



Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C¹

This standard is issued under the fixed designation E 136; 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 test method covers the determination under specified laboratory conditions of combustion characteristics of building materials. It is not intended to apply to laminated or coated materials.

1.2 This test method references notes and footnotes that provide explanatory information. These notes and footnotes, excluding those in tables and figures, shall not be considered as requirements of this test method.

1.3 The values stated in SI units are to be regarded as standard. The values given in brackets are for information only.

1.4 *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.*

1.5 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

D 1929 Test Method for Ignition Properties of Plastics

D 3174 Test Method for Ash in the Analysis Sample of Coal and Coke from Coal

E 84 Test Method for Surface Burning Characteristics of Building Materials

E 176 Terminology of Fire Standards

2.2 ISO Standard:

ISO 1182 Noncombustibility Test for Building Materials³

2.3 Other Standard:

BS 476 Combustibility Test of Materials³

3. Terminology

3.1 Definitions—For definitions of terms found in this test method, refer to Terminology E 176.

4. Significance and Use

4.1 While actual building fire exposure conditions are not duplicated, this test method will assist in indicating those materials which do not act to aid combustion or add appreciable heat to an ambient fire.

4.2 Materials passing the test are permitted limited flaming and other indications of combustion.

5. Apparatus

5.1 The apparatus, as shown in Fig. 1, shall consist primarily of the following:

5.1.1 *Refractory Tubes*—Two concentric, refractory tubes, 76 and 102 mm [3 and 4 in.] in inside diameter and 210 to 250 mm [8½ to 10 in.] in length, with axes vertical, and with heat applied by electric heating coils outside of the larger tube. A controlled flow of air is admitted tangentially near the top of the annular space between the tubes and passes to the bottom of the inner tube. The outer tube rests on a refractory bottom and the inner tube rests on three spacer blocks so as to afford a total opening under the inner tube equal to or greater than that of the annular space. The refractory bottom plate has a removable plug for cleaning.

5.1.2 *Transparent Cover*—A transparent cover of heat-resistant glass or other transparent material shall be provided over the top of the inner tubes. The cover shall have a circular opening 28.7 ± 0.8 mm [$1\frac{1}{8} \pm \frac{1}{32}$ in.] centered over the axis of the tubes. This opening has an area of 645 mm² [1.0 in.²]. The cover shall be in two equally-sized, movable parts.

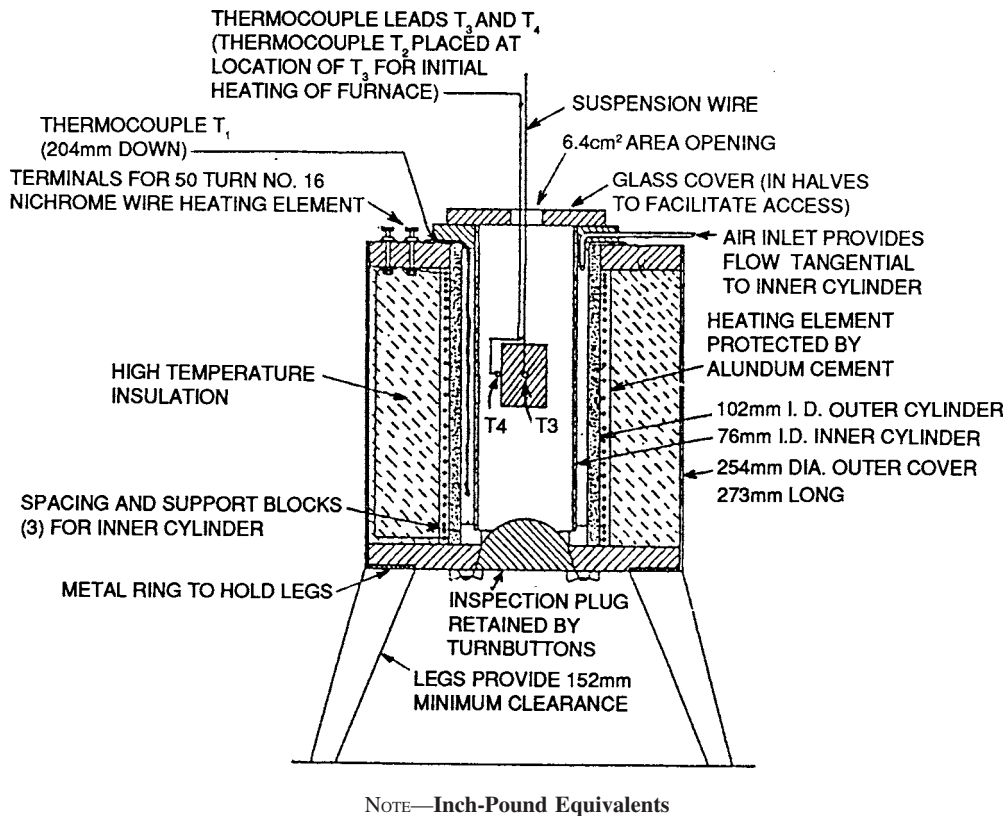
5.1.3 *Thermocouples* and an automatically recording device shall be provided. The thermocouples shall be located as follows:

