Designation: E 162 – 02

An American National Standard

Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source[1]

This standard is issued under the fixed designation E 162; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This fire-test-response standard, to be used for research and development purposes, covers the measurement of surface flammability of materials. It is not intended for use as a basis of ratings for building code purposes.

1.2 *This standard should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire-hazard or fire-risk of materials, products, or assemblies under actual fire conditions. However, results of the test may be used as elements of a firehazard assessment or a fire-risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard or fire risk of a particular end use.*

1.3 *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.*

1.4 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

E 176 Terminology Relating to Fire Standards[2]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method refer to the terminology contained in Terminology E 176.

4. Summary of Test Method

4.1 This test method of measuring surface flammability of materials employs a radiant heat source consisting of a 12 by 18-in. (305 by 457-mm) panel, in front of which an inclined 6 by 18-in. (152 by 457 mm) specimen of the material is placed. The orientation of the specimen is such that ignition is forced near its upper edge and the flame front progresses downward.

4.2 A factor derived from the rate of progress of the flame front and another derived from the rate of heat liberated by the material under test are combined to provide a radiant panel index.

5. Significance and Use

5.1 This test method provides a laboratory test procedure for measuring and comparing the surface flammability of materials when exposed to a prescribed level of radiant heat energy. It is intended for measurements on materials whose surfaces may be exposed to fire. The test is made on specimens of small size (6 by 18 in. (150 by 460 mm)) that are representative, to the extent possible, of the material or assembly being evaluated. The test is intended for research and development only.

5.2 The rate at which flames will travel along surfaces depends upon the physical and thermal properties of the material, its method of mounting and orientation, the type and level of fire or heat exposure, the availability of air, and properties of the surrounding enclosure.[3]

6. Apparatus

6.1 The apparatus shall be essentially as shown in Figs. 1 and 2 and shall include the following:

6.1.1 *Radiant Panel with Air and Gas Supply*—The radiant panel shall consist of a porous refractory material vertically mounted in a cast iron frame, exposing a radiating surface of 12 by 18 in. (300 by 460 mm) and shall be capable of operating

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[1] This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.22 on Surface Burning.

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[2] *Annual Book of ASTM Standards*, Vol 04.07.

[3] Robertson, A. F., "Surface Flammability Measurements by the Radiant Panel Method," *Symposium on Fire Test Methods, ASTM STP 344*, ASTM, 1962, pp. 33–46.

Robertson, A. F., Gross, D., and Loftus, J., "A Method for Measuring Surface Flammability of Materials Using a Radiant Energy Source," *Proceedings*, ASTM, Vol 56, 1956, pp. 1437–1453.

Gross, D. and Loftus, J. J., "Surface Flame Propagation on Cellulosic Materials Exposed to Thermal Radiation," *Journal of Research*, NBS, Vol 67C, 1963, pp. 251–258.

Magee, R. S. and McAlevy III, R. F., "The Mechanism of Flame Spread," *Journal of Fire and Flammability*, Vol 2, 1971, pp. 271–297.

FIG. 1 Radiant Panel Flame Spread Test Equipment

at temperatures up to 1500°F (815°C). The panel shall be equipped (see Fig. 2) with a venturi-type aspirator for mixing gas and air at approximately atmospheric pressure; a centrifugal blower, or equivalent, to provide 100 ft^3/min (50 L/s) air at a pressure of 2.8 in. of water (700 Pa); an air filter to prevent dust from obstructing the panel pores; a pressure regulator and a control and shut-off valve for the gas supply.

6.1.2 *Specimen Holder*—The specimen holder shall conform in shape and dimension to Fig. 3 and be constructed from heat-resistant chromium steel. Observation marks shall be filed on the surface of the specimen holder to correspond with 3-in. (76-mm) interval lines on the specimen.

6.1.3 *Framework for Support of the Specimen Holder*—The framework shall have two transverse rods of stainless steel, each ½ in. (13-mm) in diameter, with a stop to center the specimen holder directly in front of the radiant panel. The support and bracing members should be constructed from metal stock. Since the angle of the specimen and its position with respect to the panel are critical, the framework dimensions specifying these conditions shall be within ⅛ in. (3.2 mm) of the values given in Fig. 2.

