

8.45.5.6.2 An inert specimen (aluminum foil) shall be placed in the test cell using the procedures described in 8.45.5.2.

8.45.5.6.3 The challenge chemical shall be applied to the inert specimen in the pattern described in 8.45.5.5.

8.45.5.6.4 After placement of the chemical, the specimen shall be visually inspected to verify that the agent was correctly applied.

8.45.5.6.5 The contaminated specimen shall be carefully removed and shall be placed in a closed large vial containing a known volume of solvent compatible with the analysis procedure.

8.45.5.6.6. The vial of solvent shall be agitated for at least one hour to ensure complete extraction of the challenge chemical from the swatch.

8.45.5.6.7 After agitation, the solvent vial shall be removed and submitted for analysis for challenge chemical using a procedure capable of detecting 1 µg using the density of the challenge chemical.

8.45.5.7 Test Start-Up for Liquid Chemical Challenges.

8.45.5.7.1 The test cells shall be installed in test cell holder prior to chemical challenge and all connections shall be ensured to have been properly made.

8.45.5.7.2 The operation of any analytical system shall be initiated according to its instructions.

8.45.5.7.3 After placing the challenge chemical on the specimen in the test cell, the cell cap shall be closed.

8.45.5.7.4 The air delivery system shall be immediately operated to provide filtered air at a temperature of 32°C ±2°C (90°F ±5°F) and a relative humidity of 80 percent ±5 percent, flowed through the collection chamber of the test cell at a rate of 1.0 Lpm ±0.1 Lpm to both the challenge and collection sides of the test cells.

8.45.5.7.5 Challenge chemical in the effluent air streams shall be collected, measured, and analyzed either by using appropriate discrete sample methods or continuously.

8.45.5.7.5.1 If bubblers or sorbent tubes are used for collecting challenge chemical, bubblers or sorbent tubes shall be replaced at a prescribed frequency.

8.45.5.7.6 The collection media for challenge chemical shall be analyzed using an appropriate analytical procedure.

8.45.5.7.7 The exposure to challenge chemical shall be conducted for 60 minutes, -0,+1 minute.

8.45.5.7.8 A minimum of three specimens shall be tested with challenge chemical.

8.45.5.7.9 At least one test shall be conducted with the specimen but without challenge chemical.

8.45.5.7.10 At least one test shall be conducted with an inert specimen (e.g., aluminum foil).

8.45.5.8 Test Start-Up for Gas or Vapor Chemical Challenges.

8.45.5.8.1 The test cells shall be installed in test cell holder prior to chemical challenge and all connections shall be ensured to have been properly made.

8.45.5.8.2 The operation of any analytical system shall be initiated according to its instructions.

8.45.5.8.3 The initial of the test shall occur when the gas or vapor chemical challenge is introduced into the test cell.

8.45.5.8.3.1 The flow of the gas or vapor chemical challenge shall be continuous over the exposure period of 60 minutes, -0,+1 minute.

8.45.5.8.3.2 The gas shall be at a temperature of 32°C ±3°C (90°F ±5°F).

8.45.5.8.3.3 The concentration of the challenge chemical in the gas shall be 40 ppm +10 ppm/-0 ppm.

8.45.5.8.4 The air delivery system shall be immediately operated to provide filtered air at a temperature of 32°C ±3°C (90°F ±5°F) and a relative humidity of 80 percent ±5 percent, flowed through the collection chamber of the test cell at a rate of 1.0 Lpm ±0.1 Lpm.

8.45.5.8.5 Challenge chemical in the effluent air streams shall be collected, measured, and analyzed either by using appropriate discrete sample methods or continuously.

8.45.5.8.5.1 If bubblers or sorbent tubes are used for collecting challenge chemical, bubblers or sorbent tubes shall be replaced at a prescribed frequency.

