UL 1256

STANDARD FOR SAFETY

Fire Test of Roof Deck Constructions

UL Standard for Safety for Fire Test of Roof Deck Constructions, UL 1256

Fifth Edition, Dated October 11, 2023

Summary of Topics

This new Fifth Edition of ANSI/UL 1256 dated October 11, 2023 incorporates editorial changes including renumbering and reformatting to align with current style.

The requirements are substantially in accordance with Proposal(s) on this subject dated July 28, 2023.

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UL 1256

Standard for Fire Test of Roof Deck Constructions

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Second Edition – August, 1993
Third Edition – March, 1998
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Fifth Edition

October 11, 2023

This ANSI/UL Standard for Safety consists of the Fifth Edition.

The most recent designation of ANSI/UL 1256 as an American National Standard (ANSI) occurred on October 11, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

The Department of Defense (DoD) has adopted UL 1256 on August 19, 1989. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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CONTENTS

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INTRODUCTION

1 Scope

1.1 These requirements cover fire test methods to evaluate the performance of metallic and nonmetallic roof deck constructions subjected to internal (under deck) fire exposures for the purpose of determining the contribution of the roof covering material, insulation, and other components of the roofing system to the spread of fire within a building. As the extent of flame propagation, thermal degradation, and combustive damage are determined after roof deck constructions are exposed to controlled fire conditions, these requirements are not intended for use in describing or defining the fire hazard or risk of fire under actual fire conditions.

1.2 These requirements do not include tests to evaluate other potential hazards to roof deck constructions, such as structural integrity under fire exposure or wind uplift.

1.3 Two fire test methods are described in Parts I and II of this Standard. One of these test methods shall be selected based on assessment of fire test experience, as outlined in 1.4, 1.5 and 1.6.

1.4 Part I describes the large-scale fire test method used to evaluate roof deck constructions which by experience in actual installations were known to have contributed extensively to underdeck fire spread or, conversely, were regarded as being eligible for classification from this standpoint.

1.5 Part II describes the small-scale fire test method whereby the Steiner fire test chamber is used to evaluate roof deck constructions for resistance to underdeck fire spread. The conditions of acceptance under this test method were initially established by analysis of correlative data developed on a specific construction which exhibited adequate performance in the large scale fire test method described in Part I. This construction consisted of a steel roof deck, without vapor retarder or adhesives, insulated with one-inch-thick plain vegetable fiberboard roof insulation mechanically attached and covered with a three ply bitumen built-up roof covering with gravel surface. Subsequent Part I large scale tests were conducted with other steel deck constructions. These results continued to support the conditions of acceptance established for the Part II small scale tests.

1.6 For roof deck constructions dissimilar to any constructions previously evaluated under Part I, the large-scale fire test method is to be conducted.

2 Units of Measurement

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

3 Referenced Publications

3.1 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.

3.2 The following publications are referenced in this Standard:

ASTM D4442, *Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials*

UL 263, *Fire Tests of Building Construction and Materials*

PART I – LARGE-SCALE FIRE TEST METHOD FOR EVALUATION OF ROOF DECK CONSTRUCTIONS UNDER INTERIOR FIRE EXPOSURE

4 Test Method

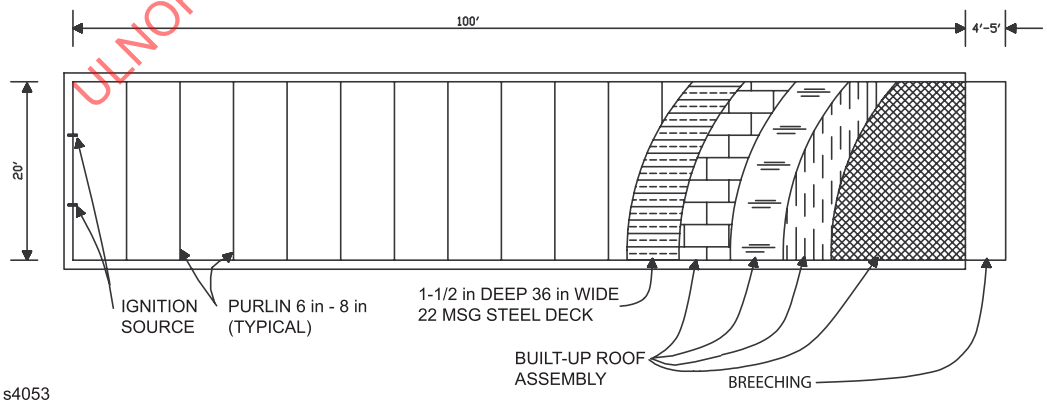
4.1 The test method utilizes a 10 foot (3.1 m) high by 20 foot (6.1 m) wide by 100 foot (30.5 m) long structure which is open at one 20 foot (6.1 m) wide end (flue-end). At the opposite end (fire end) is located an ignition source burner assembly consisting of atomized heptane pumped through two nozzles. An air supply to support combustion is produced by a blower and discharged into the structure at the fire end. The fuel flow rate for this test was developed through preliminary trials to produce a fire exposure condition within the first 20 feet (6.1 m) of structure that is representative of the standard time-temperature curve in UL 263. Observations are recorded with respect to maximum underdeck flame spread within the structure, and with respect to the maximum flame spread on the top surface of the structure. Temperature data is recorded at specified locations at intervals not to exceed 30 seconds throughout the entire test. Post-test observations are also recorded with respect to the conditions of the structure and roof covering materials. The test is terminated after 30 minutes elapsed time.

