UL 1820

STANDARD FOR SAFETY

Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics

UL Standard for Safety for Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics, UL 1820

Fourth Edition, Dated October 15, 2004

Summary of Topics

This revision of ANSI/UL 1820 dated September 24, 2021 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated August 6, 2021.

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UL 1820

Standard for Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics

First Edition – March, 1989
Second Edition – May, 1994
Third Edition – August, 1997

Fourth Edition

October 15, 2004

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through September 24, 2021.

The most recent designation of ANSI/UL 1820 as a Reaffirmed American National Standard (ANS) occurred on September 24, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 This is a test method for determining values of flame propagation distance and optical smoke density for pneumatic tubing that is to be installed in ducts, plenums, and other spaces used for environmental air. The purpose of this test method is to determine whether the flame-propagation and smoke-generating characteristics of these tubes are in accordance with the provisions of Installation of Air Conditioning and Ventilating Systems, NFPA 90A. Exception No. 3 of Section 2-2.1.2 of NFPA 90A states that pneumatic tubing having the required fire-resistant and low-smoke-producing characteristics are capable of being installed in the space between the ceiling and the floor or roof above, used as an air handling plenum.

1.2 This test method does not cover the construction requirements for tubes for pressure or other performance requirements.

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Units of measurement

2.1.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2 Undated references

2.2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

PERFORMANCE

3 Test Assembly

3.1 Fire test chamber

3.1.1 The fire test chamber is to consist of a horizontal duct having the shape and size shown in Figure 3.1 – Figure 3.3. The sides and base of the duct are to be lined with insulating masonry as illustrated in Figure 3.2 consisting of a row of refractory fire brick[a]. One side is to be provided with a row of double-pane (inside pane mounted flush with inner wall – see Figure 3.2) pressure-tight (as described in 5.2 and 5.3) observation windows[b] [exposed area: 2-3/4 ±1/4 by 11 ±1-1/2 inches (69.8 ±6.3 by 279 ±38.1 mm)] located so that the entire length of the specimens being tested is capable of being observed from outside the fire test chamber.

[a] The operation and calibration of this equipment is based on the use of A. P. Green G-26 refractories.

[b] Vycor, 100 percent silica glass, nominal 1/4 inch (6.4 mm) thick or equivalent, is capable of being used for the inside pane. Pyrex glass, nominal 1/4 inch thick, or equivalent is capable of being used for the outer pane.

3.1.2 The ledges are to be fabricated of structural metal. Water-cooled structural-steel tubing is capable of being used for this purpose.

3.1.3 To provide air turbulence for combustion, turbulence-inducing baffling is to be provided by positioning six refractory fire bricks[a] [long dimension vertical and 4-1/2-inch (114-mm) dimension parallel to the wall] along the side walls of the chamber at distances of 7, 12, and 20 ±1/2 foot (2.1, 3.7, and 6.1 ±0.2 m) on the window side and 4-1/2, 9-1/2, and 16 ±1/2 foot (1.4, 2.9, and 4.9 ±0.22 m) on the opposite side.

3.1.4 The top is to consist of a removable metal-and-mineral-insulation composite unit whose insulation consists of nominal 2-inch-thick (50-mm) mineral-composition material. The top unit is shown in Figure 3.2 and is to completely cover the fire test chamber. The mineral-composition material shall have physical characteristics comparable to the following:

