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Designation: E 648 – 04

An American National Standard

Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source[1]

This standard is issued under the fixed designation E 648; 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 covers a procedure for measuring the critical radiant flux of horizontally mounted floor-covering systems exposed to a flaming ignition source in a graded radiant heat energy environment in a test chamber. A specimen is mounted over underlayment, a simulated concrete structural floor, bonded to a simulated structural floor, or otherwise mounted in a typical and representative way.

1.2 This fire-test-response standard measures the critical radiant flux at flame-out. It provides a basis for estimating one aspect of fire exposure behavior for floor-covering systems. The imposed radiant flux simulates the thermal radiation levels likely to impinge on the floors of a building whose upper surfaces are heated by flames or hot gases, or both, from a fully developed fire in an adjacent room or compartment. The standard was developed to simulate an important fire exposure component of fires that develop in corridors or exitways of buildings and is not intended for routine use in estimating flame spread behavior of floor covering in building areas other than corridors or exitways. See Appendix X1 for information on proper application and interpretation of experimental results from use of this test.

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

1.4 The text of this standard 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 standard.

1.5 *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 materials, products, or assemblies under actual fire conditions..*

1.6 *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.* Specific hazard statements are given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 1186 Specification for Flat Non-Asbestos Fiber-Cement Sheets

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process

E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials

E 176 Terminology of Fire Standards

3. Terminology

3.1 *Definitions*—See Terminology E 176 for additional definitions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *blackbody temperature*, *n*—the temperature of a perfect radiator—a surface with an emissivity of unity and, therefore, a reflectivity of zero.

3.2.2 *corridor*, *n*—an enclosed space connecting a room or compartment with an exit. The corridor includes normal extensions, such as lobbies and other enlarged spaces, where present.

3.2.3 *critical radiant flux*, *n*—the level of incident radiant heat energy on the floor covering system at the most distant flame-out point. It is reported as W/cm^2 ($Btu/ft^2{\cdot}s$).

3.2.4 *flame-out*, *n*—the time at which the last vestige of flame or glow disappears from the surface of the test specimen, frequently accompanied by a final puff of smoke; Time 0 is the

[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] 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.

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time at which the specimen is moved into the chamber and the door closed. (See 12.3.)

3.2.5 *floor covering*, *n*—an essentially planar material having a relatively small thickness in comparison to its length or width, which is laid on a floor to enhance the beauty, comfort, and utility of the floor.

3.2.6 *floor covering system*, *n*—a single material, composite or assembly comprised of the floor covering and related installation components (adhesive, cushion, etc.), if any.

3.2.7 *flux profile*, *n*—the curve relating incident radiant heat energy on the specimen plane to distance from the point of initiation of flaming ignition, that is, 0 cm.

3.2.8 *total flux meter*, *n*—the instrument used to measure the level of radiant heat energy incident on the specimen plane at any point.

4. Summary of Test Method

4.1 The basic elements of the test chamber, Fig. 1, are (*1*) an air-gas fueled radiant heat energy panel inclined at 30° to and directed at (*2*) a horizontally mounted floor covering system specimen, Fig. 2. The radiant panel generates a radiant energy flux distribution ranging along the 100-cm length of the test specimen from a nominal maximum of 1.0 W/cm^2 to a minimum of 0.1 W/cm^2. The test is initiated by open-flame ignition from a pilot burner. The distance burned to flame-out is converted to watts per square centimetre from the flux profile graph, Fig. 3, and reported as critical radiant flux, W/cm^2.

5. Significance and Use

5.1 This fire test response standard is designed to provide a basis for estimating one aspect of the fire exposure behavior of a floor-covering system installed in a building corridor. The test environment is intended to simulate conditions that have been observed and defined in full scale corridor experiments.

5.2 The test is intended to be suitable for regulatory statutes, specification acceptance, design purposes, or development and research.