5 Fire Test Structure

5.1 The fire test structure is to consist of a rectangular building 10 feet (3.1 m) high by 20 feet (6.1 m) wide by 100 feet (30.5 m) long with one 20 foot (6.1 m) long side left opened (flue-end). The walls are to be constructed from nominal 8 by 8 by 16-inch (203 by 203 by 406 mm) concrete blocks. The space between the parapet wall, support wall and roof deck is to be tightly-packed with mineral wool insulation. The fire end wall and first 40 feet of each sidewall are to be protected from the floor to the underside of the roof deck on the interior by a nominal 1-inch (25 mm) thickness of spray or trowel applied cementitious mixture. The floor of the structure is to consist of concrete, crushed stone, or packed-soil covered with a 2-inch (50.8 mm) thickness of sand. The roof covering system is to have perimeter terminations and flashing construction that are representative of standard practice as specified by the roof covering material manufacturer. See Figure 5.1.

Figure 5.1

Large Scale Test Structure



Note: Conversion Factors:

1 inch = 25.4 mm

1 foot = 0.3048 m

5.2 To facilitate observations, the flue-end of the structure is to have a breeching wall positioned transverse to and 4.5 ±0.5 feet (1.4 ±0.2 m) outward from the end of the 100 foot (30.5 m) long structure. The height of the breeching wall shall be at least 10 feet (0.9 m) and shall not exceed the height of the roof structure by more than 3 feet (0.9 m). It is also required to further enclose the flue-end by extending the sides of the 100 foot (30.5 m) end of the structure to connect to the breeching wall. The entire overhead space enclosed within this extension beyond the end of the structure is to remain open to exhaust combustion products. See Figure 5.1.

5.3 Open view ports for observations during the fire test are to be provided in both 100 foot (30.5 m) walls and spaced not greater than 10 feet (3.1 m) OC. These ports are to be a maximum of 1.5 square feet (1394 cm^2) and are to be of such dimensions and elevation so that all underdeck and floor areas across the entire width and length of the structure are visible through one or both sides.

5.4 For structural steel roof deck constructions the purlins are to consist of a maximum M12 by 11.8 Jr. beams spaced 6 feet, 8 inches (2.0 m) OC. The steel deck is to consist of No. 22 gage, 1-1/2 inch (38 mm) Type B decking. It is also not prohibited to use lesser mass Jr. beams or bar joist when the spacing is maintained at 6 feet, 8 inches (2.0 m) OC.

5.5 Other types of roof deck construction are to be constructed with structural support, decking and roof covering systems representative of the construction under evaluation.

5.6 The roof covering material's system shall have perimeter terminations, parapets and flashing construction to be representative of standard practice as specified by the roof covering materials' manufacturers.

6 Fire Control Equipment

6.1 The fire exposure is produced by two nozzles atomizing heptane. Flow to each nozzle is to be monitored and balanced so that equal amounts of fuel is being delivered. The combined fuel rate delivered to the two nozzles is as shown in Table 6.1.