a) Maximum effective temperature – 1200°F (649°C),

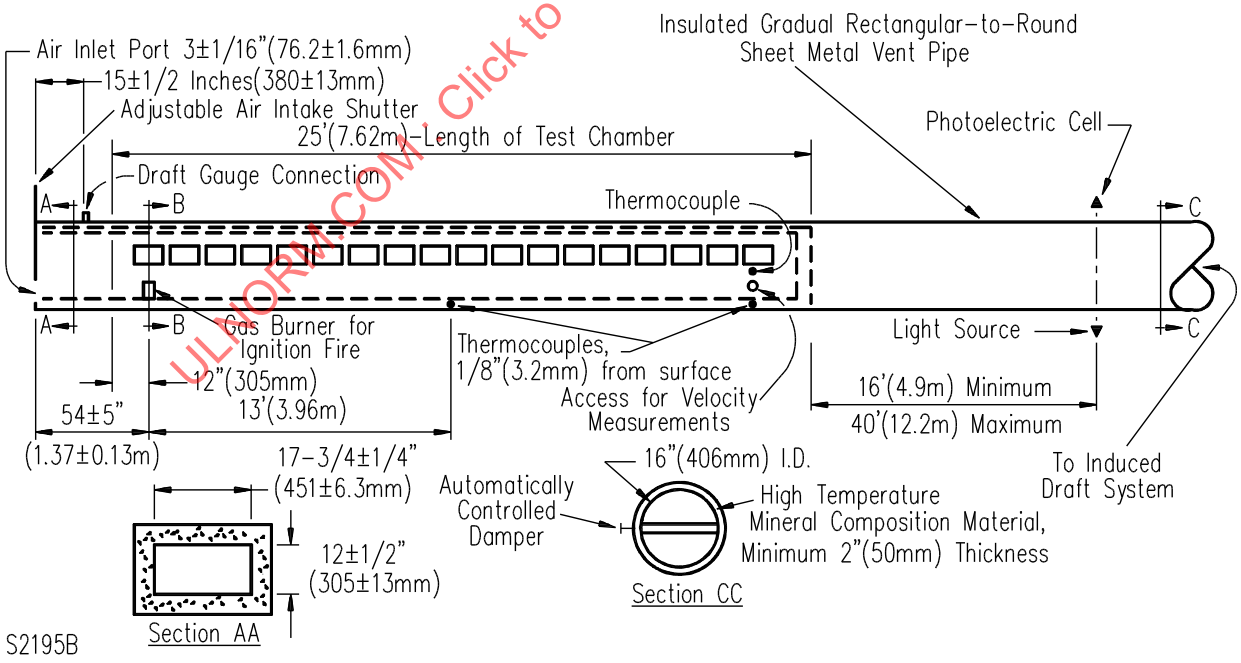
b) Bulk Density – 21.0 ±1.55 pounds per cubic feet (336 ±24 kgm/m^3), and

c) Thermal conductivity – 0.50 – 0.71 Btu (thermochemical) • inch per hour • square foot •°F (0.0722 – 0.102 W/m K) at 300 – 700°F (149 – 371°C).

The entire top-panel unit is to be protected with flat sections of high-density [nominally 110 pounds per cubic foot (1761 kg/m^3)], 1/4 inch (6.3 mm) thick mineral-fiber/cement board maintained in an unwarped and uncracked condition through continued replacement. While in place, the top panel is to be completely sealed against the leakage of air into the fire test chamber during the test.

