



# Standard Test Method for Determination of Fire-Test-Response Characteristics of Components or Composites of Mattresses or Furniture for Use in Correctional Facilities after Exposure to Vandalism, by Employing a Bench Scale Oxygen Consumption Calorimeter<sup>1</sup>

This standard is issued under the fixed designation F1550; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

In correctional occupancies, vandalism of mattresses or furniture occurs with significant frequency. After such vandalism, it is possible that the filling material (foam or other padding) of the mattress or furniture becomes exposed. If the mattress or furniture filling material is exposed, it is possible for a product which meets prescribed fire-test-response characteristics in its intact state to perform in a decidedly less satisfactory manner. This standard test method provides a means for measuring, in bench scale, fire-test-response characteristics of composite upholstered components of mattresses or furniture, for use in correctional facilities, after having been vandalized in a prescribed manner so as to expose the filling material, using an oxygen consumption calorimeter.

### 1. Scope

1.1 This fire-test-response test method is designed for use to determine various fire-test-response characteristics, including ignitability and heat release rate, from composites of mattresses or furniture, or correctional facilities, which have been vandalized in a prescribed manner to expose the filling material, by using a bench scale oxygen consumption calorimeter.

1.2 This test method provides for measurements of the time to sustained flaming, heat release rate, peak and total heat release, and effective heat of combustion at a constant radiant initial test heat flux of 35 kW/m<sup>2</sup>. See 5.7 for limitations.

1.3 The apparatus used in this test method is also capable of determining heat release data at different initial test heat fluxes.

1.4 The specimen is oriented horizontally and a spark ignition source is used.

1.5 All fire-test-response characteristics are determined using the apparatus and the procedures described in Test Method E1354.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F33 on Detention and Correctional Facilities and is the direct responsibility of Subcommittee F33.05 on Furnishings and Equipment.

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1.6 The tests are done on bench-scale specimens combining the mattress or furniture outer layer components. Frame elements are not included.

1.7 The vandalism is simulated by causing a prescribed cut on the outer layer of the composite, deep enough to expose the filling material to the incident radiation.

1.8 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.9 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.10 *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 safety precautions, see Section 7.*

1.11 Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**D123** Terminology Relating to Textiles

**E176** Terminology of Fire Standards

**E1354** Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter

**E1474** Test Method for Determining the Heat Release Rate of Upholstered Furniture and Mattress Components or Composites Using a Bench Scale Oxygen Consumption Calorimeter

**E1537** Test Method for Fire Testing of Upholstered Furniture

**E1590** Test Method for Fire Testing of Mattresses

### 2.2 ISO Standards:<sup>3</sup>

**ISO 13943** Fire Safety—Vocabulary

**ISO 4880** Burning Behavior of Textiles and Textile Products—Vocabulary

### 2.3 California Bureau of Home Furnishings and Thermal Insulation Standards:<sup>4</sup>

**CA Technical Bulletin 129** (October 1992), Flammability Test Procedure for Mattresses for Use in Public Buildings

**CA Technical Bulletin 133** (January 1991), Flammability Test Procedure for Seating Furniture for Use in Public Occupancies

## 3. Terminology

### 3.1 Definitions:

3.1.1 For definitions of terms used in this test method and associated with fire issues, refer to the terminology contained in Terminology **E176** and in ISO 13943. In case of conflict, the terminology in Terminology **E176** shall prevail.

3.1.2 For definitions of terms used in this test method and associated with textile issues, refer to the terminology contained in Terminology **D123** and in ISO 4880. In case of conflict, the terminology in Terminology **D123** shall prevail.

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

3.2.1 *effective heat of combustion, n*—measured heat release divided by the mass loss for a specified time period.

3.2.2 *heat release rate, n*—heat evolved from the specimen, expressed per unit area of exposed specimen area per unit of time.

3.2.3 *heat flux, n*—heat transfer to a surface per unit area, per unit time (see also *initial test heat flux*).