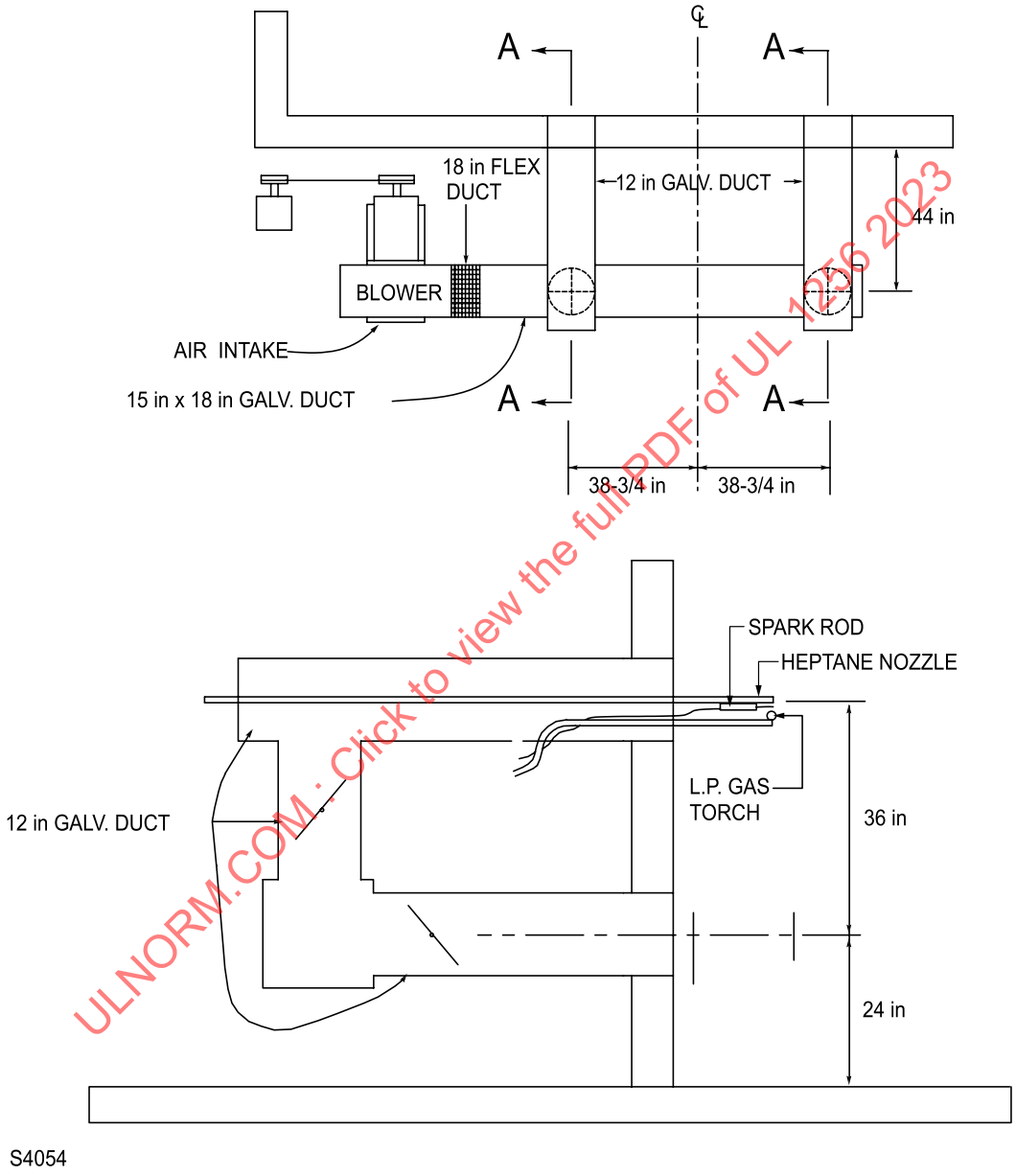
Table 6.1
Combined Fuel Rate to Nozzles

Test time, minutes	Fuel rate, gpm (l/s)	
0 to 2	1.0	(0.06)
2 to 4	1.5	(0.09)
4 to 7	2.0	(0.13)
7 to 17	2.5	(0.16)
17 to 30	2.7	(0.17)

6.2 Air for combustion is furnished by a blower located outside the test structure. An air supply totaling 4700 to 5500 ft^3/min (2.2 to 2.6 m^3/s) is delivered by four ducts through the fire end wall of the test structure. Two ducts are located with their centerlines 5 feet (1.5 m) above the floor of the structure and discharge air to the two nozzles positioned in front of the ducts. The other two ducts are located beneath with their centerlines 2 feet (0.6 m) above the floor of the structure. Dampers are to be provided in the blower system so as to equalize the balance of air being discharged through each duct. The blower and ignition details are shown in Figure 6.1.