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

¹ This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.23 on Combustibility.

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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.



in.	3	4	6	10	10 $\frac{3}{4}$	1 in. ²	No. 16 Awg
mm	76	102	152	254	273	6.4 cm ²	1.29

FIG. 1 Cross Section of Furnace Assembly

5.1.3.1 Thermocouple T_1 is located in the center of the air space between the two concentric, refractory tubes; approximately 204 mm [8 in.] down from the top of the 102-mm [4-in.] diameter tube (Note 1).

5.1.3.2 Thermocouple T_3 is located at the approximate geometric center of the specimen.

5.1.3.3 Thermocouple T_4 is located on the surface, in contact with the specimen; in the same horizontal plane as T_3 .

5.1.3.4 Thermocouples T_1 , T_3 and T_4 shall have a time constant (time to reach 63.2 % of the furnace air temperature of 750°C [1382°F]) of 5 to 10 s (Note 2).

NOTE 1—Thermocouple T_1 is used for better regulation of the temperature of the air in the furnace space.

NOTE 2—Ungrounded, metallic-sheathed thermocouples of 1-mm diameter have been found to meet the time constant requirements.

5.2 Specimen Holder—The specimen holder for solid specimens shall be as shown in Fig. 2.

5.2.1 Specimens in granular or powder form shall be contained in thin-wall, open-top vessels of inert materials whose outside dimensions conform to the specimen shape and maximum size specified in 6.1. These vessels shall have walls of either solid or mesh construction.

5.3 Specimen Location—During the test, the geometric center of the specimen shall be located at the geometric center ± 3 mm [$\pm \frac{1}{8}$ in.] of the 76-mm [3-in.] diameter tube.

6. Test Specimens

6.1 All test specimens shall be 38 by 38 by 51 $\pm$ 2.5 mm [1.5 by 1.5 by 2.0 $\pm$ 0.1 in.]. The specimens shall be dried at 60 $\pm$ 3°C [140 $\pm$ 5°F] for not less than 24 h but no more than 48 h. Specimens shall then be placed in a desiccator to cool at least 1 h before testing.

6.2 Not less than four identical specimens shall be tested.

7. Procedure

7.1 Furnace Preparation:

7.1.1 Conduct the test at room conditions of 21 $\pm$ 3°C [70 $\pm$ 5°F].

7.1.2 Air Flow—Provide an external air source to supply clean air through a metal tube located near the furnace top, tangentially between the annular spaced ceramic tubes. The air shall be supplied at a steady and controllable rate of 0.0027 m³/min [0.10 ft³/min] $\pm$ 20 %, which will give an air flow of 3 m [10 ft]/min past a loaded specimen in the furnace at 750°C