3.2.3.1 *Discussion*—The heat flux from an energy source, such as a radiant heater, can be measured at the initiation of a test (such as Test Method **E1354**) and then reported as the initial test heat flux, with the understanding that the burning of the test specimen can generate additional heat flux to the

specimen surface. The heat flux can also be measured at any time during a fire test, on any surface, and with measurement devices responding to radiative and convective fluxes. Typical units are kW/m<sup>2</sup>, W/cm<sup>2</sup>, or BTU/(s ft<sup>2</sup>).

3.2.4 *ignitability, n*—propensity for ignition, as measured by the time to sustained flaming at a specified heating flux.

3.2.5 *initial test heat flux, n*—the heat flux set on the test apparatus at the initiation of the test (see also *heat flux*).

3.2.6 *mattress, n*—mattress is a ticking (outermost layer of fabric or related material) filled with a resilient material used alone or in combination with other products intended or promoted for sleeping upon.

3.2.7 *net heat of combustion, n*—oxygen bomb calorimeter value for the heat of combustion, corrected for the gaseous state of product water.

3.2.8 *orientation, n*—plane in which the exposed face of the specimen is located during testing, which is horizontal facing up for this test.

3.2.9 *oxygen consumption principle, n*—expression of the relationship between the mass of oxygen consumed during combustion and the heat released.

3.2.10 *sustained flaming, n*—existence of flame on or over the surface of the specimen for periods of 4 s or more.

3.2.11 *upholstered, n*—covered with material (as fabric or padding) to provide a soft surface.

## 4. Summary of Test Method

4.1 This test method is based on the observation that, generally, the net heat of combustion is directly related to the amount of oxygen required for combustion (**1**).<sup>5</sup> Approximately 13.1 × 10<sup>3</sup> kJ of energy are released as heat for each kg of oxygen consumed. Specimens in the test are burned in ambient air conditions, while being subjected to a prescribed external initial test heat flux of 35 kW/m<sup>2</sup>.

4.2 The heat release is determined by the measurement of the oxygen consumption, as determined by the oxygen concentration and the flow rate in the combustion product stream, as described in Test Method **E1354**.

4.3 The primary measurements are oxygen concentration and exhaust gas flow rate, used to calculate heat release. Additional measurements include the mass loss rate of the specimen, the time to sustained flaming, and the effective heat of combustion. Ignitability is determined by measuring the time for initial exposure to time of sustained flaming of the specimen.

4.4 In order to simulate vandalism, the outer layers of the composite to be tested are cut across the surface, in the form of an X, to expose the interior filling material.

4.5 The procedure in this test method is identical to that in Test Method **E1474**, except for the slashing of the surface of the specimen prior to testing.

<sup>2</sup> 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.

<sup>3</sup> Available from International Organization for Standardization (ISO), 1 rue de Varembe, Case postale 56, CH-1211, Geneva 20, Switzerland.

<sup>4</sup> Available from California Bureau of Home Furnishings and Thermal Insulation, State of California, Department of Consumer Affairs, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595.

<sup>5</sup> The boldface numbers in parentheses refer to the list of references at the end of this standard.

## 5. Significance and Use

5.1 This test method provides a means to determine various fire-test-response characteristics, including the time to sustained flaming and the heat release rate, of composites exposed to a prescribed initial test heat flux in the cone calorimeter apparatus, after they have been vandalized in a prescribed manner, to expose the filling material.

5.2 It is clearly impossible to predict the manner in which a mattress or furniture will be vandalized. The objective of this test method is to develop data indicating the effect of violating the integrity of the fabric (or fabric-interliner) protection and exposing the padding to the source of heat (see [Appendix X3](#)).

5.3 Quantitative heat release measurements provide information which is useful for product design and product development, for mattresses or furniture destined for correctional occupancies.

5.4 Heat release measurements provide useful information for product development by giving a quantitative measure of specific changes in fire performance caused by component and composite modifications. Heat release data from this method will not be predictive of product behavior if the product will not spread flame over its surface under the fire exposure conditions of interest.