5.3 The fundamental assumption inherent in the test is that critical radiant flux is one measure of the sensitivity to flame spread of floor-covering systems in a building corridor.

5.4 The test is applicable to floor-covering system specimens that follow or simulate accepted installation practice. Tests on the individual elements of a floor system are of limited value and not valid for evaluation of the flooring system.

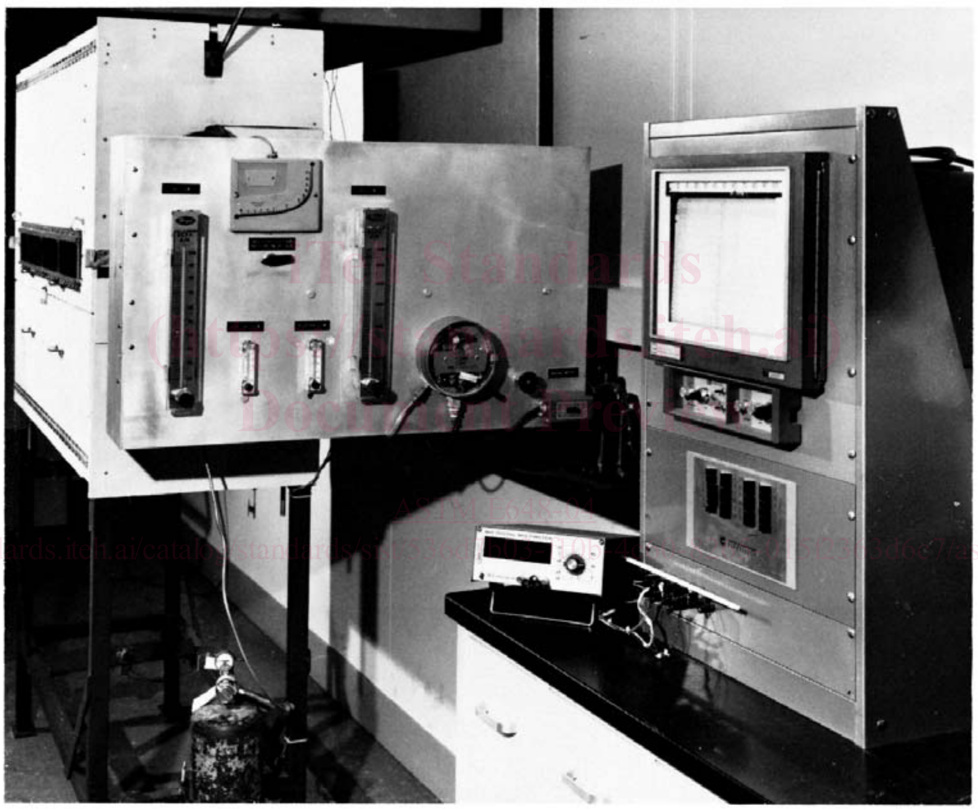

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FIG. 1 Flooring Radiant Panel Tester Apparatus