Figure 3.1

Details of fire-test chamber



NOTE – See Figure 3.2 for Section B-B

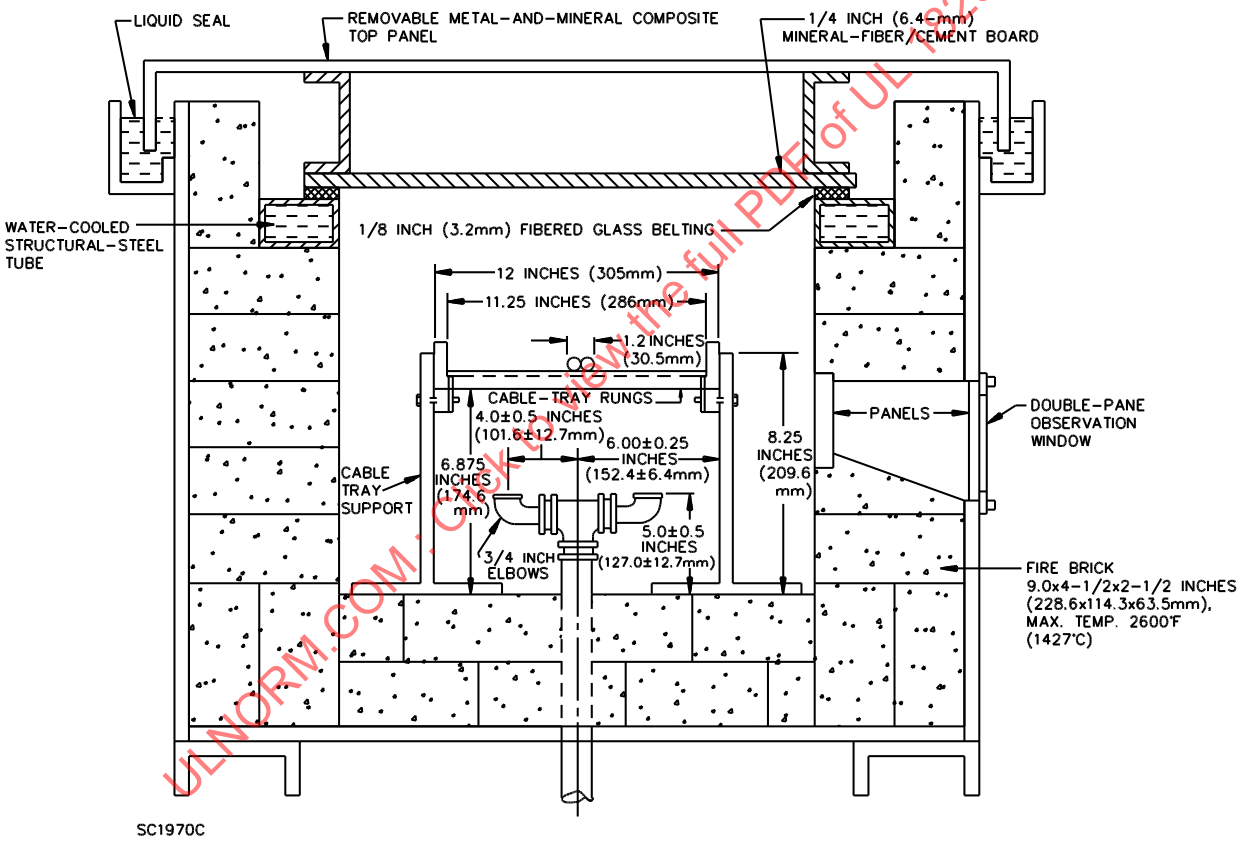
3.1.5 The ladder-type tray used to support the test specimens is shown in Figure 3.2 and Figure 3.3. The tray is to be fabricated from cold-rolled steel, 50,000 psi minimum (350 MPa) tensile strength. The solid-

bar-stock side rails are to be as shown in Section S-S in Figure 3.3. The C-shaped channel rungs are to be as shown in Section Q-Q in Figure 3.3. Each rung is to be 11-1/4 inches (286 mm) long. The rungs are to be welded to the side rails 9 inches (229 mm) on centers along the tray length. The tray is to consist of one or several sections having a total assembled length of 23.9 feet (7.28 m) and is to be supported with 16 supports equally spaced along the length of the tray. The supports (see Figure 3.3) are to be fabricated from bar steel.

3.1.6 One end of the test chamber, designated as the "fire end" in Figure 3.1, is to be provided with two gas burners delivering flames upward that engulf the test specimens. As shown in Figure 3.2, the burners are to be positioned transversely to each side of the centerline of the furnace so that the flame is evenly distributed over the width of the specimens.

Figure 3.2

Section B-B



NOTE – See Figure 3.3 for details of the tray and supports

3.1.7 The controls used to maintain a constant flow of gas to the burners are to consist of:

a) A pressure regulator,

b) A gas meter calibrated to read in increments of not more than 0.1 cubic feet (2.88 mm^3),

c) A gauge to indicate gas pressure in inches of water (Pa),

d) A quick-acting gas-shutoff valve,

e) A gas-metering valve, and

f) An orifice plate in combination with a manometer to assist in maintaining uniform gas-flow conditions.

An air intake fitted with a vertically sliding shutter extending the entire width of the test chamber is to be provided at the fire end. The shutter is to be positioned to provide an air-inlet port as shown in Figure 3.1.

