Designation: E2067 – 23

An American National Standard

Standard Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests[1]

This standard is issued under the fixed designation E2067; 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.

1. Scope*

1.1 This practice deals with methods to construct, calibrate, and use full scale oxygen consumption calorimeters to help minimize testing result discrepancies between laboratories.

1.2 The methodology described herein is used in a number of ASTM test methods, in a variety of unstandardized test methods, and for research purposes. This practice will facilitate coordination of generic requirements, which are not specific to the item under test.

1.3 The principal fire-test-response characteristics obtained from the test methods using this technique are those associated with heat release from the specimens tested, as a function of time. Other fire-test-response characteristics also are determined.

1.4 This practice is intended to apply to the conduction of different types of tests, including both some in which the objective is to assess the comparative fire performance of products releasing low amounts of heat or smoke and some in which the objective is to assess whether flashover will occur.

1.5 This practice does not provide pass/fail criteria that can be used as a regulatory tool, nor does it describe a test method for any material or product.

1.6 For use of the SI system of units in referee decisions, see IEEE/ASTM SI-10. The units given in parentheses are provided for information only.

1.7 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.

NOTE 1—This is the standard caveat described in section F2.2.2.1 of the Form and Style for ASTM Standards manual for fire-test-response standards. In actual fact, this practice does not provide quantitative measures.

1.8 Fire testing of products and materials is inherently hazardous, and adequate safeguards for personnel and property shall be employed in conducting these tests. Fire testing involves hazardous materials, operations, and equipment. See also Section 7.

1.9 *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.*

1.10 *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]

D5424 Test Method for Smoke Obscuration of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

D5537 Test Method for Heat Release, Flame Spread, Smoke Obscuration, and Mass Loss Testing of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

D6113 Test Method for Using Cone Calorimeter to Determine Fire-Test-Response Characteristics of Insulating Materials Contained in Electrical or Optical Fiber Cables

E84 Test Method for Surface Burning Characteristics of Building Materials

E176 Terminology of Fire Standards

E603 Guide for Room Fire Experiments

E906/E906M 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 practice 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 Nov. 1, 2023. Published November 2023. Originally approved in 2000. Last previous edition approved in 2022 as E2067 – 22. DOI: 10.1520/E2067-23.

[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.

*A Summary of Changes section appears at the end of this standard

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
E1623 Test Method for Determination of Fire and Thermal Parameters of Materials, Products, and Systems Using an Intermediate Scale Calorimeter (ICAL)
E1740 Test Method for Determining the Heat Release Rate and Other Fire-Test-Response Characteristics of Wall Covering or Ceiling Covering Composites Using a Cone Calorimeter
E1822 Test Method for Fire Testing of Stacked Chairs
E2965 Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter
IEEE/ASTM SI-10 International System of Units (SI) The Modernized Metric System

2.2 *ISO Standards:*[3]
ISO 13943 Fire Safety-Vocabulary
ISO 5660-1 Fire Tests—Reaction to Fire—Rate of Heat Release from Building Products (Cone Calorimeter Method)
ISO 9705 Fire Tests - Full-Scale Room Test for Surface Products

2.3 *California Bureau of Home Furnishings and Thermal Insulation Standards:*[4]
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

2.4 *NFPA Standards:*[5]
NFPA 265 Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings
NFPA 266 Standard Method of Test for Fire Characteristics of Upholstered Furniture Exposed to Flaming Ignition Source – Withdrawn
NFPA 267 Standard Method of Test for Fire Characteristics of Mattresses and Bedding Assemblies Exposed to Flaming Ignition Source – Withdrawn
NFPA 286 Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Wall and Ceiling Interior Finish
NFPA 289 Standard Method of Fire Test for Individual Fuel Packages

2.5 *UL Standards:*[6]
UL 1685 Standard Vertical Tray Fire Propagation and Smoke Release Test for Electrical and Optical Fiber Cables
UL 1975 Standard Fire Tests for Foamed Plastics Used for Decorative Purposes

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this practice, refer to Terminology E176 and ISO 13943. In case of conflict, the definitions given in Terminology E176 shall prevail.