Figure 6.1

Blower and Ignition Details



Note: Conversion Factors:

1 inch = 25.4 mm

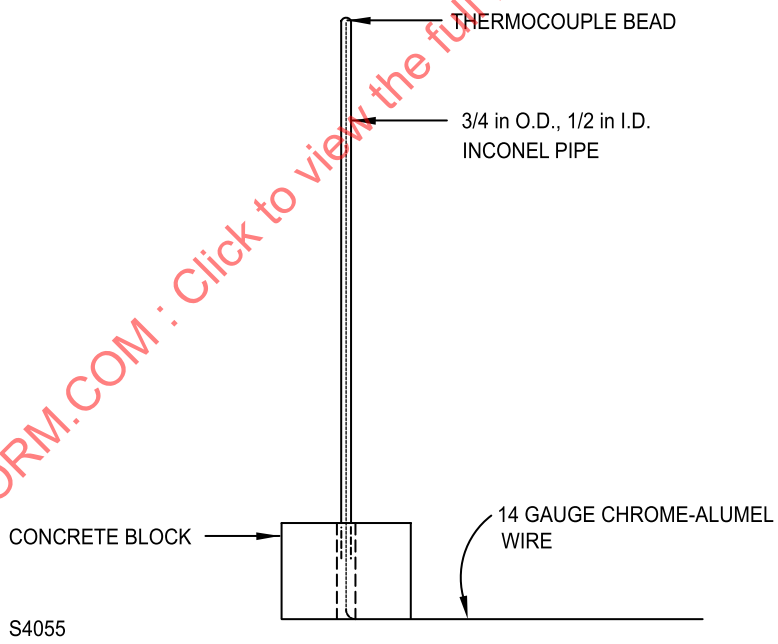
1 foot = 0.3048 m

6.3 The severity of the ignition fire is to be monitored separately by six No. 14 gage chromel-alumel (Type K) thermocouples located 12 inches (305 mm) below the roof deck. These thermocouples are to be located within Inconel pipes and supported in concrete pylons. An example of such an assembly is shown in Figure 6.2. The locations of these thermocouples (Nos. 1 through 6) are shown in Figure 6.3.

6.4 Prior to the conduct of testing the fire control equipment is to be calibrated by selection of atomizing nozzles, air flow and fuel pressure such as to provide a fire exposure that follows the standard time-temperature curve as specified in UL 263. The fire exposure at the fire end of the structure is to be controlled so that the area under the measured time-temperature curve, obtained by averaging the temperatures recorded from the thermocouples described in 7.1, is within 10 % of the corresponding area under the standard time-temperature curve. The calibration is to be conducted with the roof deck (without the roof covering system being in place) and structural supports in place. Steel deck constructions are to be insulated on the top surface with a minimum of 2-inch (50.8 mm) thick mineral insulation for the first 40 feet (12.2 m) of the structure. The underside of the deck and structural supports are to be protected during the calibration with 2-inch thick (50.8 mm) mineral board or blanket insulation for the first 40 feet (12.2 m) of the structure.

