



## Standard Test Method for Pressure Testing Vapor Protective Ensembles<sup>1</sup>

This standard is issued under the fixed designation F 1052; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### INTRODUCTION

Personnel in industry and emergency response can be exposed to numerous chemicals capable of causing harm upon contact with the human body. The deleterious effects of these chemicals can range from acute trauma such as skin irritation and burn, to chronic degenerative disease such as cancer. Since engineering controls may not eliminate all possible exposures, attention is often placed on reducing the potential for direct skin contact through the use of protective clothing.

Protective clothing is available in a variety of constructions, configurations and materials, and is designed to provide various levels of protection against many hazards. Chemical protective ensembles offering the highest level of chemical protection are constructed to prevent contact of solid, liquid, or gaseous chemicals with the wearer. This test method evaluates the integrity and construction of vapor protective ensembles by way of an internal pressure test. Other related whole suit tests include Test Method F 1359 for evaluating splash resistance using a Shower test, and Practice F 1154 for evaluating the overall form, fit, and function of a garment using a simulated wear test.

Resistance to chemical permeation of materials used in protective clothing should be evaluated by Test Methods F 739 for continuous contact and F 1383 for intermittent contact (that is, splash), or by Test Method F 1407 according to the permeation cup method. Resistance of protective clothing materials to liquid penetration should be determined by Test Method F 903.

Physical properties of materials used in the construction of protective clothing can be determined using a variety of test methods, including Test Methods D 751 (dimensions, weight, breaking strength, elongation, burst, tear resistance, hydrostatic resistance, coating adhesion, tack-tear, low temperature impact and bend, accelerated aging, blocking, and crush resistance), D 2582 (puncture propagation tear), D 4157 (abrasion resistance), F 392 (flexural fatigue), F 1358 (flammability), as well as many others.

### 1. Scope

1.1 This test method measures the ability of a vapor protective ensemble (VPE), including seams, and closures to maintain a fixed, positive pressure.

1.2 This test method measures the integrity of the suit, glove, boot/bootie, and visor materials, as well as the seams, and closures of a VPE. Exhaust valves fitted in the VPE must be sealed or blocked for this test and therefore are not functionally tested.

1.3 The values as stated in in.-H<sub>2</sub>O (mm-H<sub>2</sub>O) units are to be regarded as the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applica-*

*bility of regulatory limitations prior to use.* For specific hazard statements, see Section 7.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

D 751 Test Methods for Coated Fabrics<sup>2</sup>

D 2582 Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting<sup>3</sup>

D 4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)<sup>4</sup>

F 392 Test Method for Flex and Durability of Flexible Barrier Materials<sup>5</sup>

F 739 Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gas under Conditions of Continuous Contact<sup>6</sup>

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 09.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 08.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 07.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 15.09.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 11.03.

F 903 Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids<sup>6</sup>

F 1154 Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical Protective Suit Ensembles<sup>6</sup>

F 1358 Test Method for the Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance<sup>6</sup>

F 1359 Test Method for Determining the Liquid Penetration Resistance Protective Clothing or Protective Ensembles Under a Shower Spray Wheel on a Mannequin<sup>6</sup>

F 1383 Test Method for Resistance of Clothing Materials to Permeation by Liquids or Gases Under Conditions of Intermittent Contact<sup>6</sup>

F 1407 Test Method for Resistance of Chemical Protective Clothing Materials to Liquid Permeation—Permeation Cup Method<sup>6</sup>

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *chemical protective ensemble, n*—a combination of a chemical protective suit, gloves, boots, respiratory protective equipment, and any other clothing and equipment worn to provide the wearer with integrity against exposure to hazardous chemicals.

3.1.2 *chemical protective suit, n*—an item of protective clothing which is designed and configured to provide the wearer's torso, head, arms, and legs with integrity against exposure to hazardous chemicals either by itself or in conjunction with other protective clothing.

3.1.3 *integrity, n*—the ability of protective clothing or a protective ensemble to prevent inward leakage of hazardous substances from the outside environment.

3.1.3.1 *Discussion*—For evaluating air-tight integrity, the ability of vapor protective ensembles to prevent inward leakage of gases is determined by the amount of leakage following the inflation of a vapor protective ensemble to a specified pressure over a specified period of time. Exhaust valves and other components and interfaces may not be functionally evaluated depending on the technique used to fill the protective suit or ensemble.

3.1.4 *protective ensemble, n*—the combination of protective clothing with respiratory protective equipment, hoods, helmets, gloves, boots, communications systems, cooling devices, and other accessories intended to protect the wearer from a potential hazard when worn together.

3.1.5 *protective clothing, n*—apparel used for the purpose of protecting parts of the body from a potential hazard.

3.1.6 *liquid splash protective ensemble, n*—a chemical protective ensemble used to protect the wearer from liquid splashes.

3.1.7 *liquid splash protective suit, n*—a chemical protective suit used to protect the wearer from liquid splashes of chemicals.

3.1.8 *vapor protective ensemble, (VPE), n*—a chemical protective ensemble used to protect the wearer from chemical liquids, vapors, and gases.

3.1.8.1 *Discussion*—In this test method, the vapor protective ensemble will only include those protective clothing items

or accessories that are necessary for providing air-tight integrity.

3.1.9 *vapor protective suit, n*—a chemical protective suit used to protect the wearer from chemical liquids, vapors, and gases.

### 4. Summary of Test Method

4.1 The VPE is visually inspected and modified for the test. A test apparatus is attached to the VPE (Fig. 1) to permit inflation to the pre-test suit expansion pressure for removal of wrinkles and creases, and to equalize/stabilize the air temperatures internal and external to the VPE. The pressure is lowered to the test pressure and monitored for 4 min. If the pressure drop is excessive, the VPE fails the test and is removed from service. The test is repeated after leak location and repair.

4.2 Pressure testing of VPEs should be conducted at a frequency recommended by the manufacturer but no less often than upon receipt of the garment, after each wearing if the suit is to be reused, and at least annually thereafter.

### 5. Significance and Use

5.1 Workers involved in the production, use, and transportation of liquid and gaseous chemicals can be exposed to numerous compounds capable of causing harm upon contact with the human body. The deleterious effects of these chemicals can range from acute trauma such as skin irritation and burn to chronic degenerative disease such as cancer. Since engineering controls may not eliminate all possible exposures, attention is often placed on reducing the potential for direct skin contact through the use of protective clothing that resists permeation, penetration, and degradation.

5.2 This test method is only appropriate for chemical protective ensembles, such as totally encapsulating protective suits, that are designed and manufactured to prevent the inward leakage of solids, liquids, gases, and vapors. Garments designed to prevent the penetration of solid and liquid chemicals should be tested according to Test Method F 1359.

5.3 This non-destructive test method is useful as a quality control tool for manufactures and as a field method for end users to determine changes in garment integrity following use.

5.4 This test method is useful to end users for determining the integrity of vapor protective suits upon receipt from the manufacturer, prior to use, following use and decontamination, following repairs, and as a periodic maintenance test.

### 6. Required Materials Apparatus

6.1 *Source of Compressed Air:*

6.2 *Test Apparatus for Suit Testing*—(Fig. 2), including a pressure measurement device with the capability of indicating ¼-in. (6.35-mm) water gage pressure change.

6.3 *Vent Valve Closure Plugs*, or sealing tape.

6.4 *Soapy Water Solution and Soft Brush.*

6.5 *Stop Watch*, or appropriate timing device.

6.6 *Thermometer*, or appropriate temperature measuring device.

### 7. Hazards

7.1 Take care to provide the correct pressure safety devices required for the source of compressed air used.