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Designation: F1359/F1359M – 13

StandardTest Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin[1]

This standard is issued under the fixed designation F1359/F1359M; 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 cannot 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. Protective clothing offering the highest level of chemical protection is constructed to prevent any contact of solid, liquid, or gaseous chemicals with the wearer. Test Method F1052 evaluates the integrity and construction of the vapor protective ensembles by way of an internal pressure test. In some applications, chemical protective clothing need only isolate the wearer from splashes of liquids. This test method evaluates the integrity of the construction and configuration of liquid-penetration-resistant protective clothing or protective ensembles with a shower-spray test.

Resistance of materials used in protective clothing to chemical permeation should be evaluated by Test Method F739 for continuous contact and Test Method F1383 for intermittent contact (that is, splash), or by Test Method F1407 using 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 for dimensions, weight, breaking strength, elongation, burst, tear resistance, and hydrostatic resistance; Test Method D2582 for puncture propagation tear resistance; Test Method D4157 for abrasion resistance; Test Method F392 for flexural fatigue; Test Method F1358 for flammability, as well as many others.

1. Scope

1.1 This test method measures the ability of protective clothing or protective ensembles to resist liquid penetration in the form of a shower spray with surfactant-treated water.

1.2 This test method measures the liquid penetration resistance of the construction and configuration of the overall protective clothing or protective ensemble, but especially of seams, closures, and interfaces with other components such as gloves, boots, hoods, and respiratory protective equipment. It is intended that this test method be used to assess the liquid penetration resistance of protective clothing and protective ensembles as received from the manufacturer and worn in accordance with their instructions.

1.3 Resistance of materials used in protective clothing to permeation or penetration can be determined in accordance with Test Methods F739 and F903, respectively.

1.4 The integrity of vapor protective ensembles is measured by its ability to maintain positive internal pressure with Test Method F1052.

[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 Feb. 1, 2013. Published February 2013. Originally approved in 1991. Last previous edition approved in 2007 as F1359 - 07 DOI: 10.1520/F1359-13.

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1.5 The values in SI units or in other units shall be regarded separately as standard. The values stated in each system must be used independently of the other, without combining values in any way.

1.6 *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.*

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
F1052 Test Method for Pressure Testing Vapor Protective Suits
F1358 Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance
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

3. Terminology

3.1 *Definitions:*

3.1.1 *liquid splash protective clothing, n*—protective clothing used to protect the wearer from liquid splashes.

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

3.1.3 *penetration, n*—for chemical protective clothing, the movement of substances through voids in protective clothing materials or items on a nonmolecular level.

3.1.3.1 *Discussion*—Voids include gaps, pores, holes and imperfections in closures, seams, interfaces and protective clothing materials. Penetration does not require a change if state; solid chemicals move through voids in materials as solids, liquids as liquids and gases as gases. Penetration is a distinctly different mechanism from permeation.

3.1.4 *permeation, n*—for chemical protective clothing, the movements of chemicals as molecules through protective clothing materials by the processes of (*1*) absorption of the chemical into the contact surface of the materials, (*2*) diffusion of the absorbed molecules throughout the material, and (*3*) desorption of the chemical from the opposite surface of the material.

3.1.4.1 *Discussion*—Permeation is a distinctly different mechanism from penetration.

3.1.5 *protective clothing, n*—an 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

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

3.1.6.1 *Discussion*—For evaluating liquid penetration resistance, the protective ensemble includes only those clothing items or accessories which are necessary to provide resistance to liquid penetration.

4. Summary of Test Method

4.1 A test specimen (protective clothing or protective ensemble) is placed on a mannequin that is already dressed in a liquid-absorptive garment covering portions of the mannequin form that are of interest.

4.2 Water, treated to achieve a surface tension of 0.032 ± 0.002 N/m (32 ± 2 dynes/cm) is sprayed at the test specimen from five nozzles positioned in a specific configuration with respect to the specimen. The specimen is exposed to the liquid spray for a period of 15 min in each of four specimen orientations.

4.3 Liquid penetration resistance is determined by the absence of liquid inside the specimen, or on the inner liquid-absorptive garment, or both.

4.4 The test specimen is rated as passing if liquid does not penetrate and as failing if liquid does penetrate.

5. Significance and Use

5.1 This test method evaluates the ability of the construction and configuration of protective clothing or protective ensembles to resist liquid penetration. In most cases, the conditions used in this test method will not represent actual end-use conditions.

5.2 The one-hour duration of the test is not intended to simulate user exposure to splashes of liquid chemical but rather to provide sufficient time for enough liquid to penetrate to make visual detection easier.

5.2.1 It is permissible to specify shorter test durations. The duration of exposure in each mannequin orientation must be the same.

5.2.2 The choice of different test duration is partly based on the number of layers in the specimen being tested, some of which serve to absorb the surfactant-treated test liquid and result in attenuating the severity of the liquid challenge to the specimen.

[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.

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