3.1.2 *continuous (as related to data acquisition in large-scale tests), adj*—conducted at data collection intervals of 6 s or less. **(E176)**

3.1.3 *heat release rate, n*—the heat evolved from the specimen, per unit of time. **(E176)**

3.1.4 *ignition, n*—the initiation of combustion. **(E176)**

3.1.4.1 *Discussion*—The combustion may be evidenced by glow, flame, detonation or explosion. The combustion may be sustained or transient.

3.1.5 *oxygen consumption principle, n*—the expression of the relationship between the mass of oxygen consumed during combustion and the heat released. **(E176)**

3.1.6 *smoke, n*—the airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion. **(E176)**

3.1.7 *smoke obscuration, n*—reduction of light transmission by smoke, as measured by light attenuation. **(E176)**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *sample, n*—an amount of the material, product, or assembly, to be tested, which is representative of the item as a whole.

3.2.2 *specimen, n*—representative piece of the product, which is to be tested together with any substrate or treatment.

4. Significance and Use

4.1 The oxygen consumption principle, used for the measurements described here, is based on the observation that, generally, the net heat of combustion is directly related to the amount of oxygen required for combustion **(1)**.[7] Approximately 13.1 MJ of heat are released per 1 kg of oxygen consumed. Test specimens in the test are burned in ambient air conditions, while being subjected to a prescribed external heating source.

4.1.1 This technique is not appropriate for use on its own when the combustible fuel is an oxidizer or an explosive agent, which release oxygen. Further analysis is required in such cases (see Appendix X2).

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, in a full scale environment.

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

[4] 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.

[5] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[6] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.

[7] The boldface numbers in parentheses refers to the list of references at the end of this standard.

4.3 The primary measurements are oxygen concentration and exhaust gas flow rate. Additional measurements include the specimen ignitability, the smoke obscuration generated, the specimen mass loss rate, the effective heat of combustion and the yields of combustion products from the test specimen.

4.4 The oxygen consumption technique is used in different types of test methods. Intermediate scale (Test Method E1623, UL 1975) and full scale (Test Method D5424, Test Method D5537, Test Method E1537, Test Method E1590, Test Method E1822, ISO 9705, NFPA 265, NFPA 266, NFPA 267, NFPA 286, UL 1685) test methods, as well as unstandardized room scale experiments following Guide E603, using this technique involve a large instrumented exhaust hood, where oxygen concentration is measured, either standing alone or positioned outside a doorway. A large test specimen is placed either under the hood or inside the room. This practice is intended to address issues associated with equipment requiring a large instrumented hood and not stand-alone test apparatuses with small test specimens.

4.4.1 Small scale test methods using this technique, such as Test Methods D6113, E1354, E1474 and E1740, as well as ISO 5660 internationally, are based on a stand-alone apparatus, wherein a small specimen is tested within the equipment. A small-scale test using oxygen consumption calorimetry with a larger test specimen (than the above referenced test methods) and intended for low levels of heat release is Test Method E2965.

4.4.2 Another small scale heat release test method, Test Method E906/E906M, does not use the oxygen consumption technique.

4.4.3 Annex A1 contains the considerations needed for heat release measurements and Annex A2 contains the corresponding measurement equations as well as the equations for smoke and gas release measurements. These equations apply to Test Methods D5424, D5537, E1537, E1590, E1623, and E1822. See also Section 14.