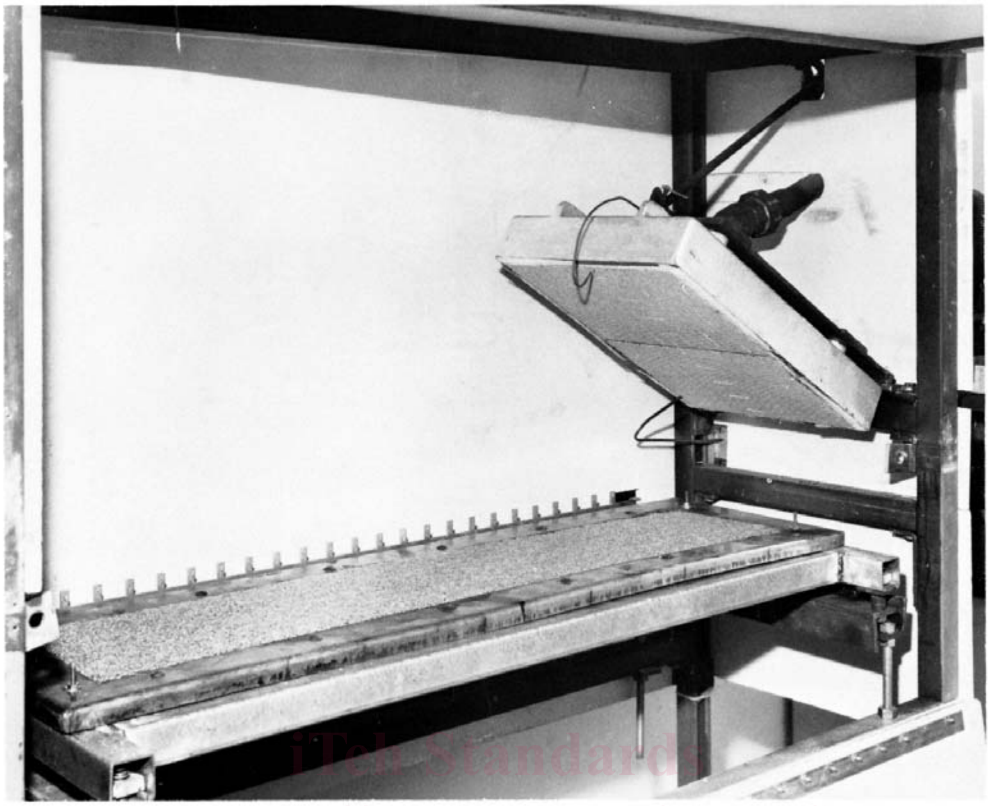

FIG. 2 Flooring Radiant Panel Test Showing Carpet Specimen and Gas Fueled Panel

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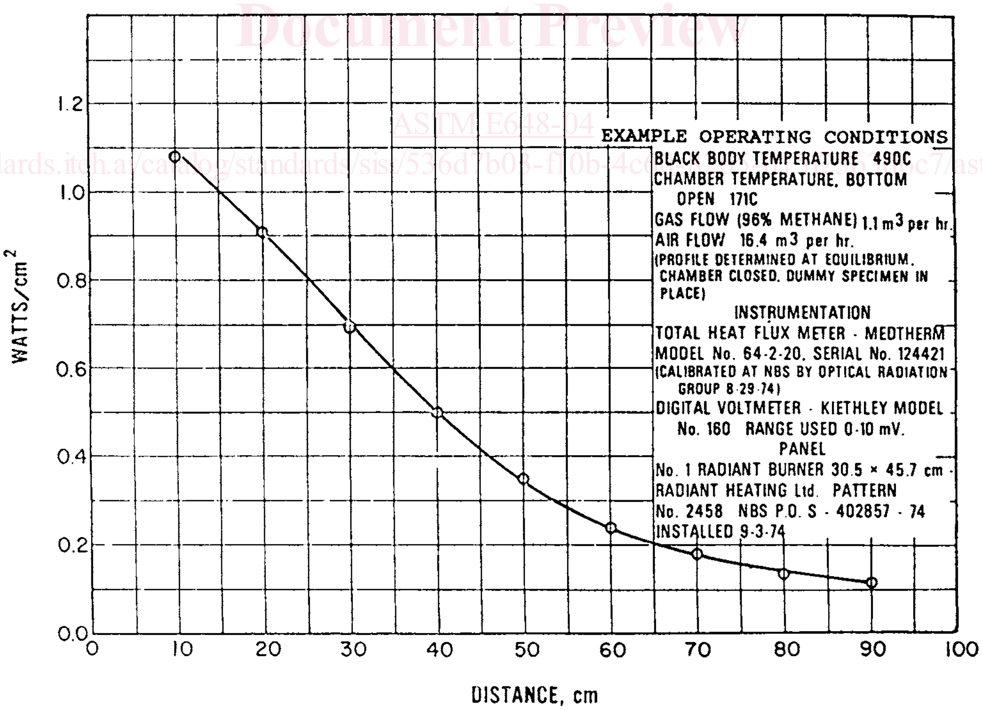

