



Standard Test Method for Pressure Testing Vapor Protective Suits¹

This standard is issued under the fixed designation F1052; 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. Vapor protective suits generally offer the highest level of chemical protection being constructed to prevent contact of solid, liquid, or gaseous chemicals with the wearer. This test method evaluates the integrity and construction of vapor protective suits by way of an internal pressure test.

This test method does not measure the protection of the suit. Other tests measure the protective aspects of the ensembles that are based on these suits, including Test Method F2588 for evaluating chemical vapor inward leakage, Test Method F1359 for evaluating splash resistance using a shower test, and Practice F1154 for evaluating the overall form, fit, and function of a protective ensemble using a simulated wear test.

Resistance to chemical permeation of materials used in protective clothing should be evaluated by Test Methods F739 for continuous contact and F1383 for intermittent contact (that is, splash), or by Test Method F1407 according to the permeation cup method. Resistance of protective clothing materials to liquid penetration should be determined by Test Method F903.

Physical properties of materials used in the construction of protective clothing can be determined using a variety of test methods, including Test Methods D751 (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), D2582 (puncture propagation tear), D4157 (abrasion resistance), F392 (flexural fatigue), F1358 (flammability), as well as many others.

1. Scope

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

1.2 This test method does not measure vapor protection of suits. This test method measures the integrity of the suit, glove,

foot protection, and visor materials, as well as the seams, and closures of a vapor protective suit. Exhaust valves fitted in the vapor protective suit must be sealed or blocked for this test and therefore are not functionally tested.

1.3 The values as stated in in.-H₂O (mm-H₂O) 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.

¹ This test method is under the jurisdiction of ASTM Committee F23 on Personal Protective Clothing and Equipment and is the direct responsibility of Subcommittee F23.30 on Chemicals.

Current edition approved May 1, 2014. Published May 2014. Originally approved in 1987. Last previous edition approved in 2009 as F1052 – 09. DOI: 10.1520/F1052-14.

2. Referenced Documents

2.1 ASTM Standards:²

- D751 Test Methods for Coated Fabrics
- D2582 Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting
- D4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)
- F392 Test Method for Flex Durability of Flexible Barrier Materials
- F739 Test Method for Permeation of Liquids and Gases through Protective Clothing Materials under Conditions of Continuous Contact
- F903 Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Liquids
- F1154 Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Durability of Protective Ensembles and Ensemble Components
- F1358 Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance
- F1359 Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin
- F1383 Test Method for Permeation of Liquids and Gases through Protective Clothing Materials under Conditions of Intermittent Contact

- F1407 Test Method for Resistance of Chemical Protective Clothing Materials to Liquid Permeation—Permeation Cup Method
- F2588 Test Method for Man-In-Simulant Test (MIST) for Protective Ensembles

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *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.

3.1.2 *protective clothing, n*—item of clothing that is specifically designed and constructed for the intended purpose of isolating all or part of the body from a potential hazard; or, isolating the external environment from contamination by the wearer of the clothing.

3.1.3 *protective suit, n*—an item of protective clothing that at a minimum covers the wearer’s torso, head, arms, and legs.

3.1.3.1 *Discussion*—For purposes of this test method, the protective suit is also equipped with a visor, and tightly attached glove and foot protection and exhaust valves. These suits are designed to cover the wearer’s respiratory equipment and provide protection from vapors.

4. Summary of Test Method

4.1 The vapor protective suit is visually inspected and modified for the test. A test apparatus is attached to the vapor protective suit (Fig. 1) to permit inflation to the pre-test expansion pressure for removal of wrinkles and creases, and to

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard’s Document Summary page on the ASTM website.