3.1.8 The other end of the test chamber, designated as the "vent end" in Figure 3.1, is to be fitted with a rectangular-to-round transition piece, which in turn is to be fitted to a round flue pipe. The movement of air is to be by induced draft. The draft-inducing system is to have a total draft capacity of at least 0.15 inch of water (37 Pa) with the specimens in place, with the shutter at the fire end open to its normal position, and with the damper (see Section CC in Figure 3.1) in the wide-open position. A draft-gauge manometer to indicate static pressure is to be inserted through the top at the midwidth of the tunnel, just downstream of the air-intake shutter (see Figure 3.1).

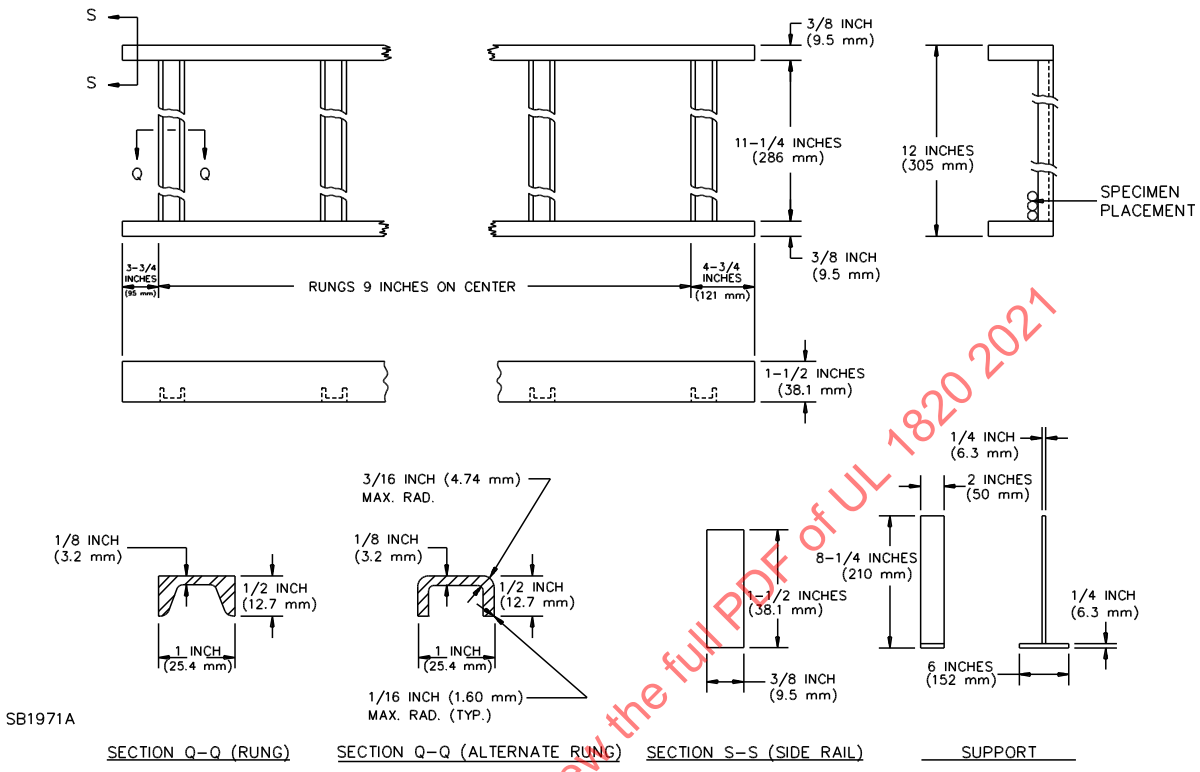
3.1.9 The damper is to be installed in the vent pipe downstream of the smoke-indicating attachment prescribed in 3.2.1.

3.1.10 An automatic draft-regulator controller is to be mounted in the vent pipe downstream of the manual damper. When required, other manual, automatic, or special draft-regulation devices are to be incorporated to maintain air-flow control throughout each test run.

3.1.11 The room in which the test chamber is located is to have provision for a free inflow of air to maintain the room at atmospheric pressure throughout each test run.