FIG. 3 Standard Radiant Heat Energy Flux Profile

NOTE 1—In this procedure, the specimens are subjected to one or more specific sets of laboratory fire test exposure conditions. If different test conditions are substituted or the anticipated end-use conditions are changed, it may not be possible by or from this test to predict changes in the performance characteristics measured. Therefore, the results are strictly valid only for the fire test exposure conditions described in this procedure.

If the test results obtained by this method are to be considered in the total assessment of fire risk, then all pertinent established criteria for fire risk assessment developed by Committee E05 must be included in the consideration.

6. Flooring Radiant Panel Test Chamber—Construction and Instrumentation

6.1 The flooring radiant panel test chamber employed for this test shall be located in a draft-protected laboratory.

6.1.1 The flooring radiant panel test chamber, Fig. 4 and Fig. 5, shall consist of an enclosure 1400 mm (55 in.) long by 500 mm (19½ in.) deep by 710 mm (28 in.) above the test specimen. The sides, ends, and top shall be of 13-mm (½-in.) calcium silicate, 0.74 g/cm^3 (46 lb/ft^3) nominal density, insulating material with a thermal conductivity at 177°C (350°F) of 0.128 W/(m·K) [0.89 Btu·in./(h·ft^2·°F)]. One side shall be provided with an approximately 100 by 1100-mm (4 by 44-in.) draft-tight fire-resistant glass window so the entire length of the test specimen will be observable from outside the fire test chamber. On the same side and below the observation window is a door that, when open, allows the specimen platform to be moved out for mounting or removal of test specimens. When required for observation, a draft-tight fire-resistant window shall be installed at the low flux end of the chamber.

6.1.2 The bottom of the test chamber shall consist of a sliding steel platform that has provisions for rigidly securing the test specimen holder in a fixed and level position. The free, or air access, area around the platform shall be in the range from 2580 to 3225 cm^2 (400 to 500 in.^{2}).

6.1.3 When the rate of flame front advance is to be measured, a metal scale marked with 10-mm intervals shall be installed on the back of the platform or on the back wall of the chamber.

6.1.4 When the extent of flame travel is to be measured after a prescribed burning period, for example, 15 min, the metal scale described in 6.1.3 shall be used.

6.1.5 The top of the chamber shall have an exhaust stack with interior dimensions of 102 ± 3 mm (4.00 ± 0.13 in.) wide by 380 ± 3 mm (15.00 ± 0.13 in.) deep by 318 ± 3 mm (12.50± 0.13 in.) high at the opposite end of the chamber from the radiant energy source.

6.2 The radiant heat energy source shall be a panel of porous material mounted in a cast iron or steel frame with a radiation surface of 305 by 457 mm (12 by 18 in.). It shall be capable of operating at temperatures up to 816°C (1500°F). The panel fuel system shall consist of a venturi-type aspirator

