Designation: E906/E906M – 21

An American National Standard

Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using a Thermopile Method[1]

This standard is issued under the fixed designation E906/E906M; 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 provides for determining the release rates of heat and visible smoke (Note 1) from materials, products, or assemblies when exposed to different levels of radiant heat.

NOTE 1—Visible smoke is described in terms of the obscuration of transmitted light caused by combustion products released during the tests (see 14.2.1).

1.2 This fire-test-response method assesses heat release by a thermal method, thermopile, using a radiant heat source composed of an array of four electrical resistance elements.

1.3 This test method provides for radiant thermal exposure of a specimen both with and without a pilot. Piloted ignition results from direct flame impingement on the specimen (piloted, point ignition) or from use of the pilot to ignite gases evolved by pyrolysis of the specimen.

1.4 Heat and smoke release are measured from the moment the specimen is injected into a controlled exposure chamber. The measurements are continued during the period of ignition (and progressive flame involvement of the surface in the case of point ignition), and to such a time that the test is terminated.

1.5 The apparatus described in this test method is often referred to as the Ohio State University (OSU) rate of heat release apparatus. Configurations A and B are variations on the original design.

1.6 This test method is suitable for exposing essentially planar materials, products or assemblies to a constant, imposed external heat flux that ranges from 0 kW/m^2 to 80 kW/m^2.

1.7 The apparatus described in this test method has been used in two configurations. Configuration A is that which is used by the Federal Aviation Administration for assessing materials for aircraft use, at an external heat flux of 35 kW/m^2 (DOT/FAA/AR-00/12), while configuration B is suitable, at various incident heat fluxes, for research and development purposes.

1.8 This test method does not provide information on the fire performance of the test specimens under fire conditions other than those conditions specified in this test method. Known limitations of this test method are described in 1.8.1 – 1.8.5.

1.8.1 Heat and smoke release rates depend on a number of factors, including the formation of surface char, the formation of an adherent ash, sample thickness, and the method of mounting.

1.8.2 Heat release values are a function of the specific specimen size (exposed area) tested. Results are not directly scaleable to different exposed surface areas for some products.

1.8.3 The test method is limited to the specified specimen sizes of materials, products, or assemblies. If products are to be tested, the test specimen shall be representative of the product in actual use. The test is limited to exposure of one surface; the options for exposed surface are vertical and horizontal facing up.

1.8.4 At very high specimen heat release rates, it is possible that flaming is observed above the stack, which makes the test invalid.

1.8.5 No general relationship has been established between heat release rate values obtained from horizontally and vertically oriented specimens. Specimens that melt and drip in the vertical orientation shall be tested horizontally.

1.9 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.10 Fire testing involves hazardous materials, operations, and equipment. See Section 6.

1.11 *This standard is used to measure and describe the response or 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*

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

assessment of the materials, products, or assemblies under actual fire conditions.

1.12 *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.*

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

1.14 *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]

D618 Practice for Conditioning Plastics for Testing

E176 Terminology of Fire Standards

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

2.2 *ISO Standard:*

ISO 13943 Fire Safety-Vocabulary[3]

2.3 *Federal Aviation Administration Standard:*

Aircraft Material Fire Test Handbook, DOT/FAA/AR-00/12, FAA Technical Center, April 2000[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method refer to the terminology contained in Terminology E176 and ISO 13943, Fire Safety-Vocabulary. In case of conflict, the definitions given in Terminology E176 shall prevail.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *continuous, as related to data acquisition, adj*—conducted at data collection intervals of 5 s or less.

3.2.2 *exposed surface, n*—that surface of the specimen subjected to the incident heat.

3.2.3 *gas phase ignition, n*—ignition of pyrolysis products leaving a heated surface by a pilot flame or other ignition source that does not impinge on, nor significantly affect, for example, by reradiation, the heated surface.

3.2.4 *orientation, n*—plane in which the exposed face of the specimen is located during testing, either vertical or horizontally face upwards.

3.2.5 *SMOKE unit, n*—the concentration of smoke particulates in a cubic metre of air that reduces the percent transmission of light through a 1 m path to 10 %. SMOKE = Standard Metric Optical Kinetic Emission.

3.2.6 *time to ignition, n*—time between the start of the test and the presence of a flame on or over most of the specimen surface for a period of at least 4 s.

4. Summary of Test Method

4.1 The specimen to be tested is injected into an environmental chamber through which a constant flow of air passes. The specimen's exposure is determined by a radiant heat source adjusted to produce the desired total heat flux on the specimen. Exposure options include: horizontal or vertical orientations; nonpiloted ignition, piloted ignition of evolved gases, or point ignition of the surface. The changes in temperature and optical density of the gas leaving the chamber are monitored, and from this data the release rates of heat and visible smoke (see 14.2.1) are calculated.

5. Significance and Use

5.1 This test method provides a description of the behavior of material specimens under a specified fire exposure in terms of the release rate of heat and visible smoke. It is possible to determine the change in behavior of materials and products with change in heat-flux exposure by testing specimens in a series of exposures that cover a range of heat fluxes.

5.2 The data obtained for a specific test describe the rate of heat and smoke release of the specimen when exposed to the specific environmental conditions and procedures used in performing that test.

5.3 The entire exposed surface of the specimen will not be burning during the progressive involvement phase when piloted, point ignition (impingement) procedures are used. During the period of progressive surface involvement, release rates of heat and smoke are "per square metre of original exposed surface area" not "per square metre of flame involved surface."

5.4 The rates of both heat and smoke release are calculated per square metre of original surface area exposed. If a specimen swells, sags, delaminates, or otherwise deforms so that the exposed surface area changes, calculated release rates correspond to the original area, not to the new surface area.

5.5 Heat-release values depend on mode of ignition. Gas phase ignition gives a more dimensionally consistent measure of release rate when very rapid or immediate flame involvement of the specimen surface occurs. However, piloted, point ignition allows release-rate information to be obtained at external heat flux from zero up to that required for satisfactory gas-phase ignition, usually over 20 kW/m^2 external exposure. No correlation between the two modes of piloted ignition has been established.

5.6 Release rates depend on many factors, some of which cannot be controlled. It is possible that samples that produce a surface char, a layer of adherent ash, or those that are composites or laminates do not attain a steady-state release rate. Thermally thin specimens, that is, specimens whose

[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] Available from International Standardization Organization, P.O. Box 56, CH-1211, Geneva 20, Switzerland.

[4] Available from National Technical Information Service (NTIS), Springfield, VA 22161. An electronic version of the handbook with the latest revisions can be found at the FAA website: http://www.fire.tc.faa.gov/handbook.stm.