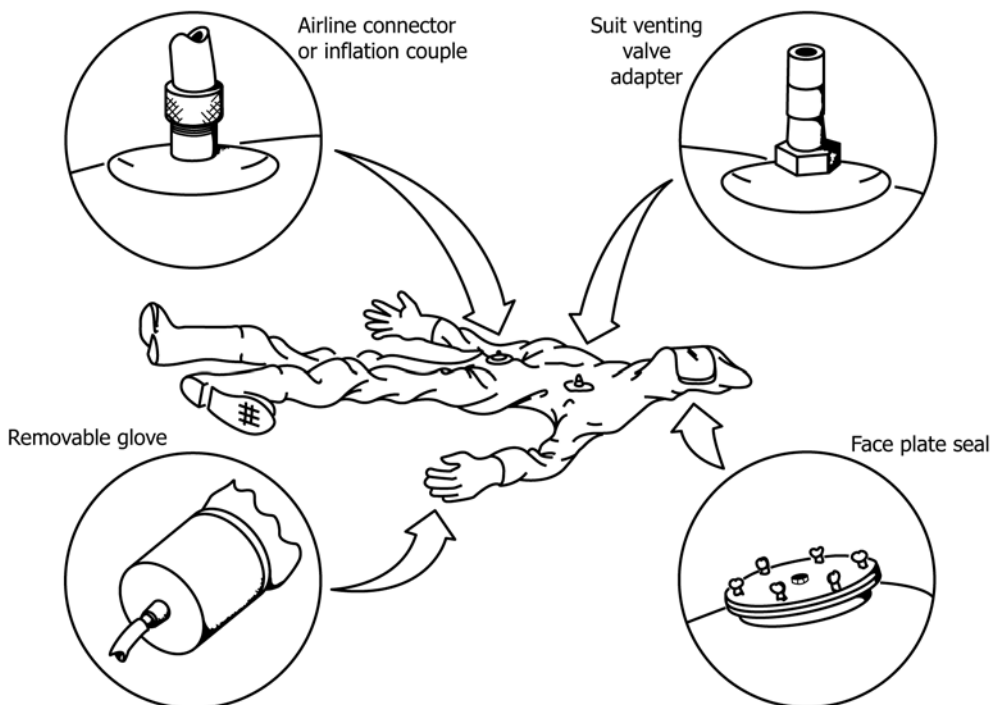


FIG. 1 Typical Examples of Suit Modification to Permit Inflation

equalize/stabilize the air temperatures internal and external to the vapor protective suit. The pressure is lowered to the test pressure and monitored for 4 min. If the pressure drop is excessive, the vapor protective suit fails the test and is removed from service. The test is repeated after leak location and repair.

4.2 Pressure testing of vapor protective suits 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 evaluating the integrity of totally encapsulating protective suits, that are designed and manufactured to prevent the inward leakage of gases and vapors. The vapor protection should be tested in accordance with Test Method F2588. Garments designed to protect from liquid chemicals should be tested in accordance with Test Method F1359.

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 1/4-in. (6.35-mm) water gauge 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.

7.2 Visually inspect all parts of the vapor protective suit 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 vapor protective suit 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.

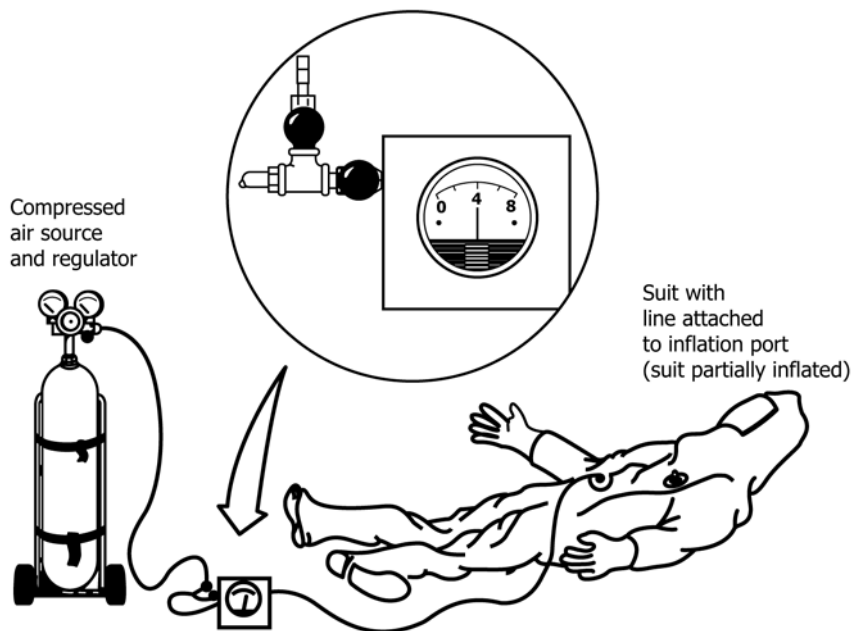


FIG. 2 Recommended Pressure Test Apparatus and Typical Test Configuration

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

8.2 Prior to each test, perform a visual inspection of the vapor protective suit. Check the suit 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 vapor protective suit components are not damaged.

8.2.2 Close all closure assemblies.

8.2.3 Prepare the vapor protective suit for inflation utilizing one of the techniques illustrated in Fig. 1. Attach the pressure test apparatus to the suit 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 suit and ensuring 5-in. (127-mm) water gauge for 4 min can be maintained. Establish intervals for checking 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 suit manufacturer. However, do not use pressures less than 5-in. (127-mm) water gauge for A, and 4-in. (101-mm) water gauge 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 suit 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 suit. Extend the settling time if air temperatures inside and outside the suit are not equal (see Note 2). During the settling time, it is normal for the pressure to change. As the temperature stabilizes, and suit extremities are filled, the pressure will likely fall. It is permissible during the settling time to refill the suit, in order to maintain it at Pressure A.

NOTE 2—In practice, it has been found that a minimum of three minutes at Pressure A will produce more repeatable results. This allows more time for internal pressure to stabilize, and for suit extremities (that is, gloves and booties) to fully inflate.

8.2.6 Release sufficient air to reduce the 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 vapor protective suit fails the test and shall be removed from service.

9. Retest Procedure

9.1 If the vapor protective suit fails the test, check for leaks by inflating the suit to pressure A and by brushing or wiping the entire suit (including seams, closures, lens gaskets, glove-to-sleeve joints, and so forth) with a mild soap and water solution.³ Observe the suit 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 suit as outlined in Section 8.

10. Report

10.1 Report the following information:

10.1.1 Vapor protective suit was tested as directed in Test Method F1052.

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 suit 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 gauge.

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 F1052 for determining the integrity of vapor protective ensembles because no vapor protective suit can be identified that offers an acceptable reference value.

12. Keywords

12.1 integrity; pressure testing; protective clothing

³ Any commercially available, high-sudsing soap solution such as children's bubbles, has been found to offer satisfactory performance for this purpose.

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