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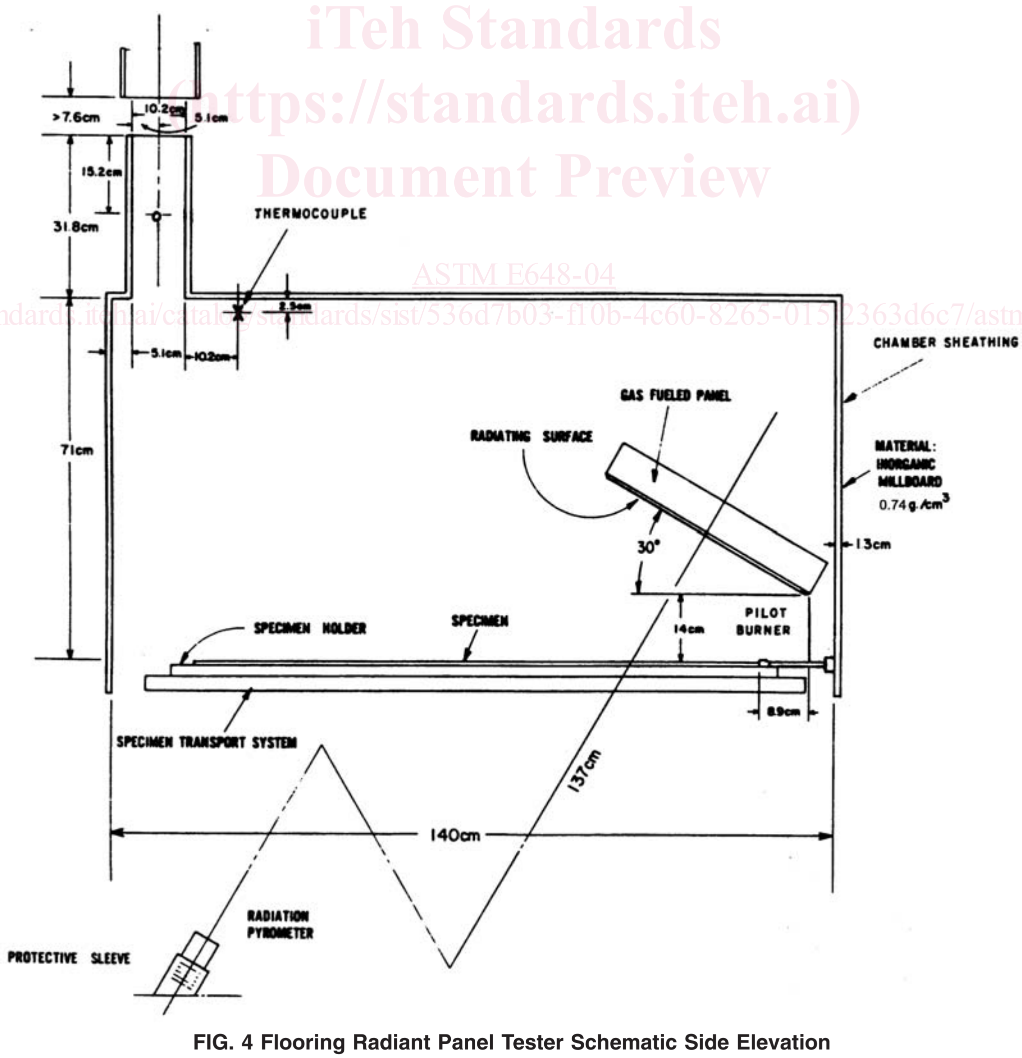