8.45.5.8.6 The collection media for challenge chemical shall be analyzed using an appropriate analytical procedure.

8.45.5.8.45 The exposure to challenge chemical shall be conducted for 60 minutes, -0,+1 minute.

8.45.5.8.8 A minimum of three specimens shall be tested with challenge chemical.

8.45.5.8.9 At least one test shall be conducted with the specimen but without challenge chemical.

8.45.5.8.10 At least one test shall be conducted with an inert specimen (e.g., aluminum foil).

8.45.5.9 Test Conclusion, Test Cell Clean Up and Specimen Disposal.

8.45.5.9.1 At the conclusion of the test, the air delivery and analytical systems shall be shut down.

8.45.5.9.2 The test cells shall be removed from the test cell holders after completion of each trial.

8.45.5.9.3 Each cell shall be disassembled one at a time.

8.45.5.9.4 The test specimen shall be removed and inspected for any degradation or obvious abnormalities; these observations shall be recorded with test results.

8.45.5.9.5 Each specimen shall be extracted using appropriate extraction procedures for challenge chemical.

8.45.5.9.6 The extracted protective clothing material specimens and test cell O-rings shall be disposed of according to local, stated, Federal or other applicable regulations.

8.45.5.9.7 Each component of the test cell shall be rinsed with acetone or other appropriate solvent to remove residual chemicals.

8.45.5.9.8 The cells shall be allowed to air-dry in a clean area between 4 and 24 hours before reuse.

~~8.45.5~~ 8.45.6 Report.

~~8.45.5.1 For permeation testing of chemical warfare agents specified in 8.45.4.2(1), t~~ 8.45.6.1 The cumulative permeation in 60 minutes shall be recorded and reported in µg/cm² for each specimen. The average cumulative

permeation in 1 hour for all specimens shall be calculated, recorded, and reported. The report shall include the pass or fail results for each chemical tested.

~~8.45.5.2 For permeation testing of liquid and gaseous industrial chemicals specified in 8.45.4.2(2) and 8.45.4.3, the normalized breakthrough time shall be recorded and reported in minutes for each specimen. The average normalized breakthrough time shall also be calculated and reported.~~

8.45.6.2 If no challenge chemical is detected at the end of the 60-minute test period, the cumulative permeation shall be reported as less than the minimum detectable mass per unit area for the specific chemical being tested.

8.45.6.3 The average cumulative permeation shall be calculated for all specimens for each challenge chemical.

8.45.6.3.1 If no challenge chemical is detected for one or two specimens, the average cumulative permeation shall be the average of all specimens where the cumulative permeation is measured and the minimum detectable cumulative permeation for those specimens where no challenge chemical is detected.

8.45.6.3.2 If no challenge chemical is detected in all of the specimens tested, the average cumulative permeation shall be reported as less than the minimum detectable mass per unit area for the specific chemical being tested.

8.45.6.4 Observations for the condition of the specimen following the test shall be provided with the test results.

~~8.45.6~~ 8.45.7 Interpretation.

~~8.45.6.1 For permeation testing of chemical warfare agents specified in 8.45.4.2(1), t~~The average cumulative permeation shall be used to determine pass or fail performance.

~~8.45.6.2* For permeation testing of liquid and gaseous industrial chemicals specified in 8.45.4.2(2) and 8.45.4.3, the average normalized breakthrough time shall be used to determine pass or fail performance.~~

Renumber Section 6.67.7 as 6.67.8

Renumber Section 6.67.8 as 6.67.9

Renumber Section 6.67.9 as 6.67.10

Renumber Section 6.67.10 as 6.67.11

A.8.45.4.1.4 A test cell meeting these requirements is available from Aerospace Tooling & Machining, 2190 West 1700 South, Salt Lake City, UT 84104.

A.8.45.4.1.6 It is essential that the air delivery system provide precise flow to each test cell and achieve the specified temperature and humidity conditions. This delivery is controlled by the conditioning of the incoming air to achieve the temperature and humidity conditions before reaching each test cell and is monitored by separate flow meters or controllers for each test cell.