5.5 The use of test specimens simulating vandalism allows the investigation of the variation in response between the system as designed by the manufacturer and the way the system is occasionally present in actual use, with the filling material exposed to the incident energy.

5.6 This test method allows alternative strategies to be employed for producing a product (mattress or upholstered furniture) with the required fire-test-response characteristics for the scenario under consideration.

### 5.7 Limitations:

5.7.1 The test data are invalid if any of the events in [5.7.1.1](#) or [5.7.1.2](#) occur.

5.7.1.1 Explosive spalling.

5.7.1.2 The specimen swells sufficiently prior to ignition to touch the spark plug or swells up to the plane of the heater base during combustion.

5.7.2 This test method is not applicable to ignition by cigarettes, or by any other smoldering source.

5.7.3 The ignition source in this test method is a radiant energy source of relatively high intensity (35 kW/m<sup>2</sup> initial test heat flux). It has been shown that this source models well, for furniture composites, a full scale source equivalent to five sheets of newspaper (2). It has also been shown that upholstered furniture and mattresses, particularly in public occupancies, are, on occasion, involved in fires after exposure to flaming ignition sources. However, it is not known what fraction of actual flaming mattress or furniture fires occur with ignitions more or less intense than the one modeled here.

5.7.4 It is not known whether the results of this test method will be equally valid when it is carried out under conditions different from the specified ones. In particular, it is unclear whether the use of a different ignition source, or the same

ignition source but at a different initial test heat flux, will change relative results.

5.7.5 The value of heat release rate corresponding to the critical limit between propagating mattress fires and non-propagating mattress fires is not known.

5.7.6 It is not known what fraction of the vandalism that occurs is represented by the prescribed model used in this standard. However, the method described here is adequate to address one of the major objectives of the standard, namely investigate the effect of the exposed filling material on the fire-test-response characteristics of the composite.

## 6. Apparatus

6.1 Use the apparatus described in Test Method [E1354](#), also known as the cone calorimeter, for this test.

## 7. Safety Precautions

7.1 These test procedures involve high temperatures and combustion processes. Therefore, there is a potential hazard for burns, ignition of extraneous objects or clothing, and for inhalation of combustion products.

7.2 The operator must use protective gloves for insertion and removal of the test specimens. The operator must refrain from touching either the cone heater or the associated fixtures while hot, except with the use of protective gloves.

## 8. Test Specimen Preparation (Method A)

### 8.1 *Equipment and Supplies for Specimen Preparation (3):*

8.1.1 *Cutting Equipment*—Cut foams with a band saw. Use a foam-cutting blade. This blade has no teeth. Instead, it has a wavy scallop to the edge. Ensure that the blade is well sharpened, and make certain that no silicones or other oils are applied to lubricate the blade. Lubrication must be solely with graphite or molybdenum compounds. The band saw blade must make a straight and true cut of the foam; therefore, set the blade guide no higher than 12 mm above the stock to be cut.

8.1.2 *Forming Blocks*—The specimen preparation rests crucially upon the proper use of forming blocks. These blocks are made in dimensions of 98 × 98 × 50 mm. Each of these dimensions must be controlled to ±0.5 mm. As the material for the forming blocks, use a dense wood, such as maple, which is minimally subject to dimensional changes when the humidity is changed. Do not use pine. Use only fully kiln-dried timber for making the forming blocks. Ensure that all surfaces are cut straight and true and are smooth. Do not round the edges but slightly round the corners. It is preferable to lacquer the blocks with an acrylic lacquer to ensure a hard, smooth, stable surface. Make up a minimum of 12 blocks to allow a reasonable number of specimens to be prepared at the same time.

8.1.3 *Adhesive*—Several adhesives have been found suitable for securing the fabrics. The adhesive must be low in flammability and must have suitable holding power to permit inserting the resilient padding, stay in place until the testing is performed (that is, through the required conditioning) and during the flammability test procedure. For the latter, the glued portions of the fabric must neither flame excessively nor retard burning. Adhesives that are based on polychloroprene (neoprene), acrylic or water have been found suitable.