6.1.4 *Pilot Burner*—The pilot burner shall be a length of stainless steel tubing aproximately 8 to 9 in. (203 to 229 mm) long with ⅛-in (3.2-mm) inside diameter by 3⁄16-in. (4.8 mm) outside diameter. The part of the burner that is exposed to radiant energy may be protected with a porcelain tube 13⁄64-in. (5.16 mm) inside diameter by 9⁄32-in. (6.84 mm) outside diameter. The burner shall be mounted horizontally and at a slight angle to the intersection of the horizontal plane of the burner with the plane of the specimen. The burner shall also be capable of being moved out of position when not in use. The pilot shall provide a 2 to 3-in. (51 to 76-mm) flame of gas premixed with air in an aspirating type fitting. Acetylene has been found satisfactory for this purpose. The position of the burner tip is such that the flame will contact or be within ½ in. (12.7 mm) of contacting the top center area of the specimen.

6.1.5 *Stack*—The stack shall be made from 0.040-in. (1.0-mm) sheet steel with shape and dimensions as shown in Fig. 2. The position of the stack with respect to the specimen and radiant heat panel shall also comply with the requirements of Fig. 2.

6.1.6 *Thermocouples*—Eight thermocouples of equal resistance and connected in parallel shall be mounted in the stack and supported with porcelain insulators as indicated in Fig. 2 and Fig. 4. Each junction shall be formed by fusing the end of a twisted pair of Chromel and Alumel wires of 0.020-in. (0.5-mm) diameter.

6.1.7 *Automatic Potentiometer Recorder*—An automatic potentiometer in the range from 100 to 1000°F (38 to 538°C) shall be installed to record the temperature variation of the stack thermocouples as described in 6.1.6. The recorder should give a continuous record or shall print at time intervals of not more than 15 s.

6.1.8 *Hood*—A hood with exhaust blower placed over the stack is required. The blower should produce a velocity of 100 ft/min (0.5 m/s) (30.5 m)/min at the top of the stack with the radiant panel not operating, or approximately 250 ft/min (1.3 m/s) with the radiant panel at operating temperature. The velocity through the stack is not critical for flame-spread measurements provided a stack thermocouple temperature calibration is performed (see Annex A1.2) for the established test conditions. The hood surfaces should clear the top and sides of the stack by a minimum of 10 in. (254 mm) and 7½ in. (191 mm) respectively.

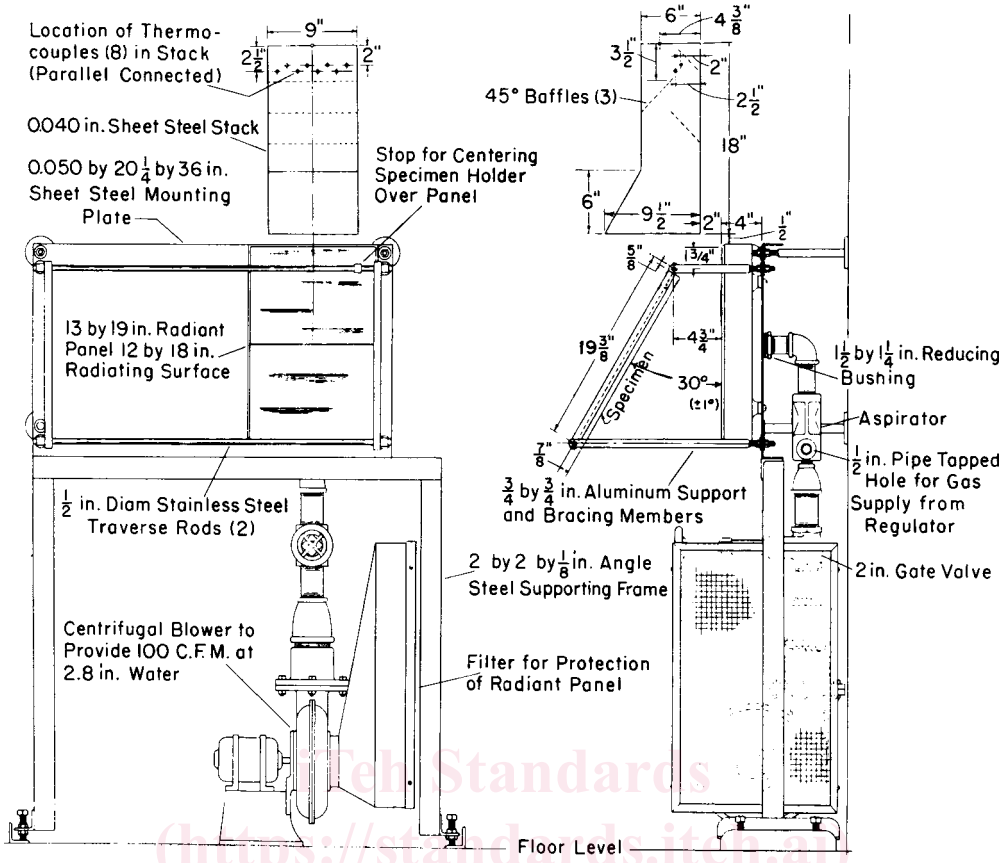
6.1.9 *Radiation Pyrometer*—The radiation pyrometer for standardizing the thermal output of the panel shall be suitable for viewing a circular area 10 in. (254 mm) in diameter at a range of about 4 ft (1.2 m). It shall be calibrated over the operating black body temperature range in accordance with the procedure described in the Annex A1.