A.8.45.4.1.7 It is not required to provide an analytical and sampling approach that provides discrete measurements of cumulative permeation as the criterion for this test is based on total cumulative permeation over a one hour period. This approach allows complete collection of any permeating chemical and subsequent analysis. The efficacy of the selected sampling and analysis approach should be validated for each challenge chemical through the use of procedure where a known amount of the challenge chemical representative of a cumulative permeation close to the minimum requirement is injected into the collection medium of a trial test. The selected sampling and analytical approach should be able to demonstrate a recovery of 95% or better to be considered a valid part of the procedures.

A.8.45.4.3.2 It is recommended that the concentrations for the gases be achieved by ordering prepared gas mixtures at the prescribed concentration.

Add the following additional references:

In section 2.3.2, ASTM Publications:

ASTM D 1777 Test Method for Thickness of Textile Materials, 2007.

ASTM D 3776 Standard Test Methods for Mass per Unit Area (Weight) of Fabric, 2009.

In section 2.3.6, Military Publications:

~~Test Operations Procedure (TOP 10-2-022), Man-In-Simulant Test (MIST) — Chemical Vapor Testing of Chemical/Biological Protective Suits, September 2001.~~

Test Operations Procedure (TOP) 8-2-501, Permeation and Penetration Testing of Air—Permeable, Semipermeable, and Impermeable Materials with Chemical Agents or Simulants (Swatch Testing), Report No. WDTC-TR-99-095, January 2002

Substantiation: The procedures used in NFPA 1951 for measuring the permeation resistance of chemical warfare agents do not reflect the actual industry practice for certification of chemical protective ensembles. The proposed test procedures provide the appropriate details for conducting permeation testing with chemical warfare agents and are document in Technical Support Working Group Contract No. W91CRB-07-C-0006 Project Final Report, *Risk-Based Protective Clothing Material Permeation Criteria*, dated 31 March 2010 on pages 82 to 88. These changes harmonize the test procedures with those in NFPA 1994 for Class 3 protective ensembles. A copy of the Technical Support Working Group Contract No. W91CRB-07-C-0006 Project Final Report, *Risk-Based Protective Clothing Material Permeation Criteria*, dated 31 March 2010 will be separately forwarded to NFPA to be provided upon request.

Committee Meeting Action: Accept in Principle

Committee Statement: See Comment on 1951-29 (Log #42).

1951-68 Log #27 FAE-SCE
(8.46.2.2 and 8.47.2.2)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-28

Recommendation: Change "8.1.3" to "8.1.9".

Substantiation: The correct laundering preconditioning for CBRN materials and garments is in 8.1.9, not 8.1.3.

Committee Meeting Action: Accept

1951-69 Log #37 FAE-SCE
(A.1.2.2.3)

Final Action: Accept

Submitter: Daniel J. Gohlke, W. L. Gore and Associates

Comment on Proposal No: 1951-1

Recommendation: Delete second paragraph.

Substantiation: This paragraph is inconsistent with the labeling instruction in 5.1.6.4 or the practice for CBRN elements in NFPA 1994 Class 2 or Class 3, where CBRN elements can be individually labeled as long as they are looped as part of an ensemble. It is desirable to allow replacement of elements as after market service to end users.

