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An American National Standard

Standard Test Method for Pressure Testing Vapor Protective Ensembles[1]

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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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_2O (mm-H_2O) 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 applicability 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[2]

D 2582 Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting[3]

D 4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)[4]

F 392 Test Method for Flex and Durability of Flexible Barrier Materials[5]

F 739 Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gas under Conditions of Continuous Contact[6]

[1] This test method is under the jurisdiction of ASTM Committee F-23 on Protective Clothing and is the direct responsibility of Subcommittee F23.50 on Ensemble Performance.

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[2] *Annual Book of ASTM Standards*, Vol 09.02.

[3] *Annual Book of ASTM Standards*, Vol 08.02.

[4] *Annual Book of ASTM Standards*, Vol 07.02.

[5] *Annual Book of ASTM Standards*, Vol 15.09.

[6] *Annual Book of ASTM Standards*, Vol 11.03.

F 903 Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids[6]

F 1154 Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical Protective Suit Ensembles[6]

F 1358 Test Method for the Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance[6]

F 1359 Test Method for Determining the Liquid Penetration Resistance Protective Clothing or Protective Ensembles Under a Shower Spray Wheel on a Mannequin[6]

F 1383 Test Method for Resistance of Clothing Materials to Permeation by Liquids or Gases Under Conditions of Intermittent Contact[6]

F 1407 Test Method for Resistance of Chemical Protective Clothing Materials to Liquid Permeation—Permeation Cup Method[6]

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.