Figure 6.2

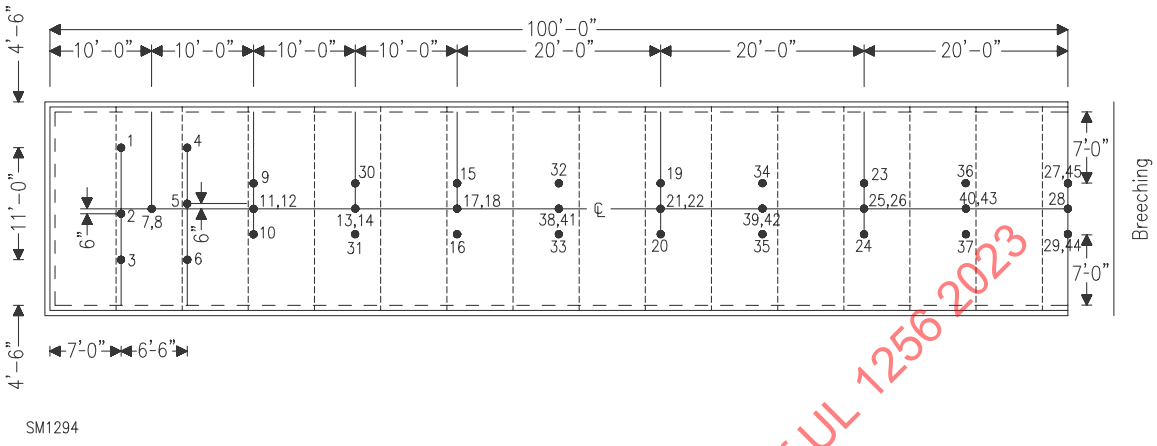
Control Thermocouples



Note: 1 inch = 25.4 mm

Figure 6.3

Thermocouple Locations



Note: Conversion Factors:

1 inch = 25.4 mm

1 foot = 0.3048 m

7 Instrumentation

7.1 The severity of the ignition source is to be separately monitored by Type K (14 gage) thermocouples located within a pylon assembly as shown in Figure 6.2, identified as Nos. 1 – 6 and positioned as shown in Figure 6.3 (see 6.3).

7.2 Temperature measurements are to be obtained using Type K (20 – 24 gage) thermocouples at the locations and positions as shown in Figure 6.3:

a) Air temperatures located 9 inches (229 mm) below the roof deck – Nos. 9, 10, 15, 16, 23, 24, 30, 31, 32, 33, 34, 35, 36, 37, 44, and 45;

b) Top side of roof deck – Nos. 7, 11, 13, 17, 21, 25, 38, 39, and 40;

c) Top side of membrane of roof covering system – Nos. 8, 12, 14, 18, 22, 26, 41, 42, and 43;

d) Exit air temperature 3 feet (0.9 m) below roof deck – Nos. 27, 28, and 29; and

e) Air temperatures located 9 inches (229 mm) below the roof deck and spaced as specified in footnote [a] across the width of the test structure at 60 feet (18.3 m) and at 72 feet (21.9 m) from the fire end wall – Nos. 19, 20, and 46 through X[a].

[a] The number of thermocouples required is commensurate with that required to locate a thermocouple a maximum of 6 inches (152 mm) to either side (but not both sides) of each exposed edge of steel deck sidelap joints and to either side (but not both sides) of each longitudinal seam of other types of deck construction. In no case shall there be less than six thermocouples evenly spaced across the structure at 60-ft and 72-ft distances from the fire end wall. Thermocouples Nos. 46 and higher are not shown in Figure 6.3.

7.3 The flow rate of heptane to each nozzle is to be monitored using a calibrated flow meter.

7.4 All temperature data are to be recorded at intervals not exceeding 30 seconds.

8 Documentation

8.1 Documentation shall consist of the following information:

a) Thirty-five mm colored slides/prints taken during construction of the test assembly and post-test to include dissection of the test assembly;

b) Color video tape of the fire within the structure as viewed from the flue-end. Color video tape of the top surface throughout the test; and

c) A clock or timer depicting "real time" is to be included in all videos. The time is to be integral to the video camera or a clock/timer is to be used that is visible and legible throughout the test.

9 Test Procedure

9.1 Instrumentation on the completed assembly is to be verified for operation.

9.2 Ambient conditions prior to test are to be as follows:

a) Temperature: 40 to 90 °F (4.4 °C to 32 °C);

b) Relative humidity: 20 to 80 %; and

c) Air flow across the roof surface of the test assembly is to be less than 1050 ft/min (12 mph) as determined by an anemometer positioned in the direction of the prevailing wind. The velocity and direction of the prevailing wind is to not be such as to restrict fire spread across the roof surface of the structure.

9.3 Video and data collection are to begin one minute prior to ignition of the heptane burner.

9.4 Two 3/8-inch (9.5 mm) LP-Gas pilot nozzles are to be used to ignite the heptane initially and provide a continuous source of ignition. An example of such an assembly is shown in Figure 6.1.

Exception: LP-Gas pilot nozzles are not required when heptane-soaked fabric is secured to the heptane nozzle so as to provide ignition of the atomized heptane once the pumps are started.

9.5 The flow regime for heptane burners is to be followed.

9.6 Record visual observations of all flaming including flaming droplets of molten materials and flaming of residue on the floor and the respective time of occurrence and distance within the structure (see Conditions of Acceptance, Section 10) from both sides as well as the top surface of the assembly throughout the entire test.