Committee Meeting Action: Accept

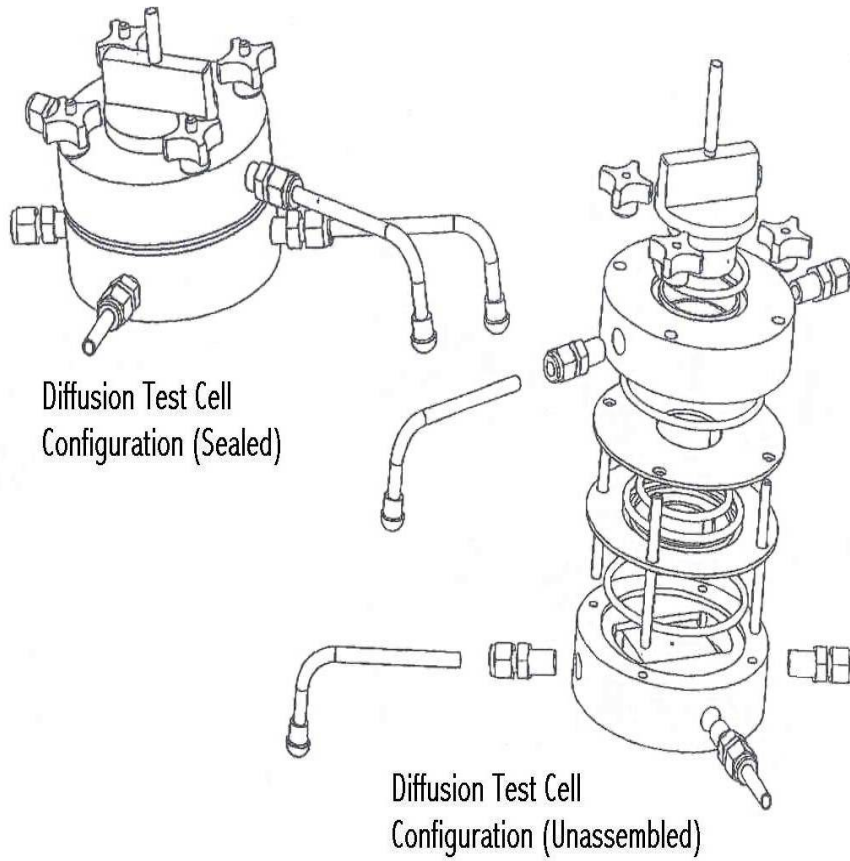


Figure 8.45.4.1.4 Liquid Challenge/Vapor Penetration (L/V) Test Cell.

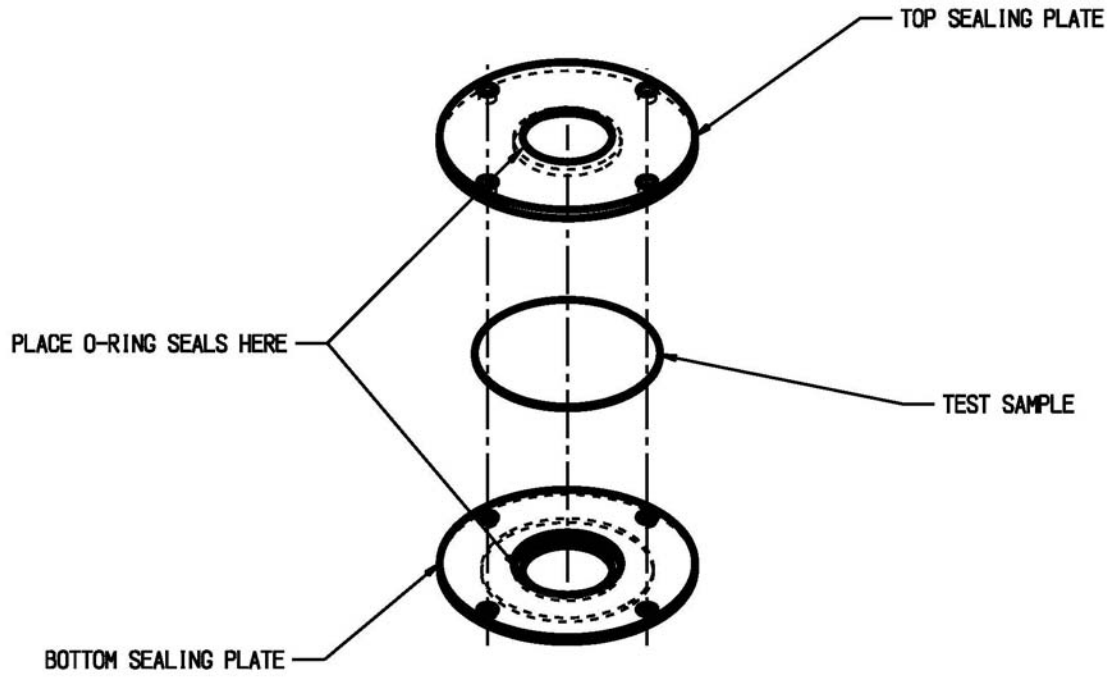


Figure 8.45.4.1.4(2)-1 Modifications to Sample Support Plate and Compression Plate.