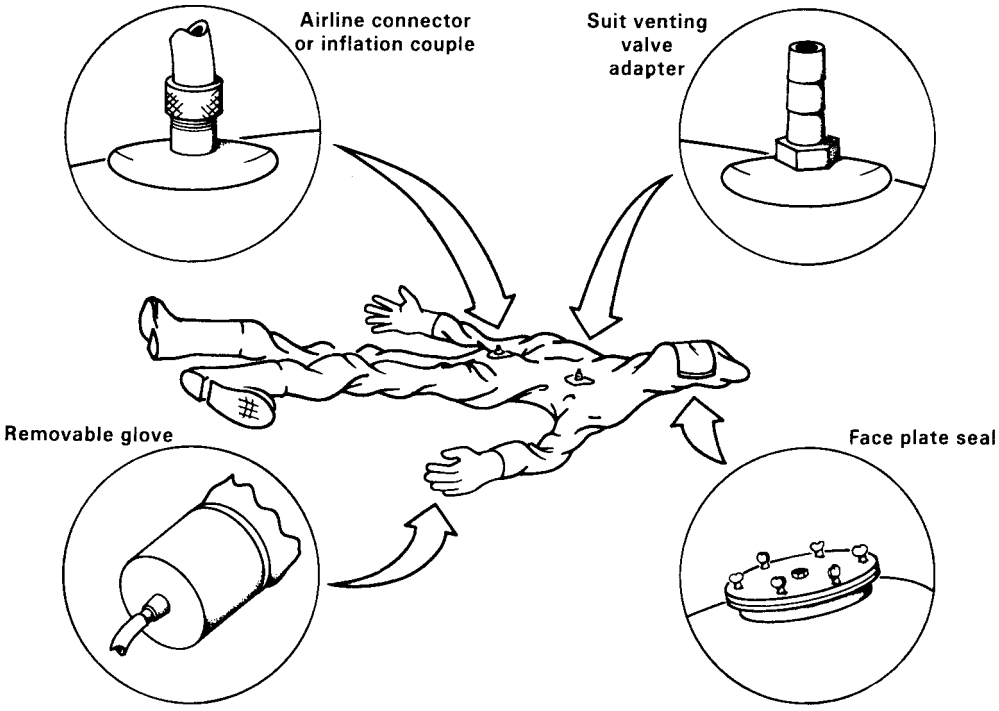

FIG. 1 Typical Examples of Suit Modification to Permit Inflation

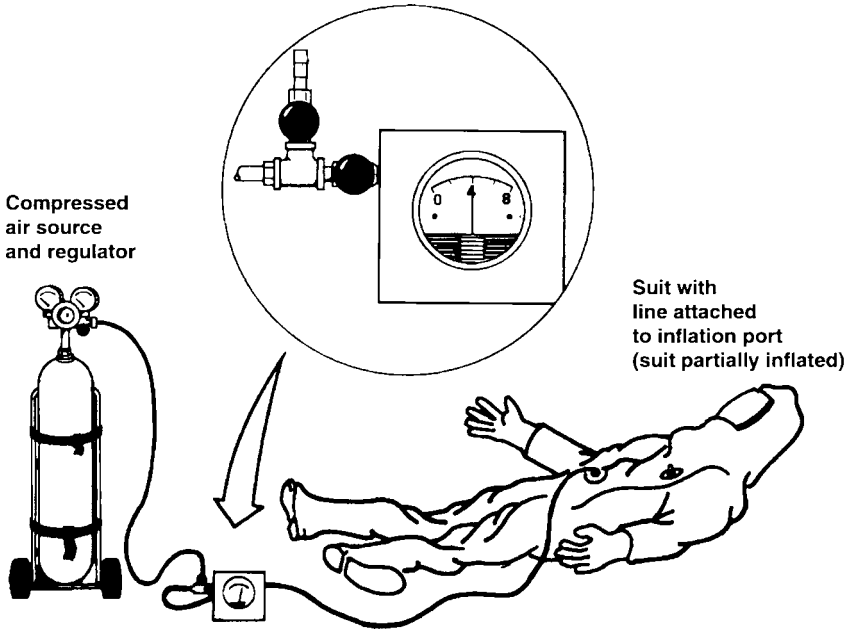

FIG. 2 Recommended Pressure Test Apparatus and Typical Test Configuration

7.2 Visually inspect all parts of the VPE to be sure that they are positioned correctly and secured tightly before putting the suit back into service. Take special care to examine each exhaust valve to make sure it is not blocked and that any re-assembly has been performed correctly.

7.3 Exercise care to ensure that the inside and outside of the VPE are completely dry before it is put into storage.

8. Procedure

8.1 Select an area for pressure testing that is away from direct sunlight, open doors, drafts, and HVAC registers. Temperature variations during testing should not exceed ±5°F of the nominal starting temperature. Testing should be repeated if temperature variations are outside of these limits.

NOTE 1—Temperature variations during testing should be avoided as they can result in both false positive and false negative test results according to this test method.

8.2 Prior to each test, perform a visual inspection of the VPE. Check the VPE for seam integrity by visually examining the seams and gently pulling on the seams. Ensure that all air supply lines, fittings, visor, zippers, and valves are secure and

show no signs of deterioration.

8.2.1 Seal off the vent valves along with any other normal inlet or exhaust points (such as umbilical air line fittings or facepiece opening) with tape or other appropriate means (cap, plug, fixture, and so forth). Test all detachable components as part of this test method, if their removal is required to allow the test to be completed. Exercise care in the sealing process so that the VPE components are not damaged.

8.2.2 Close all closure assemblies.

8.2.3 Prepare the VPE for inflation utilizing one of the techniques illustrated in Fig. 1. Attach the pressure test apparatus to the VPE to permit inflation from a compressed air source equipped with a pressure indication regulator (Fig. 2). Check the leak tightness of the pressure test apparatus at pre-determined intervals by closing off the end of the tubing attached to the VPE and ensuring 5-in. (127-mm) water gage for 4 min can be maintained. Establish intervals for checking the integrity of the test device at a frequency sufficient to assure reliable performance.

8.2.4 Use the pre-test expansion pressure A, and the Test Pressure, B, recommended by the VPE manufacturer. However, do not use pressures less than 5-in. (127-mm) water gage for A, and 4-in. (101-mm) water gage for B. Do not use an ending pressure, C, less than 80 % of the Test Pressure B; that is, do not allow a pressure drop that exceeds 20 % of the Test Pressure B.

8.2.5 Inflate the VPE until the pressure inside is equal to the Pressure A, the pre-test expansion pressure. Allow at least 1 min to fill out the wrinkles in the VPE. Extend the settling time if air temperatures inside and outside the VPE are not equal.

8.2.6 Release sufficient air to reduce the VPE pressure to the Test Pressure B. Begin timing. At the end of 4 min, record the ending pressure as C. Define the difference between the test pressure and the ending pressure, B–C, as the pressure drop.

8.2.7 If the pressure drop is more than 20 % of the Test Pressure B during the 4-min test period, the VPE fails the test and shall be removed from service.

9. Retest Procedure

9.1 If the VPE fails the test, check for leaks by inflating the VPE to pressure A and by brushing or wiping the entire VPE (including seams, closures, lens gaskets, glove-to-sleeve joints, and so forth) with a mild soap and water solution.[7] Observe the VPE for the formation of soap bubbles, which are an indication of a leak. Repair all identified leaks in accordance with specific manufacturer instructions if permitted.

9.2 Retest the VPE as outlined in Section 8.

10. Report

10.1 Report the following information:

10.1.1 VPE was tested as directed in Test Method F 1052.

10.1.2 Unique identification number identifying brand name, date of purchase, material of construction, and unique features, for example, special breathing apparatus.

10.1.3 Record the actual values for the test pressures A, B, and C, along with the specific observation times. If the ending pressure, C, is less than 80 % of the test pressure, B, identify the VPE as failing the test. When possible, identify the specific leak locations in the test records. Record the retest pressure data as an additional test.

10.1.4 Manufacturer/model number of the test apparatus used, identified along with the performance capabilities of the pressure gage.

10.2 Keep records for each pressure test even if repairs are being made at the test location.

11. Precision and Bias

11.1 *Precision*—It is not feasible to specify the precision of the procedure at this time because a suitable specimen cannot be identified for round-robin testing.

11.2 *Bias*—No information can be presented on the bias of the procedure in Test Method F 1052 for determining the air-tight integrity of vapor protective ensembles because no ensemble can be identified that offers an acceptable reference value.

12. Keywords

12.1 integrity; pressure testing; protective clothing; vapor protective ensemble; vapor protective suit

[7] Any commercially available, high-sudsing soap solution such as children's bubbles, has been found to offer satisfactory performance for this purpose.