9.7 At 30 minutes after ignition of the heptane burners the heptane supply is to be shut-off and all flaming is to be extinguished.

9.8 The interior and exterior of the roof deck construction assembly is to be photographed and visual observations made.

9.9 The roof surface is to be covered or otherwise protected from inclement weather prior to testing.

10 Conditions of Acceptance

10.1 The maximum sustained flame front progression within the structure due to underdeck flaming shall not exceed 60 feet (18.3 m) from the fire end during the 30-minute test period.

10.2 The flaming of molten residue falling from the roof deck or on the floor of the structure shall not exceed 60 feet (18.3 m) from the fire end during the 30-minute test period.

10.3 The maximum temperature measurements recorded at the 60-foot (18.3 m) location specified in 7.2(e) shall not exceed 1400 °F (760 °C) for a 30-second interval based on the average of any three thermocouples yielding the highest recorded temperatures. The maximum temperature recorded at the 72-foot (21.9 m) location specified in 7.2(e) shall not exceed 1400 °F (760 °C) for a 30-second interval for any individual thermocouple.

10.4 Intermittent underdeck flaming, tips of flaming along deck seams or flaming dissociated from the main flame front within the structure are not to exceed 72 feet (21.9 m) from the fire end during the 30-minute test period.

10.5 Post-test examination of the roof deck construction shall show that combustive damage (burning, charring) of the roof covering system has diminished at increasing distances from the fire end of the test structure.

10.6 Thermal degradation (damage in the form of charring, loss of integrity) shall not have extended throughout all components of the roof covering system at the extremity (flue end) of the structure.

11 Test Report

11.1 The test report shall include the following:

a) Drawings showing structural design of the roof deck construction, plan, elevation and principle cross-sections plus other sections as required for clarity;

b) Description of the roof covering system component materials and their placement within the assembly;

c) Ambient conditions at the start of the fire test including measured wind speed and direction in relationship to the test structure;

d) Location of all thermocouples;

e) Time history of average temperatures recorded by the six fire control thermocouple assemblies;

f) Time history of temperatures recorded within the structure and roof deck construction;

g) Visual observations of all flaming, including flaming droplets of molten materials and flaming residue on the floor at the respective time of occurrence and distance, within the structure as viewed from both sides and top surface throughout the entire 30-minute test;

h) Photographic and video documentation of the assembly prior to and post test (interior and exterior); and

i) Analysis of performance of the roof deck construction with respect to each of the Conditions of Acceptance.

PART II – SMALL-SCALE FIRE TEST METHOD UTILIZING STEINER FIRE TEST CHAMBER

12 Fire Test Chamber

12.1 The fire test chamber, Figure 12.1 and Figure 12.2, is to consist of a horizontal duct having an inside width of 17-3/4 ±1/4 inches (451 ±6 mm) measured at the ledge on which the sample is supported along the side walls and 17-5/8 ±3/8 inches (448 ±10 mm) at all other points; a depth of 12 ±1/2 inches (305 ±13 mm) measured from the bottom of the test chamber to the ledge of the inner walls on which the sample is supported [including the 1/8-inch (3.2-mm) thickness of woven fiberglass gasketing tape[a]]; and a length of 25 feet (7.62 m). The sides and base of the duct are to be lined with insulating masonry as illustrated in Figure 12.2, consisting of A. P. Green, G-26[b], refractory fire brick. One side of the chamber is to be provided with double pane observation windows[c] with the inside pane flush mounted (see Figure 12.2). The exposed area of an inside pane is to be 2-3/4 ±1/4 by 11-1/2 plus 1 minus 2 inches (69.9 ±6.4 by 280 plus 25 minus 50 mm). The centerline of the exposed area of the inside glass is to be in the upper half of the furnace wall, with the upper edge not less than 2-1/2 inches (63 mm) below the furnace ledge. Each window is to be located such that not less than 12 inches (305 mm) of the specimen width is observable. Multiple windows are to be located along the tunnel so that the entire length of the test sample is observable from outside the fire test chamber. The windows are to be pressure tight (see 13.2 and 13.3).

