Designation: E 1321 – 97a

An American National Standard

Standard Test Method for Determining Material Ignition and Flame Spread Properties[1]

This standard is issued under the fixed designation E 1321; 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 fire test response standard determines material properties related to piloted ignition of a vertically oriented sample under a constant and uniform heat flux and to lateral flame spread on a vertical surface due to an externally applied radiant-heat flux.

1.2 The results of this test method provide a minimum surface flux and temperature necessary for ignition ($\dot{q}''_{o,ig}$, T_{ig}) and for lateral spread ($\dot{q}''_{o,s}$, $T_{s,\min}$), an effective material thermal inertia value ($k\rho c$), and a flame-heating parameter (Φ) pertinent to lateral flame spread.

1.3 The results of this test method can be used to predict the time to ignition, t_{ig}, and the velocity, V, of lateral flame spread on a vertical surface under a specified external flux without forced lateral airflow. This can be done using the equations in Appendix X1 that govern the ignition and flame-spread processes and which have been used to correlate the data.

1.4 This test method can be used to obtain results of ignition and flame spread for materials. Data are reported in units for convenient use in current fire growth models.

1.5 SI units are used throughout the standard.

1.6 *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 this test may be used as elements of a fire-hazard 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.*

1.7 *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.* For specific hazard statements, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

E 84 Test Method for Surface Burning Characteristics of Building Materials[2]

E 162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source[2]

E 176 Terminology of Fire Standards[2]

E 286 Test Method for Surface Flammability of Building Materials Using an 8-ft (2.44-m) Tunnel Furnace[3]

E 648 Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source[2]

E 970 Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source[2]

E 1317 Test Method for Flammability of Marine Surface Finishes[2]

2.2 *ASTM Adjuncts:*ASTM

Detailed drawings (19), construction information, and parts list (Adjunct to E 1317)[4]

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *backing board*, *n*—a noncombustible insulating board, mounted behind the specimen during actual testing to satisfy the theoretical analysis assumption of no heat loss through the specimen. It shall be roughly 25 ± 5 mm thick with a density no greater than 200 ± 50 kg/m^3.

3.2.2 *dummy specimen*, *n*—a noncombustible insulating board used for stabilizing the operating condition of the equipment, mounted in the apparatus in the position of the specimen and removed only when a test specimen is to be inserted. It shall be roughly 20 ± 5 mm in thickness with a density of 750 ± 100 kg/m^3.

3.2.2.1 *Discussion*—For the ignition tests, the dummy specimen board shall have a hole at the 50-mm position for mounting the fluxmeter.

3.2.3 *effective thermal property*, *n*—thermal properties derived from heat-conduction theory applied to ignition/ flame-spread data treating the material as homogenous in structure.

3.2.4 *mirror assembly*, *n*—a mirror, marked and aligned with the viewing rakes, used as an aid for quickly identifying

[1] This test method is under the jurisdiction of ASTM Committee E-5 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] Discontinued; see *1992 Annual Book of ASTM Standards*, Vol 04.07.

[4] Available from ASTM Headquarters. Order ADJE1317.

and tracking the flame-front progress.

3.2.5 *special calibration board*, *n*—a specially assembled noncombustible insulating board used for standardizing the operating condition of the equipment which is used only to measure the flux distribution at specified intervals along the specimen surface. It shall be roughly 20± 5 mm in thickness with a density of 750 ± 100 kg/m^3.

3.2.6 *thermally thick*, *n*—the thickness of a medium that is large enough to have the predominate thermal (temperature) effects experienced within that distance, that is, negligible heat is lost from its unexposed side.

3.2.7 *thermal operating level*, *n*—the operating condition at which the radiance of the heat source produces a specified constant heat flux to some specified position at the specimen surface.

3.2.8 *viewing rakes*, *n*—a set of bars with wires spaced at 50-mm intervals for the purpose of increasing the precision of timing flame-front progress along the specimen.

3.3 *Symbols:Symbols:*

b = ignition correlation parameter, s$^{-1/2}$.
C = flame heat transfer factor, m $^{s/2}$/kW·s$^{1/2}$.
CF = ratio of radiation pyrometer signal to flux incident on dummy specimen as measured during calibration; a linear correlation is assumed, mV/(kW/m ^{2}).
$F(t)$ = specimen thermal response function.
$F(x)$ = surface flux configuration invariant, (kW/m^2)/mV.
h = heat loss coefficient, kW/m^2·K.
$\dot{q}''_e$ = measured incident flux, kW/m^2.
$\dot{q}''_{o,ig}$ = critical flux for ignition, kW/m^2.
$\dot{q}''_{o,s}$ = critical flux for spread, kW/m^2.
t = time, s.
t^* = characteristic equilibrium time, s.
t_1 = time at sample insertion, s.
t_2 = time at ignition, s.
t_{ig} = ignition time under incident flux, s.
T_{ig} = ignition temperature, °C.
$T_{s,\,min}$ = minimum temperature for spread, °C.
T_∞ = ambient and initial temperature, °C.
V = flame (pyrolysis front) velocity, m/s.
x = longitudinal position along centerline of specimen, m.
Φ = flame heating parameter, (kW)^2/m ^{3}.
$k\rho c$ = thermal heating property, (kW/m^2·K)^2 s.
ϵ = surface emissivity.
σ = Stefan-Boltzmann constant, kW/m^2·K^4.