Figure 3.3

Details of steel tray and supports



3.2 Smoke measurement

3.2.1 A light source[c] is to be mounted on a horizontal section of the vent pipe at a point at which it is preceded by a straight run of round pipe at least 12 diameters or 16 feet (4.88 m) from the vent end of the rectangular-to-round transition section, and it is not affected by flame from the test chamber. The light beam is to be directed upward along the vertical axis of the vent pipe. The vent pipe is to be insulated with high-temperature mineral-composition material from the vent end of the chamber to the photometer location. A photoelectric cell[c] having an overall light-to-cell path length of 36 ±2 inches (914 ±51 mm), 16 inches (406 mm) of which are taken up by the smoke in the vent-pipe interior as shown in Section CC of Figure 3.1. The cell is to be connected to recording devices for indicating changes in the attenuation of incident light by passing smoke, by particulate matter, and by other effluents.

[c] A meter capable of being used for this purpose is a Weston Instruments No. 856BB, photronic cell and 12-volt sealed beam, clear lens, auto spot lamp, with an overall light-to-cell path length of 36 ±4 inches (914 ±102 mm).

3.2.2 The output of the photoelectric cell is to be connected to a recording device that processes the signal into a continuous record of smoke obscuration according to the following formula:

$$Optical \quad density = \log_{10} \frac{T_o}{T}$$

in which:

T_o is the initial light transmission (without smoke) and

T is the light transmission during the test. T varies with the amount of smoke.

3.3 Temperature measurement

3.3.1 An 18 AWG thermocouple (nominal wire cross section of 1620 cmil or 0.823 mm^2) with 0.375±0.125 inch (10 ±3 mm) of the junction exposed in the fire chamber air is to be inserted through the floor of the test chamber so that the tip is 1.000 ±0.031 inch (25 ±1 mm) below the top surface of the gasketing tape and 23 feet ±1/2 inch (7.09 m ±13 mm) from the centerline of the burner ports, and at the center of the width of the chamber.

3.3.2 An 18 AWG thermocouple [nominal wire cross section of 1620 cmil (0.823 mm^2)] embedded 1/8 inch (3.2 mm) below the floor surface of the test chamber is to be mounted in refractory or Portland cement (carefully dried to keep it from cracking) at distances of 13-1/2 and 23 feet (3.96 and 7.09 m) from the fire end of the burner ports.

4 Test Specimens

4.1 Tubing specimens in 24-foot (7.32-m) lengths are to be installed in a single layer across the bottom of the tray. The specimens are to be laid into the tray in parallel, straight rows without any space between adjacent specimens other than that required for fasteners described in 4.3. The number of tubing specimens is to fill the center 1.2 inches (30.4 mm) of the tray as determined by dividing 1.2 inches by the tube diameter using a diameter tape or equivalent, with the result of the division rounded off to the nearest higher whole number of specimens that fit with the presence of fasteners. A minimum of two specimens, regardless of diameter, are to be tested. See Table 4.1.

4.2 The tubing specimens are to be placed on a galvanized 100 mesh insect screen supported by the tray. Individual lengths of specimen are to be fastened to the screen with fasteners as described in 4.3.

4.3 Bare copper tie wires not larger than 18 AWG [nominal wire cross section of 1620 cmil (0.823 mm^2)] are to be used to fasten specimens to the mesh screen and rungs of the tray wherever a tie is required to keep a specimen in contact with the rung, straight and parallel with all of the other specimens and to minimize movement during the test. A tie is not to be used in any manner that alters the ability of the specimen to transmit gases and/or vapor longitudinally through the core of the specimen.

4.4 Properties applicable to identification of the specimens are to be determined and recorded.

Table 4.1
Test specimens

Outside diameter of tubing, inch	(mm)	Number of specimens in tray
0.125	3	10
0.250	6	5
0.375	10	4
0.500	13	3
0.625	16 or greater	2

5 Calibration of Test Equipment

5.1 One 1/4-inch (6.3-mm) mineral-fiber/cement board is to be placed on the ledge of the furnace chamber as shown in Figure 3.2. The removable top of the test chamber is to be placed in position.

