Designation: F1154 – 24

Standard Practices for Evaluating the Comfort, Fit, Function, and Durability of Protective Ensembles, Ensemble Elements, and Other Components[1]

This standard is issued under the fixed designation F1154; 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

Protective clothing is generally used in combination with other items to form an ensemble of clothing and equipment. Generally, as the risks for exposure to chemical, biological, thermal, physical, and other hazards increase, it becomes increasingly important that the ensemble provide consistent and overall performance in protecting the wearer. At the same time, the more encumbered the individual wearer, the more likely that ensembles comprising multiple elements and components will impact the ability of the wearer to carry out different tasks and remain comfortable without increased physiological stress, particularly for clothing that incorporates barrier layers. The majority of industry test methods address specific performance attributes for protecting against specific types of hazards, but do not address particular designs or assess the impact of all elements and components forming the ensemble. These elements may comprise various types of protective clothing, ranging from partial body such as aprons and sleeve protectors, to fully encapsulating suits that also must be integrated with various types of respirators, gloves, footwear, head protection such as helmets, cooling devices, communications systems, and undergarments. Therefore, there is a need for methodology that allows the assessment of how well ensembles affect wearer comfort and function, as well as providing for evaluation of fit and any impact of wearing on the overall integrity intended for the ensemble.

This standard is intended to provide standardized methods for qualitatively evaluating the comfort, fit, function, and durability of protective ensembles and ensemble components. It may also be used by protective clothing manufacturers and users to assess current or proposed designs and their instructions for donning, doffing, and using products as an ensemble component. This standard has utility for a variety of applications, including chemical protective ensembles, ensembles used in various healthcare settings or against other types of biological hazards, and different ensembles that may include some form of barrier layer in their various elements or components.

1. Scope

1.1 These practices are intended for evaluating protective ensembles and ensemble elements to determine the suitability of the ensemble or ensemble components in a work environment on the basis of its comfort, fit, function, and durability.

1.1.1 *Option A* is a manned exercise scenario intended to evaluate the impact of the ensembles and ensemble elements on wearer mobility when worn in a series of different physical exercises that are intended to evaluate the range of motion permitted by the ensemble or ensemble element.

1.1.2 *Option B* is a manned work task scenario intended to determine the impact of the ensemble or ensemble element on wearer function.

1.1.3 Recording the length of time used to complete these tasks provides a means for quantifying the impact of the ensemble or ensemble element on the wearer function.

1.1.4 Relating the ability of the subject to completely perform all tasks provides a qualitative assessment for the impact of the ensemble or ensemble element on wearer function.

1.1.5 The optional evaluation of ensembles or ensemble elements for liquid or vapor integrity following the exercise

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protocols provides a basis for evaluating the impact of wearing on ensemble or ensemble element integrity.

1.1.6 The optional evaluation of donning and doffing instructions provides a basis for evaluating the potential for errors which may impact the effectiveness of the ensemble.

1.2 These practices apply to protective ensembles and certain ensemble elements that are used for protection against different chemical, biological, physical, thermal, and other hazards, but are primarily useful for ensembles that include barrier layers such as liquid splash protective ensembles used for protection against hazardous chemicals or highly infectious diseases, or vapor protective ensembles used for chemical protection.

1.3 The values as stated in inch-pound units are to be regarded as the standard. The values in parentheses are given for information only.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific safety precautions are given in Section 7.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1052 Test Method for Pressure Testing Vapor Protective Suits

F1359/F1359M Test Method for Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Manikin

F1494 Terminology Relating to Protective Clothing

F2407/F2407M Specification for Surgical Gowns Intended for Use in Healthcare Facilities

F2668 Practice for Determining the Physiological Responses of the Wearer to Protective Clothing Ensembles

F2704 Specification for Air-Fed Protective Ensembles

F3031 Practice for Range of Motion Evaluation of First Responder's Protective Ensembles

F3352/F3352M Specification for Isolation Gowns Intended for Use in Healthcare Facilities

2.2 *OSHA Specifications:*[3]

29 CFR Part 1910.25 Portable Wood Ladders

29 CFR Part 1910.26 Portable Metal Ladders

3. Terminology

3.1 *Definitions:*

3.1.1 *ensemble component, n*—an item used as part of the protective ensemble that provides additional protective or functional performance, but is not necessarily an item of protective clothing.

3.1.1.1 *Discussion*—Examples of ensemble components are cooling devices, communications systems, fall protection harnesses, and undergarments. In cases where the respirator does not also provide skin protection, the respirator is also considered an ensemble component.

3.1.2 *ensemble element, n*—an item of protective clothing used in the protective ensemble that provides direct protection of the individual.

3.1.2.1 *Discussion*—Examples of ensemble elements include full-body protective clothing such as coveralls, two-piece splash suits, surgical gowns, and encapsulating suits; and partial-body protective clothing such as aprons, smocks, laboratory coats, hoods, sleeve protectors, gloves, footwear, and respirators where the respirator facepiece functions to provide protection to the wearer's face.

3.1.3 *liquid splash protective ensemble, n*—protective ensemble used to protect the wearer from liquid splashes and other forms of incidental liquid contact.

3.1.4 *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.

3.1.5 *protective ensemble, n*—the combination of ensemble elements and ensemble components to protect the wearer from an exposure hazard when worn together.

3.1.5.1 *Discussion*—In these practices, the applicable protective ensemble is principally intended to provide protection from hazardous chemicals, highly infectious diseases, and other hazardous substances that require barrier layers in the protective clothing or ensemble elements. Examples of ensembles include liquid splash protective ensembles and vapor protective ensembles.

3.1.6 *vapor protective ensemble, n*—protective ensemble used to protect the wearer from exposure to chemical vapors and gases.

3.2 For definitions of other protective clothing terms used in these practices, refer to Terminology F1494.

4. Summary of Practices

4.1 Two options are provided for evaluating the comfort, fit, function, and durability of protective ensembles and ensemble elements using a test subject. These options are performed either separately or in combination.

4.1.1 In Option A, the impact of the protective ensembles or ensemble elements on wearer mobility is evaluated by subjecting the protective ensemble to a manned exercise scenario. The time for the test subject to complete all exercises is recorded. The protective ensemble, ensemble elements, and components are inspected prior to and after the series of exercises to assess damage or changes that may have occurred as a result of the exercises. The test subject qualitatively rates the ease of movement for each of the exercises.

[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.

[3] The *Code of Federal Regulations* is available from the Superintendent of Documents, Government Printing Office, Washington, DC 20401.