4. Summary of Test Method

4.1 This test method consists of two procedures; one to measure ignition and one to measure lateral-flame spread. Vertically mounted specimens are exposed to the heat from a vertical air-gas fueled radiant-heat energy source inclined at 15° to the specimen (see Fig. 1).

4.1.1 For the ignition test, a series of 155, + 0, − 5 mm by 155, + 0, − 5 mm specimens (see Fig. 1) are exposed to a nearly uniform heat flux (see Fig. 2) and the time to flame attachment, using piloted ignition (see Fig. 3), is determined.

4.1.2 For the flame spread test, a 155, + 0, − 5 mm by 800, + 0, − 5 mm specimen (see Fig. 1) is exposed to a graduated heat flux (see Fig. 2) that is approximately 5 kW/m^2 higher at the hot end than the minimum heat flux necessary for ignition; this flux being determined from the ignition test (see 11.2). The specimen is preheated to thermal equilibrium; the preheat time being derived from the ignition test (see 12.1). After using piloted ignition, the pyrolyzing flame-front progression along the horizontal length of the specimen as a function of time is tracked. The data are correlated with a theory of ignition and flame spread for the deviation of material flammability properties.

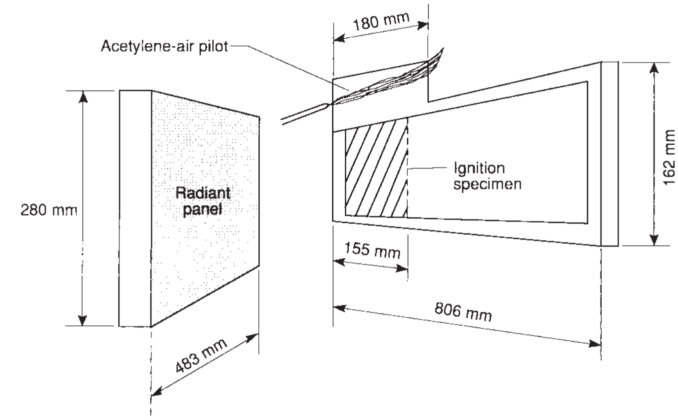


FIG. 1 Schematic of Apparatus With Ignition Specimen

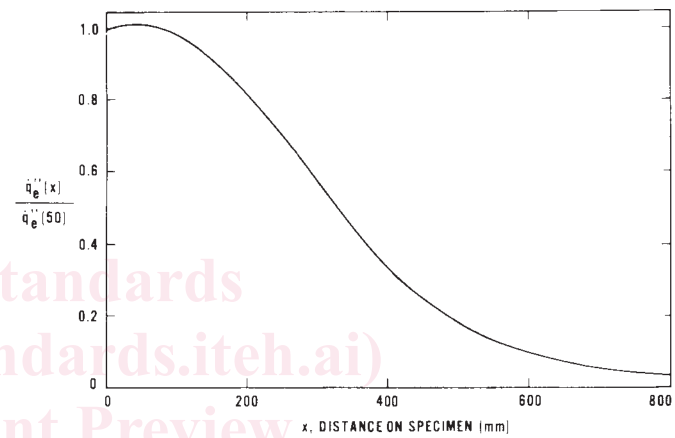
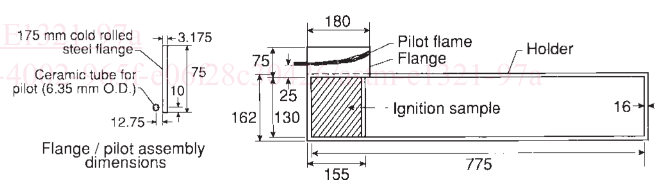


FIG. 2 Normalized Flux Over Specimen



NOTE 1—All dimensions are in millimetres.

FIG. 3 Pilot Configuration for Ignition Test

5. Significance and Use

5.1 This test method addresses the fundamental aspects of piloted ignition and flame spread. The procedure is suitable for the derivation of relevant material flammability parameters that include minimum exposure levels for ignition, thermal-inertia values, and flame-spread properties.