5.2 With the board in position and with the removable top in place, the draft is to be established to produce a 0.15-inch water column reading (37 Pa) on the draft manometer with the fire-end shutter open 3

±1/16 inches (76 ±2 mm) and with the manual damper in the wide-open position. The fire-end shutter is to be closed and sealed. The manometer reading is to increase to at least a 3/8-inch water column (93 Pa), indicating that no excessive air leakage exists.

5.3 In addition, a supplemental leakage test is to be conducted periodically by activating a smoke bomb in the fire chamber while the fire shutter and exhaust duct beyond the differential manometer tube are sealed. The bomb is to be ignited and the chamber is to be pressurized to a 0.375 ±0.15-inch water column (93 ±37 Pa). All points of leakage observed in the form of escaping smoke particles are to be sealed.

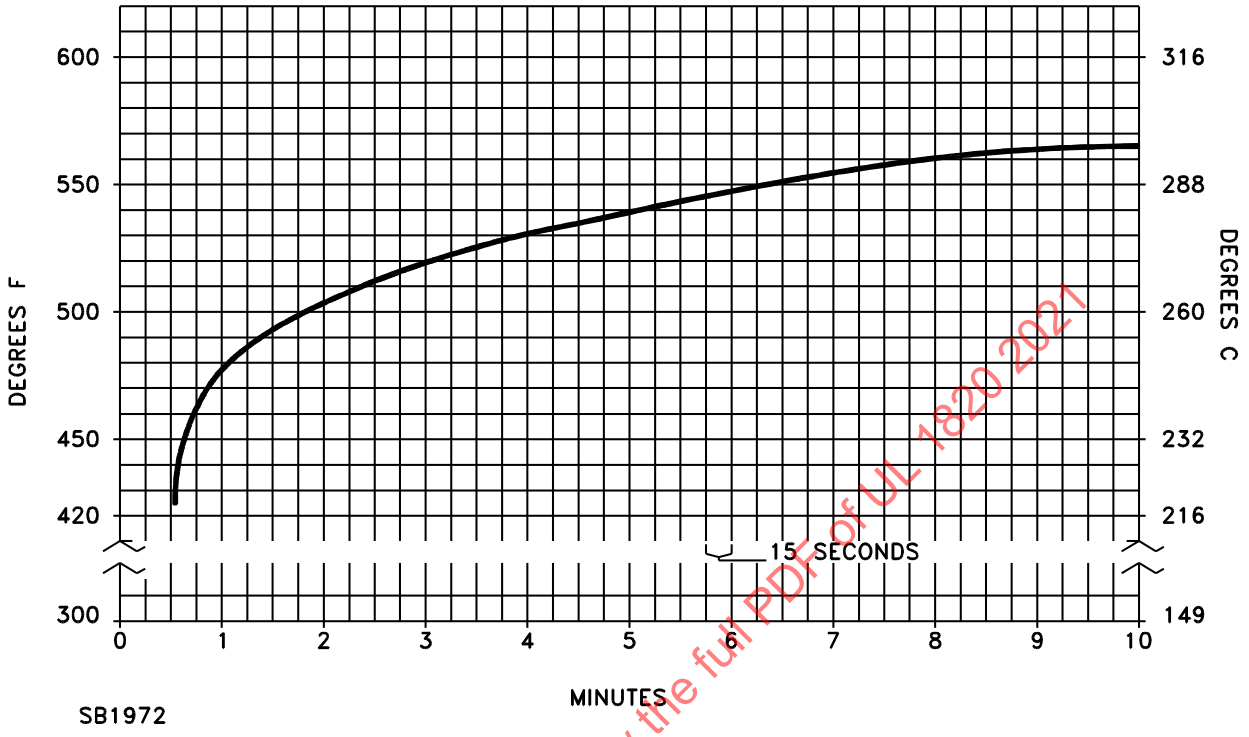
5.4 A draft reading is to be established within the range of a 0.055 – 0.085-inch water column (13.7 – 21.1 Pa). The required draft-gauge reading is to be maintained by regulating the manual damper. The air velocity at each of seven points, each located 1 foot (300 mm) from the vent end is to be recorded. These points are to be determined by dividing the width of the tunnel into seven equal sections and recording the velocity at the geometric center of each section. The average velocity shall be 240 ±5 feet (73.2 ±1.5 m) per minute.