FIG. 4 Flooring Radiant Panel Tester Schematic Side Elevation

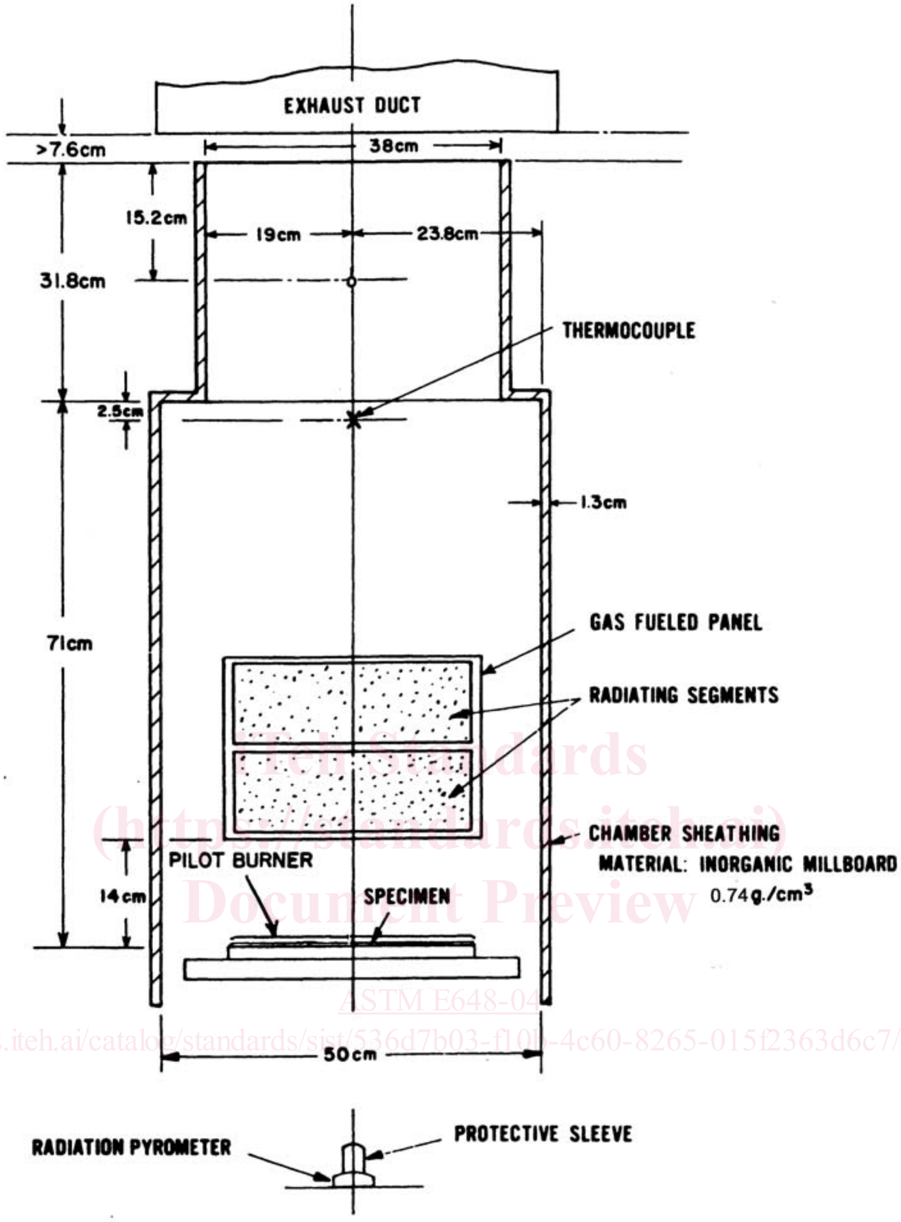

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FIG. 5 Flooring Radiant Panel Tester Schematic Low Flux End, Elevation

for mixing gas[3] and air at approximately atmospheric pressure, a clean, dry air supply capable of providing 28.3 NTP m^3/h (1000 standard ft^3/h) at 76 mm (3.0 in.) of water, and suitable instrumentation for monitoring and controlling the flow of fuel to the panel.

6.2.1 The radiant heat energy panel is mounted in the chamber at a nominal angle of 30 ± 5° to the horizontal specimen plane. The radiant panel shall be adjusted to obtain the flux profile within the limits specified in 10.6. The horizontal distance from the 0 mark on the specimen fixture to the bottom edge (projected) of the radiating surface of the panel is 89 ± 3 mm (3.5 ± 0.13 in.). The panel-to-specimen vertical distance is 140 ± 3 mm (5.5 ± 0.13 in.) (see Fig. 4).

6.2.2 The radiation pyrometer for standardizing the thermal output of the panel shall be suitable for viewing a circular area 254 mm (10 in.) in diameter at a range of about 1.37 m (54 in.). It shall be calibrated over the 490 to 510°C (914 to 950°F) operating blackbody temperature range in accordance with the procedure described in Annex A1.

