



Standard Test Method for Determining the Heat Release Rate of Upholstered Furniture and Mattress Components or Composites Using a Bench Scale Oxygen Consumption Calorimeter¹

This standard is issued under the fixed designation E1474; 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

This test method provides a means for measuring the ignition time and heat release of the composite upholstered components of upholstered furniture and mattresses using an oxygen consumption calorimeter.

1. Scope*

1.1 This fire-test-response test method can be used to determine the ignitability and heat release from the composites of contract, institutional, or high-risk occupancy upholstered furniture or mattresses using a bench scale oxygen consumption calorimeter.

1.2 This test method provides for measurement of the time to sustained flaming, heat release rate, peak and total heat release, and effective heat of combustion at a constant initial test heat flux of 35 kW/m². This test method is also suitable to obtain heat release data at different heat fluxes. The specimen is oriented horizontally, and a spark ignition source is used.

1.3 The times to sustained flaming, heat release, and effective heat of combustion are determined using the apparatus and procedures described in Test Method E1354.

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

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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.*

1.7 *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. For specific precautionary statements, see Section 6.*

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

1.9 *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

D123 Terminology Relating to Textiles

D5865 Test Method for Gross Calorific Value of Coal and Coke

E176 Terminology of Fire Standards

E603 Guide for Room Fire Experiments

E906 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using a Thermopile Method

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

¹ This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.21 on Smoke and Combustion Products.

Current edition approved April 1, 2022. Published April 2022. Originally approved in 1992. Last previous edition approved in 2021 as E1474 – 21. DOI: 10.1520/E1474-22.

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.

2.2 Other Documents:

CA TB 133, Flammability Test Procedure for Seating Furniture for Use in Public Occupancies³

ISO 5725 Part 2, Accuracy (Trueness and Precision) of Measurement Methods and Results—Basic Method for the Determination of Repeatability and Reproducibility of a Standard Measurement Method⁴

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms relating to this test method refer to Terminology D123 and E176.

3.1.2 *effective heat of combustion, n*—the amount of heat generated per unit mass lost by a material, product, or assembly, when exposed to specific fire test conditions. (see *gross heat of combustion*.)

3.1.2.1 *Discussion*—The effective heat of combustion depends on the test method and is determined by dividing the measured heat release by the mass loss during a specified period of time under the specified test conditions. Typically, the specified fire test conditions are provided by the specifications of the fire test standard that cites effective heat of combustion as a quantity to be measured. For certain fire test conditions, involving very high heat and high oxygen concentrations under high pressure, the effective heat of combustion will approximate the gross heat of combustion. More often, the fire test conditions will represent or approximate certain real fire exposure conditions, and the effective heat of combustion is the appropriate measure. Typical units are kJ/g or MJ/kg.

3.1.3 *gross heat of combustion, n*—the maximum amount of heat per unit mass that theoretically can be released by the combustion of a material, product, or assembly; it can be determined experimentally only under conditions of high pressure and in pure oxygen (contrast *effective heat of combustion*).

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

3.1.4.1 *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 or Test Method E906) 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, for example as described in Guide E603, on any surface, and with measurement devices responding to radiative and convective fluxes. Typical units are kW/m², W/cm², or BTU/(s ft²).

3.1.5 *heat release rate, n*—the thermal energy released per unit time by an item during combustion under specified conditions.

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

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

3.1.7.1 *Discussion*—The initial test heat flux is the heat flux value commonly used when describing or setting test conditions.

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

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *mattress, n*—a 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.

3.2.2 *net heat of combustion, n*—the oxygen bomb (see Test Method D5865) value for the heat of combustion, corrected for the gaseous state of product water.

3.2.2.1 *Discussion*—The net heat of combustion differs from the gross heat of combustion in that the former assesses the heat per unit mass generated from a combustion process that ends with water in the gaseous state while the latter ends with water in the liquid state.

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

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

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

3.2.6 *upholstery material, n*—the padding, stuffing, or filling material used in a furniture item, which may be either loose or attached, enclosed by an upholstery cover material and support system, if present.

3.2.6.1 *Discussion*—This includes, but is not limited to, material such as foams, cotton batting, polyester fiberfill, bonded cellulose, or down.

4. Summary of Test Method

4.1 This test method is based on the observation that the net heat released in combustion is generally directly related to the amount of oxygen required for combustion (1).⁵ Approximately 13.1×10^3 kJ of heat is released per 1 kg of oxygen consumed. Specimens in the test are burned in ambient air conditions while being subjected to a prescribed initial test heat flux of 35 kW/m².

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

4.3 This test method determines heat release rate per unit area initially exposed (in units of kW/m²) and not just heat release rate (in units of kW). Thus, the heat release rate reported in this test method is the heat release rate per unit area (see Sections 9, 10, and X1.5 and Table 7 and Table 8).

³ Available from State of California, Dept. of Home Furnishings and Thermal Insulation, North Highlands, CA 95660-5595.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁵ The boldface numbers in parentheses refer to the list of references at the end of this test method.