5.5 The air supply is to be maintained at 70 ±5°F (21 ±3°C) and the relative humidity is to be kept between 35 – 40 percent.

5.6 The test fire is to be fueled with bottled methane gas of uniform quality and with a heating value of approximately 1000 Btu per cubic foot (37.3 MJ/m^3). The gas supply is to be initially adjusted to approximately 5000 Btu per minute (87.9 kW). The gas pressure, the pressure differential across the orifice plate, and the volume of gas used are to be recorded in each test. A length of coiled copper tubing is to be inserted into the gas line between the supply and the metering connection to compensate for possible errors in the indicated flow as a result of reductions in the gas temperature associated with the pressure drop and expansion across the regulator, or other applicable means of correction are to be used. With the draft adjusted as indicated in 5.4 and the gas supply adjusted as described herein, the test flame is to extend downstream to a distance of 4.5 feet (1.4 m) over the specimens, with negligible upstream coverage.

Figure 5.1

Representative preheat curve



5.7 The test chamber is to be preheated with the mineral-fiber/cement board and the removable top in place and with the fuel supply adjusted to the required flow. The preheating is to be continued until the temperature indicated by the floor thermocouple at 24.0 feet (7.32 m) reaches 150 ±5°F (66 ±3°C). During the preheat test, the temperatures indicated by the thermocouple at the vent end of the test chamber are to be recorded at 15-second intervals and are to be compared to the preheat temperatures taken at the same intervals from the representative curve of temperature as a function of time shown in Figure 5.1. The preheating is for the purpose of establishing the conditions that exist following successive tests and to indicate the control of the heat input into the test chamber. When appreciable variation from the temperatures shown in the representative preheat curve occurs as a result of variations in the characteristics of the gas used, adjustments in the fuel supply are to be made prior to proceeding with the red-oak calibration tests.

5.8 The furnace is to be cooled after each test. As soon as the floor thermocouple at 14 feet (4.2 m) shows a temperature of 105 ±5°F (41 ±3°C), the next set of specimens is to be placed in position for test.

5.9 With the test equipment adjusted and conditioned as described in 5.2, 5.4, 5.5, and 5.7, a test or series of tests is to be made using nominally 23/32-inch (18-mm) select-grade red-oak flooring in place of the mineral-fiber/cement board specified in 5.1. Prior to the testing, the wood is to be conditioned to a moisture content of 6 – 8 percent as determined by the 221°F (105°C) oven method described in Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials, ASTM D4442-92. Continuous observations are to be made and the time is to be recorded when the flame reaches the end of the specimen – that is, 19.5 feet (5.94 m) from the end of the ignition fire. The end of the ignition fire is to be 4.5 feet (1.37 m) from the burners. The flame is determined to have reached the end point in 5.5 minutes ±15 seconds. The flame is determined to have reached the end point when the vent-end thermocouple registers a temperature of 980°F (527°C). The temperature measured by the thermocouple near the vent end is to be recorded at least every 30 seconds. The photoelectric-cell output is to be

recorded immediately prior to the test and at least every 15 seconds during the test. The test is to be run for 10 minutes.

5.10 The temperature and change in photoelectric-cell readings are to be plotted separately on coordinate paper. Figure 5.2 – Figure 5.4 are representative curves for the flame spread on red oak, fuel contribution of red oak, and the optical density from red oak.

5.11 Following the 10-minute calibration test(s) for red oak, a similar test or tests are to be conducted on specimens of mineral-fiber/cement board 1/4 inch (6.3 mm) thick. The temperature readings are to be plotted separately on coordinate paper. Figure 5.5 is a representative curve for the fuel contribution of mineral-fiber/cement board.

Figure 5.2

Representative curve for flame spread on red oak