6.2.3 A high impedance or potentiometric voltmeter with a suitable millivolt range shall be used to monitor the output of the radiation pyrometer described in 6.2.2.

6.3 The specimen holder (see Fig. 5) shall be constructed from heat-resistant stainless steel (AISI Type 300 (UNA-NO8330) or equivalent) having a thickness of 1.98 mm (0.078 in.) and an overall dimension of 1140 by 320 mm (45 by 12¾

[3] Gas used in this test shall be commercial grade propane having a heating value of approximately 83.1 MJ/m^3 (2500 Btu/ft^3), commercial grade methane having a minimum purity of 96 %, or natural gas.

in.) with a specimen opening of 200 by 1000 mm (7.9 by 39.4 in.). Six slots shall be cut in the flange on either side of the holder to reduce warping. The holder shall be fastened to the platform with two stud bolts at each end.

6.4 The pilot burner, used to ignite the specimen, is a nominal 6 mm (1/4 in.) inside diameter, 10 mm (3/8 in.) outside diameter stainless steel tube line burner having 19 evenly spaced 0.7 mm (0.028 in.) diameter (#70 drill) holes drilled radially along the centerline, and 16 evenly spaced 0.7 mm (0.028 in.) diameter (#70 drill) holes drilled radially 60° below the centerline (see Fig. 6). In operation, the gas flow is adjusted to 0.085 to 0.100 m^3/h (3.0 to 3.5 SCFH) (air scale) flow rate. The pilot burner is positioned no more than 5° from the horizontal so the flame generated will impinge on the specimen at the 0 distance burned point (see Fig. 4 and Fig. 5). When the burner is not being applied to the specimen, move it away from the ignition position so it is at least 50 mm (2 in.) away from the specimen.

6.4.1 With the gas flow properly adjusted and the pilot burner in the test position, the pilot flame shall extend from approximately 63.5 mm (2.5 in.) at either end to approximately 127 mm (5 in.) at the center.

6.4.2 The holes in the pilot burner shall be kept clean. A soft wire brush has been found suitable to remove the surface contaminants. Nickel-chromium or stainless steel wire with an outside diameter of 0.5 mm (0.020 in.) is suitable for opening the holes.

6.5 A 3.2-mm (1/8-in.) stainless steel sheathed grounded junction Chromel-Alumel thermocouple shall be located in the flooring radiant panel test chamber (see Fig. 4 and Fig. 5). The chamber thermocouple is located in the longitudinal central vertical plane of the chamber 25 mm (1 in.) down from the top and 102 mm (4 in.) back from inside the exhaust stack.

6.5.1 The thermocouple shall be kept clean to ensure accuracy of readout.

6.5.2 An indicating potentiometer with a range from 100 to 500°C (212 to 932°F) shall be used to determine the chamber temperature prior to a test.

6.6 An exhaust duct with a capacity of 28.3 to 85 NTP m^3/min (1000 to 3000 standard ft^3/min) decoupled from the chamber stack by at least 76 mm (3 in.) on all sides and with an effective area of the canopy slightly larger than plane area of the chamber with the specimen platform in the out position is used to remove combustion products from the chamber. With the panel turned on and the dummy specimen in place, the air flow rate through the stack shall be 76.2 ± 15.2 m/min (250 ± 50 ft/min) when measured with a hot wire anemometer about 30 s after insertion of the probe into the center of the stack opening at a distance of 152 mm (6 in.) down from the top of the stack opening.