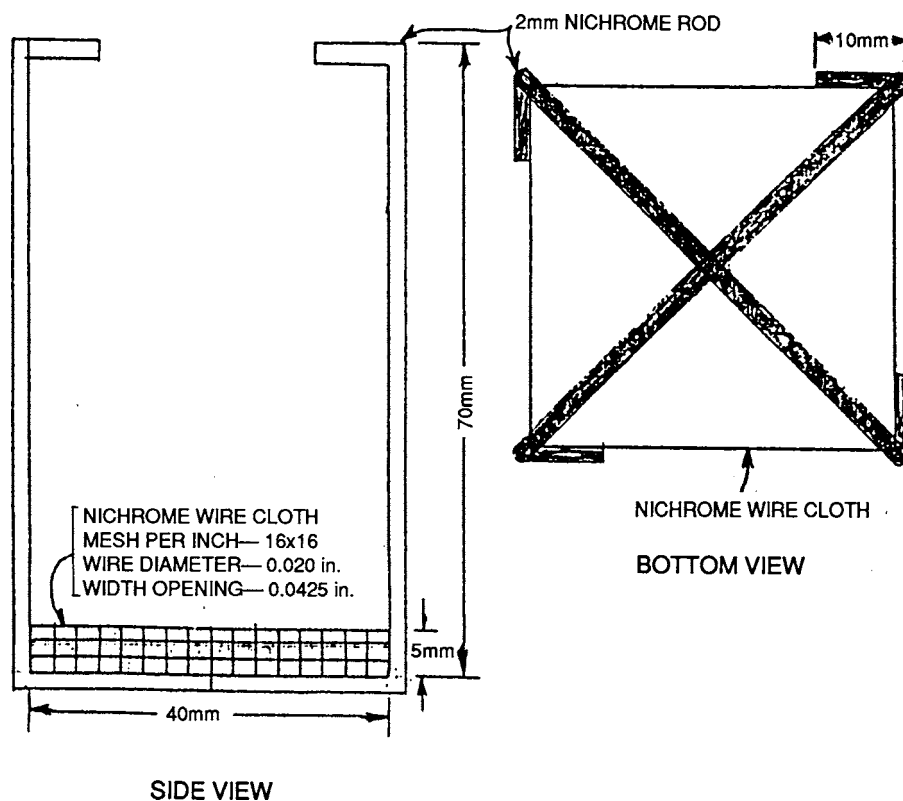


FIG. 2 Specimen Holder for Solid Specimens

[1382°F]. Measure the air at room temperature, as specified in 7.1.1 and meter by a rotameter or other metering device in line with the metal tube.

7.1.3 Prepare the furnace by bringing the temperature of thermocouple T_2 (Note 3), located in the furnace at the position to be occupied by the geometric center of the specimen, to a temperature of $750 \pm 5.5^\circ\text{C}$ [$1382 \pm 10^\circ\text{F}$]. Maintain the temperature in the unloaded furnace for at least 15 min to assure stability.

NOTE 3—The temperature T_2 is measured by means of a thermocouple inserted from the top during the initial heating period. Once the operating temperature has been established by thermocouple T_2 , note the temperature on thermocouple T_1 and control the test chamber during the test to the observed T_1 temperature reading. T_3 may be used as T_2 .

7.2 As rapidly as possible, insert the test specimen into the furnace with thermocouple T_3 inserted from the top of the specimen to its approximate geometric center and thermocouple T_4 attached to the side surface of the specimen. Close the top cover to the 6.4-cm^2 [1-in.^2] opening immediately after insertion of the specimen. Readings for thermocouples T_3 and T_4 shall be made at intervals (Note 4) not to exceed 10 s during the first 5 min, and as often as necessary afterwards to produce a smooth curve. Do not change the regulation of the current through the heating coils and the air flow during the test.

NOTE 4—A continuous read-out recording is preferred since it is possible for the maximum temperature to occur between the 10-s intervals.

7.3 Continue the test until the temperatures at thermocouples T_3 and T_4 have reached maxima, or until it is clearly evident that the specimen does not pass this test.

7.3.1 After 30 minutes of testing have elapsed, or at any time subsequent to that, testing shall be discontinued if, over the previous 10 minutes, the temperature measured at the center thermocouple T_3 has risen by no more than 1°C in any one minute. The final temperature reading shall be recorded as the maximum temperature.

7.4 Throughout the test make and record visual observations on the specimens, noting quality, quantity, or intensity and duration of flaming or smoking, or both, and change of state.

7.5 Weigh each specimen before and after testing and record the weight loss to the nearest 1 %.

8. Report

8.1 Report the material as passing the test if at least three of the four specimens tested meet the individual specimen criteria detailed in 8.2 or 8.3. The three specimens do not need to meet the same condition.

8.2 When the weight loss of the specimen is 50 % or less:

8.2.1 The recorded temperatures of the surface and interior thermocouples do not at anytime during the test rise more than 30°C [54°F] above the stabilized temperature measured at T_2 prior to the test.

8.2.2 There is no flaming from the specimen after the first 30 s.

8.3 When the weight loss of the specimen exceeds 50%:

8.3.1 The recorded temperature of the surface and interior thermocouples do not at anytime during the test rise above the stabilized temperature measured at T_2 prior to the test.

8.3.2 There is no flaming from the specimen at any time during the test.