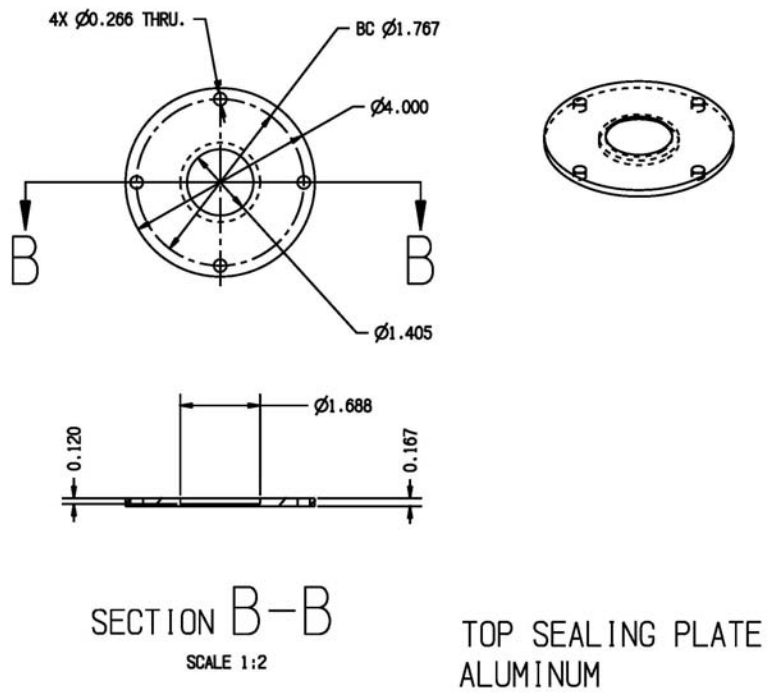


Figure 8.45.4.1.4(2)-2 Specific Modifications to Compression Plate.