6.7 The dummy specimen that is used in the flux profile determination shall be made of 19-mm (3/4-in.) inorganic 0.74 g/cm^3 (46 lb/ft^3) nominal density calcium silicate board (see Fig. 7). It is 250 mm (10 in.) wide by 1070 mm (42 in.) long with 27-mm (1 1/16-in.) diameter holes centered on and along the centerline at the 100, 200, 300, ... , 900 mm locations, measured from the maximum flux end of the specimen. To provide proper and consistent seating of the flux meter in the hole openings, a stainless or galvanized steel bearing plate shall be mounted and firmly secured to the underside of the calcium silicate board with holes corresponding to those previously specified. The bearing plate shall run the length of

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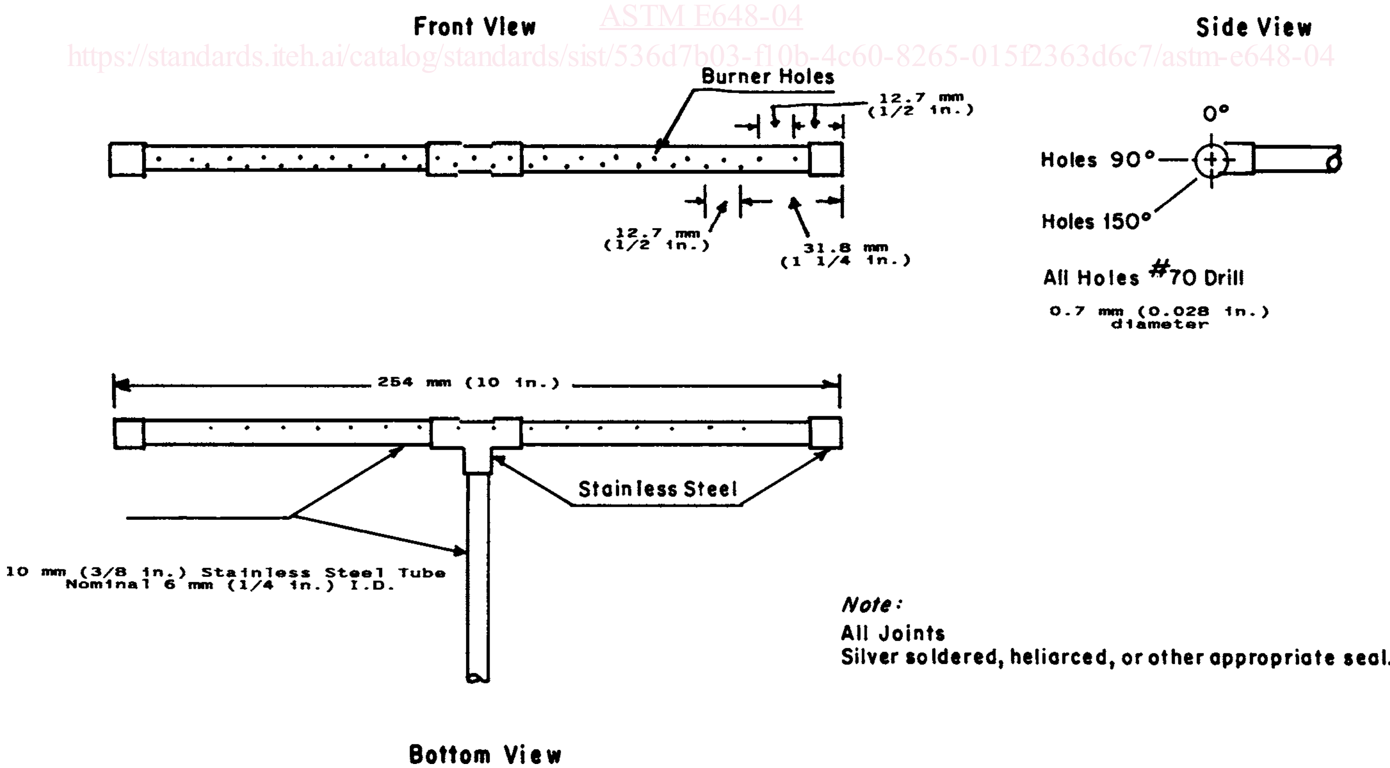

FIG. 6