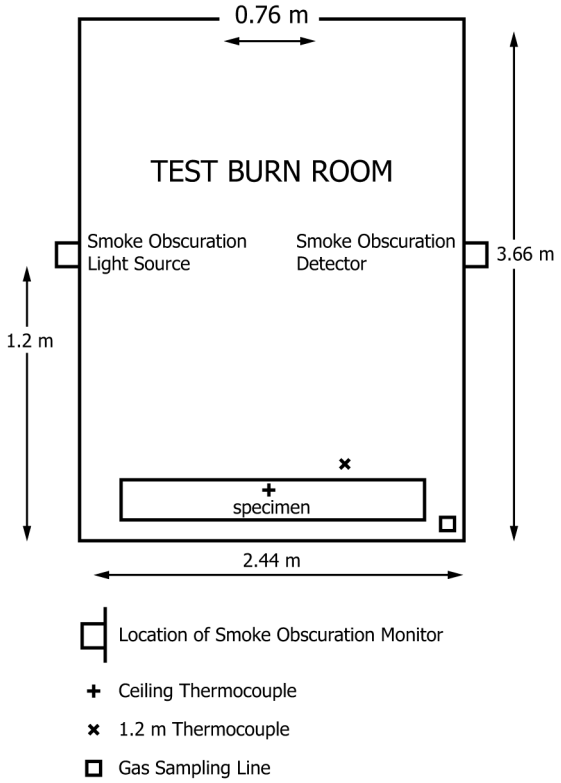
4.5 Throughout this practice, test equipment is referenced to provide helpful guidance to test facilities. Substitution of equivalent, or better, test measuring devices is permissible.

5. Test Room Layout

5.1 *Standard Rooms:*

5.1.1 Three standard room configurations have been in common use for many years, often designated as the "ASTM"/"ISO" room (cited in Guide E603 and in ISO 9705), and the "California" room (used in CA TB 129 and CA TB 133, as well as, Test Methods E1537, E1590, and E1822), and the cable tray test room (used in Test Methods D5424 and D5537, as well as, in UL 1685).

5.1.2 *ASTM/ISO Room*—The test room shall have interior dimensions of 2.44 m ± 25 mm by 3.66 m ± 25 mm by 2.44 m ± 25 mm high (8 ft by 12 ft by 8 ft high). The room shall have no openings other than a doorway opening 0.76 m ± 6 mm by 2.03 m ± 6 mm (30 in. by 80 in.), located as indicated in Fig. 1, and other small openings, as necessary to make test measurements. Construct the test room of wooden or metal studs, and line it with gypsum wallboard, Type X, or calcium silicate wallboard. Position a hood (see Section 6) outside of the room doorway, such that it collects all the combustion gases. There shall be no obstructions to the air supply to the test setup.



NOTE 1—See text for tolerances; room instrumentation is optional.

FIG. 1 Test Room Configuration A (ASTM room)

NOTE 2—Both Type X gypsum wallboard and calcium silicate wallboard with a thickness of 12.7 mm (0.5 in.) have been found acceptable. If the wallboard is thicker, it will not affect the results of this test. Gypsum wallboard is likely to generate a measurable amount of heat or smoke release at high heat inputs, due primarily to its paper facer.

5.1.2.1 Install an additional layer of fire rated wallboard on the portions of the walls or ceiling directly adjacent to the test specimen location. Cover at least 1.22 m by 1.22 m (4 ft by 4 ft) of the ceiling with the added wallboard, but do not place an additional layer of wallboard under the test specimen. This ceiling surface is the most severely exposed to flames and heat and needs frequent replacement. Replace any portion of the lining if cracks occur or severe burn damage is observed.

5.1.2.2 Frequently, whenever there is a single test specimen, such as Test Method E1537, Test Method E1590, or Test Method E1822, the test specimen location is the corner of the room furthest away from the doorway. The test specimen also is usually placed on a weighing platform. This test room is unsuitable for Test Method D5424 or Test Method D5537. The test method indicates test specimen location.

5.1.2.3 When testing surface linings (walls or ceilings), weighing of the test specimen during the test is usually not practical. Mass loss during testing, if desired, must be estimated from calculations.

5.1.3 *California Room*—The test room shall have dimensions of 3.05 m ± 25 mm by 3.66 m ± 25 mm by 2.44 m ±