6.1.10 *Portable Potentiometer*—The electrical output of the radiation pyrometer shall be monitored by means of a potentiometer provided with a millivolt range suitable for use with the radiation pyrometer described in 6.1.9.

6.1.11 *Timer*—The timer shall be calibrated to read to 0.01 min to record the time of events during the test.

7. Hazards

7.1 Safeguards shall be installed in the panel fuel supply system to guard against a gas air fuel explosion in the test chamber. Potential safeguards include, but are not limited to, one or more of the following: a gas feed cut-off activated when the air supply fails; a flame sensor directed at the panel surface that stops fuel flow when the panel flame goes out; and a heat detector mounted in contact with the radiant panel plenum that is activated when the panel temperature exceeds safe limits. Manual reset is a requirement of any safeguard system used.



Metric Equivalents

in.	mm	in.	mm
0.040	1.0	6	152
½	12.7	9½	241
⅝	16.0	18	457
⅞	22.2	19⅜	492
1¾	44	¾ by ¾	19.2 by 19.2
2	51	1½ by 1¼	38 by 32
2½	64	12 by 18	305 by 457
2.8	71	13 by 19	330 by 483
4	102	2 by 2 by ⅛	51 by 51 by 3.2
4⅜	111	0.050 by 20¼ by 36	13 by 514 by 914
4¾	121		

100 ft^3/min = 47.21 L/s

FIG. 2 Details of Construction of Test Equipment

7.2 The exhaust system must be so designed and operated that the laboratory environment is protected from smoke and gas. The operator shall be instructed on ways to minimize exposure to combustion products by following sound safety and industrial hygiene practices. For example, ensure that the exhaust system is working properly and wear appropriate clothing including gloves, safety glasses, and breathing apparatus (when hazardous fumes are expected).

7.3 During this test, very high heat fluxes and high temperatures are generated that are capable of igniting some clothing following even brief exposures. Precautions shall be taken to avoid ignitions of this type.

