Designation: E3367 – 23

An American National Standard

Standard Test Method for Determining the Combustion Behavior of Layered Assemblies using a Cone Calorimeter[1]

This standard is issued under the fixed designation E3367; 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 test method covers a means to measure the response of materials, products or layered assemblies when exposed to controlled levels of radiant heating, with or without an external ignitor.

1.2 This test method provides an alternative test configuration to Test Method E1354 to measure the ignitability, heat release rate (including peak heat release rate and total heat released), mass loss rate, effective heat of combustion and visible smoke development.

1.3 Compared to Test Method E1354, this test method adds the ability to measure the time at which the following phenomena occur: (*1*) appearance of liquid products (generated by either melting or pyrolysis of the specimen) underneath the sample, dripping and generation of a liquid pool underneath the specimen, (*2*) flaming over the bottom surface of the specimen and liquid pool, and; (*3*) burn-through.

1.4 This test method is not intended to measure the response of products comprised of noncombustible cores.

1.5 The top side of the specimens shall be exposed to an initial test heat flux of 0 kW/m^2 to 75 kW/m^2. External ignition, if any, shall be by electric spark.

1.6 This test method has been developed for use to evaluate the fire test response characteristics of materials, products or layered assemblies. It is potentially useful for mathematical modeling, material or product design purposes, and research and development.

1.7 This test method is used to measure and describe the response of 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 an end-use product under actual fire conditions.

1.8 This test method is used to measure the effect of fire barriers on the burning behavior of materials, products or layered assemblies to a range of radiant heat intensities but does not account for all factors that affect the performance of fire barriers at full scale.

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

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, refer to Section 7.1.

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

1.12 *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

D4391 Terminology Relating to The Burning Behavior of 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

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms related to fire, refer to Terminology E176.

[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.

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[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.

3.1.2 For definitions of terms related to textiles, refer to Terminology D123.

3.1.3 For definitions of terms related to the burning behavior of textiles, refer to Terminology D4391.

3.1.4 *sustained flaming, n*—flame on or over the surface of a test specimen that lasts longer than a defined period of time.

3.2 *Definitions:*

3.2.1 *bottom ignition, n*—a process leading to sustained flaming underneath the specimen.

3.2.2 *bottom layered materials, n*—optional bottom portion of the specimen, made of a single or multiple layers (such as metal foils, textiles and polymeric films), which covers the bottom surface of the core.

3.2.2.1 *Discussion*—Top and bottom layered materials can act as fire barriers protecting the core; they are sealed to the specimen holder in order to prevent pyrolyzate leaking.

3.2.3 *burn-through, n*—a process leading to the formation of a hole connecting the top to the bottom of the specimen.

3.2.4 *core, n*—main component and fuel source of the specimen.

3.2.4.1 *Discussion*—The specimen holder in the Cube Test is designed such that the lateral surface of the core is surrounded by a thermal insulator and a metal liner; this promotes the formation of a one-dimensional heat/mass transfer scenario where heat/mass transfer occurs in a direction perpendicular to the top and bottom surfaces of the core.

3.2.5 *dripping, n*—a process by which liquid products drips and accumulate underneath the specimen to form a pool.

3.2.6 *fire barrier, n*—layer of a material or a product used to prevent or decrease the burning rate of the core by inhibiting heat and mass transfer.

3.2.7 *layered assembly, n*—product comprised of one or multiple-layers including a core and, optionally, top layered materials and bottom layered materials.

3.2.8 *liquid products, n*—flammable liquid material generated by melting or pyrolysis of the core.

3.2.9 *pool ignition, n*—a process by which liquid products in a pool are ignited.

3.2.10 *release of liquid products or "wetting", n*—a process by which liquid products become visible on the bottom surface of the specimen.

3.2.10.1 *Discussion*—In presence of bottom layered materials which are permeable to liquid products, wetting can be revealed by visible stains due to liquid products percolating through the bottom layered materials.

3.2.11 *top layered materials, n*—optional portion of the specimen, made of a single or multiple layers (such as metal foils, textiles and polymeric films), which covers the top surface of the core.

4. Summary of Test Method

4.1 This test method measures the response of materials, products or layered assemblies to a range of radiant heat intensities with or without an ignition source.

4.2 This test provides means to measure time to wetting, time to dripping, time to bottom ignition, time to pool ignition, time to burn-through as well as time-resolved heat release rate and mass loss rate, peak heat release rate, total heat released, ignitability, and other fire-test-response characteristics as a function of the initial test heat flux.

4.3 The test specimen is intended to be a representative cross-section of a product or layered assembly. The specimen includes a core, constituting the main component and fuel source of the specimen and, optionally, top layered materials and bottom layered materials. The top and bottom layered materials can act as fire barriers protecting the core.

4.4 This test method is not intended for products or assemblies comprised of cores that comply with the noncombustible requirements of Test Method E1354.

4.5 The sides of the core shall be insulated and sealed to minimize loss of heat and/or of products of decomposition.

4.6 The optional top and bottom layered materials shall be sealed along their edge by the sample holder in order to inhibit leaks of pyrolizates.

4.6.1 Sealing and insulating the sides of the specimens promote, as much as possible (perfectly adiabatic conditions at the specimen sides, complete prevention of leaks, and total uniformity in the incident heat-flux are unfeasible), a one-dimensional heat/mass transfer scenario where heat/mass transfer occurs in a direction perpendicular to the top surface of the specimen.

4.7 The optional top and bottom layered materials shall be constrained along their edge by the sample holder in order to induce stress in shrinkage-prone layered materials.

4.8 The top surface of the specimen is exposed to initial test heat fluxes in the range of 0 kW/m^2 to 75 kW/m^2. External ignition, if any, shall be by means of an electric spark. For exploratory testing, the initial test heat flux shall be of 50 kW/m^2. When multiple initial test heat fluxes are to be employed, in the absence of further specifications, values of 35 kW/m^2, 50 kW/m^2, and 75 kW/m^2 shall be used.

4.9 For this test method, sustained flaming shall be considered to be a flame on or over the surface of a test specimen that lasts longer than 4 s.

5. Significance and Use

5.1 Flammable liquid products can be generated by either pyrolysis or melting of polymers. Materials that generate flammable liquid products include thermoplastic polymers (for example, polyolefins) and thermosetting polymers (for example, polyurea and flexible polyurethane), which degrade to yield, in part, liquid pyrolyzates when pyrolyzing. Such liquid material can accumulate underneath a burning item and eventually ignite to form a pool fire, generally leading to a sharp increase in heat release rate and increase in fire hazard.

5.2 Fire barriers are able to hinder the formation of a pool fire by delaying the generation and the release of flammable liquid products.