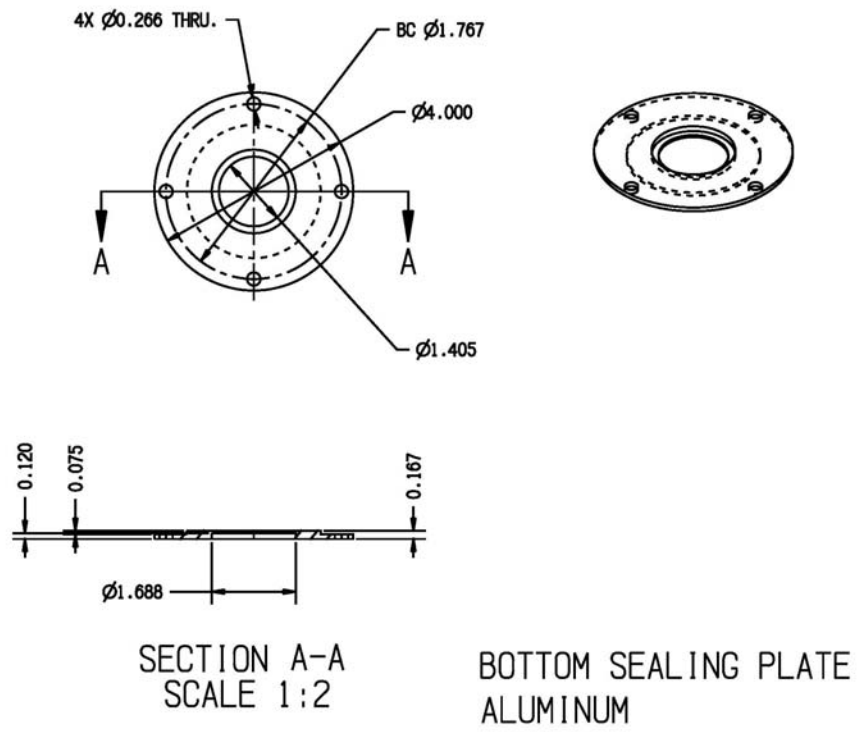
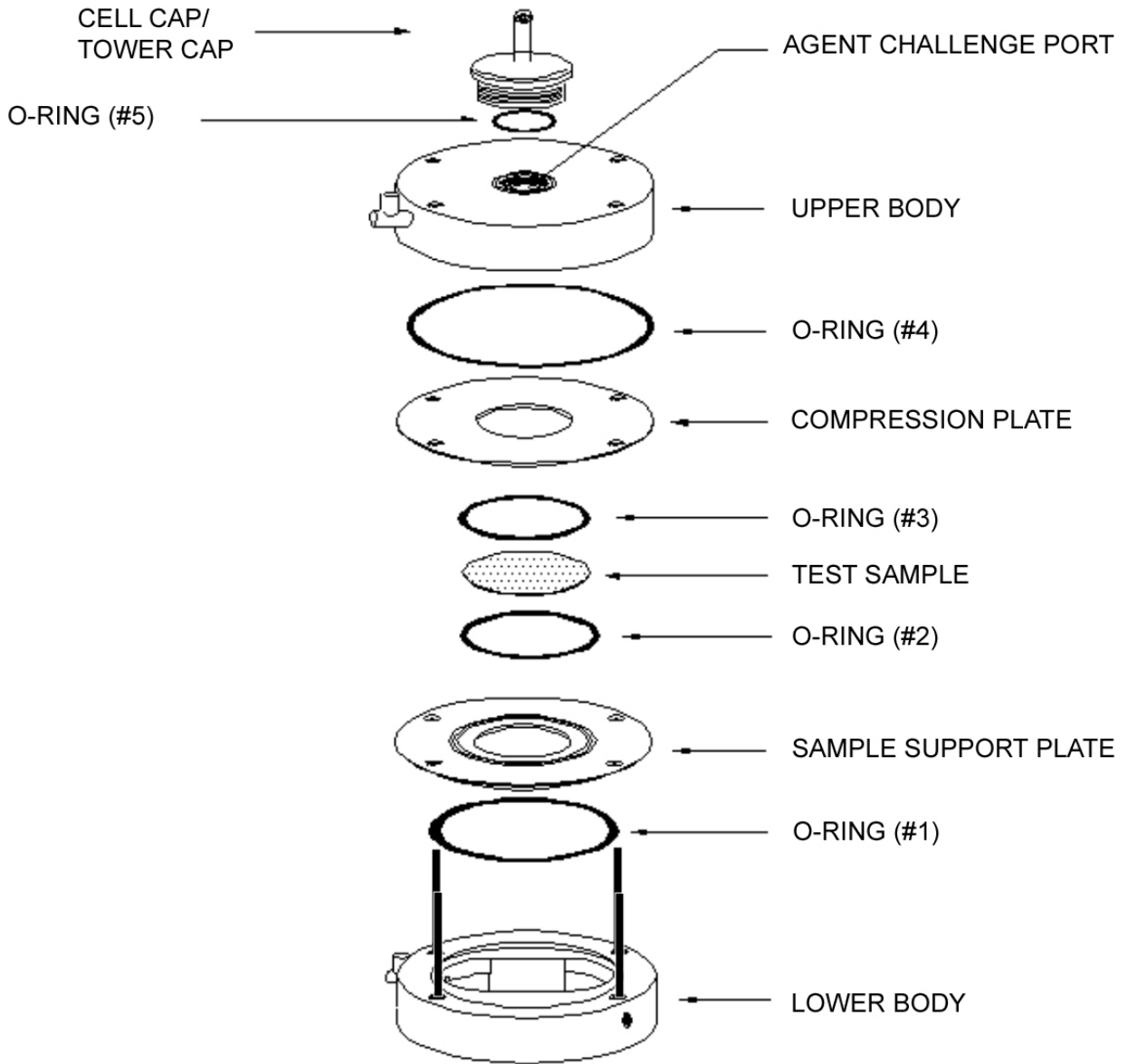


Figure 8.45.4.1.4(2)-3 Specific Modifications to Sample Support Plate.



**Figure 8.45.5.2.1 Permeation Cell Assembly.
Cell.**