8. Test Specimens

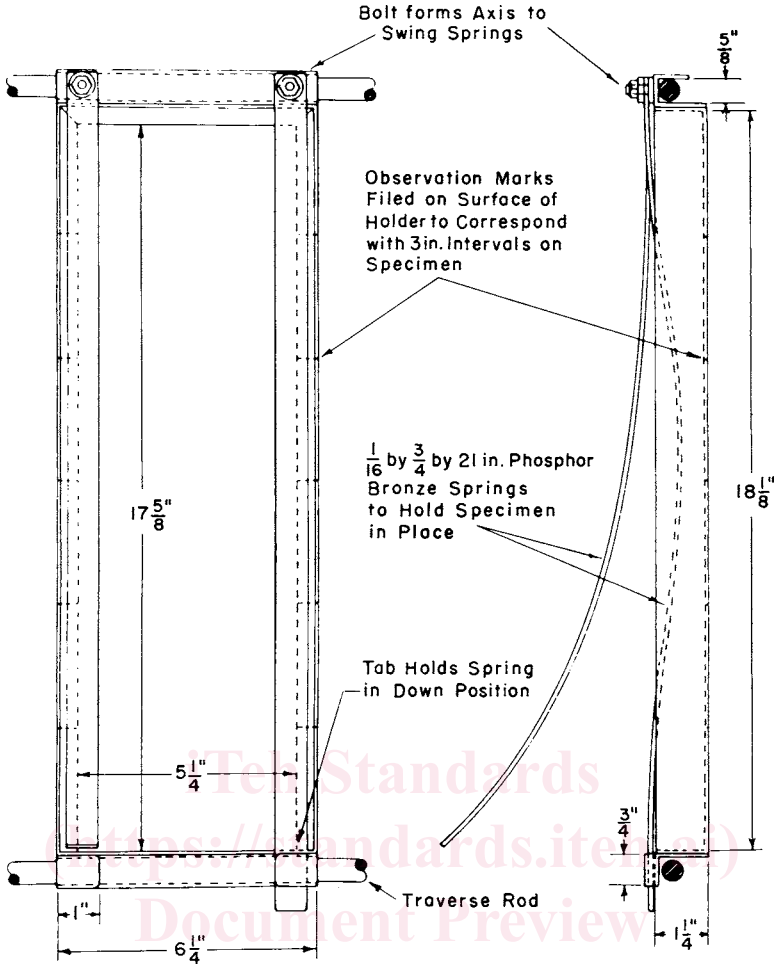
8.1 The test specimen shall be 6 by 18 in. (150 by 460 mm) by the sheet thickness, where this is less than 1 in. (25 mm). Materials supplied in greater thickness shall be cut to 1 in. (25 mm). At the request of the sponsor, materials may be tested in thickness greater than 1 in. (25 mm), but an oversize specimen holder will then be needed.

8.2 Materials intended to be applied to a substrate shall be tested on that substrate.

8.3 For comparison tests, or where the intended application of a finish material is not specified, the finish material shall be prepared for test in accordance with 8.4-8.7.

8.4 Sheet materials that are opaque to infrared radiation and greater than 1/16-in. (1.6-mm) thickness are not applied to a base.

8.5 Opaque sheet materials up to 1/16-in. (1.6-mm) thickness, and liquid films such as paints, etc. intended for application to combustible base materials, shall be applied to ¼-in. (6.4-mm)



Metric Equivalents

in.	mm	in.	mm
¾	19.0	6¼	159
1	25	17⅝	433
1¼	32	18⅛	460
3	76	1/16 by ¾ by 21	1.6 by 19 by 533
5¼	133		

FIG. 3 Specimen Holder

thick tempered hardboard using recommended application procedures. The hardboard shall have a mean flame-spread index of 130 to 160 based upon a minimum of four tests performed in accordance with this method.

8.6 Liquid films and other materials for application to a noncombustible base shall be applied to the smooth surface of ¼-in. (6.4-mm) thick inorganic reinforced cement board, using specified spreading rate requirements, or, in the absence of requirements, a minimum-coating thickness of 0.030 in. (0.76 mm).

NOTE 1—Wherever inorganic reinforced cement board is specified, the material shall be nominal ¼ in. (6.3 mm) thick, high density (110± 5 lb/ft^3 (1762 ± 80 kg/m^3)) and uncoated.

8.7 If a backing of aluminum foil 0.002 in. (0.05 mm) thick, with the bright side against the specimen, produces a higher flame spread index than without the foil, this higher result shall be adopted as the flame spread index.

8.8 Materials, including fabrics, not applied to a base but supported at one or more edges shall be mounted on a special backing of ½-in. (13-mm) thick millboard of which the surface opposite the test specimen is covered with a sheet of highly reflective aluminum foil 0.002 in. thick, with the bright side against the specimen. Millboard spacers ½ by ½ in. (12.7 by 12.7 mm) shall be used at the perimeter of the foil-covered face of the backing to separate the test material from the foil. Flexible materials shall be cut to 10 by 22-in. (255 by 560-mm) size, folded around the frame and fastened to the rear surface of the millboard with tension sufficient only to remove slack.

NOTE 2—Wherever millboard is specified, the material shall be cement bound of commercial quality nominal ½-in. (13-mm) thick and density of 60 ± 5 lb/ft^3 (960 ± 80 kg/m^3).

8.8.1 For cellular elastomers and cellular plastics, whether flexible or not, the back and sides of the test specimen shall be wrapped with aluminum foil 0.002 in. (0.05 mm) thick, with