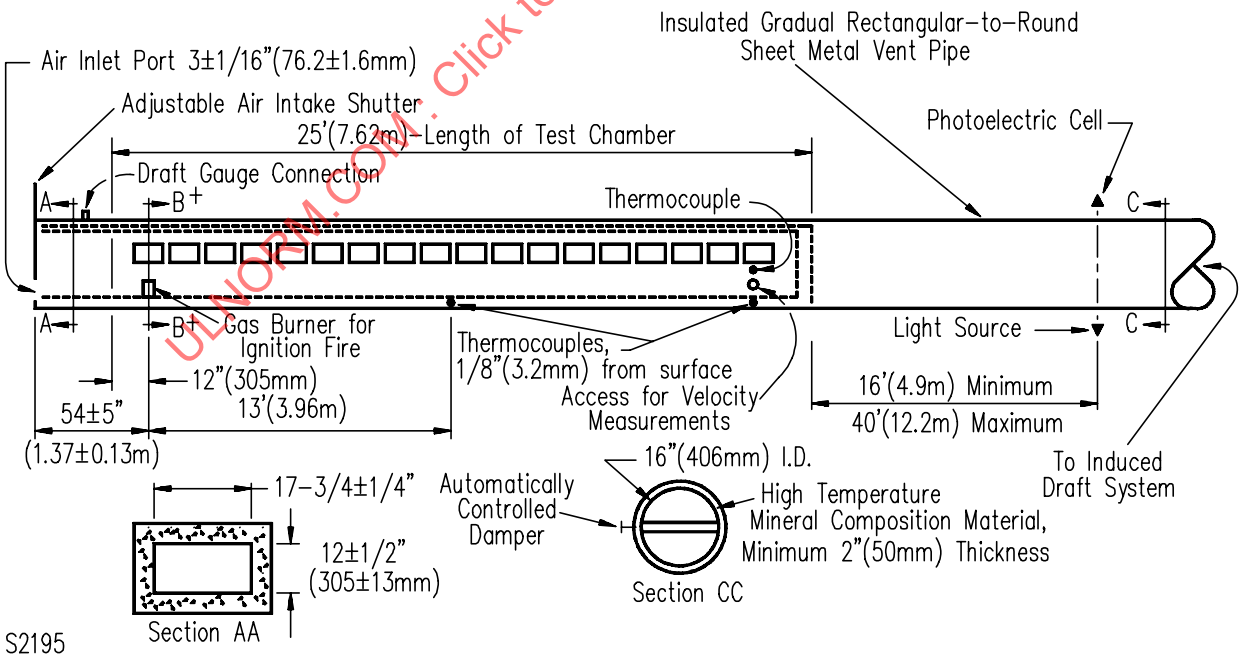
[a] McMaster-Carr No. 8817K35 1-1/2 by 1/8 inch (38.1 by 3.2 mm) woven fiberglass tape or equivalent has been found to be capable of being used for this purpose.

[b] The operation and calibration of this equipment is based on this A. P. Green Refractory.

[c] Vycor, 100 % silica glass, nominal 1/4 inch (6.4 mm) thick or equivalent, has been found to be capable of being used for the inside pane. Pyrex glass, nominal 1/4 inch thick, or equivalent has been found to be capable of being used for the outer pane.

Figure 12.1

Details of Test Furnace



+ See Figure 12.2 for Section B-B.

12.2 The ledges are to be fabricated of a structural material[a] capable of withstanding abuse of continuous testing, level with respect to length and width of the chamber and each other, and maintained in a state of repair commensurate with the frequency, volume, and severity of testing occurring any time.

[a] High temperature furnace refractories such as Zircon have been successfully used for this purpose.

12.3 To provide air turbulence for proper combustion, turbulence baffling is to be provided by positioning six A. P. Green, G-26, refractory fire bricks [long dimension vertical, 4-1/2-inch (114-mm) dimension along the wall] along the side walls of the chamber at distances of 7, 12, and 20 ±0.5 feet (2.13, 3.66, and 6.09 ±0.15 m) on the window side and 4-1/2, 9-1/2, and 16 ±0.5 feet (1.37, 2.90, and 4.88 ±0.15 m) on the opposite side.

12.4 The top is to consist of a removable structure, constructed of metal and mineral composite (noncombustible) insulated with nominal 2-inch (50.8-mm) thick mineral composition material as illustrated in Figure 12.2 and is to be of the size required to completely cover the fire test chamber and test sample. The mineral composition material is to have physical characteristics comparable to the following:

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

b) Bulk density – 21 lb/ft^3 (336 kg/m^3);

c) Thermal conductivity at 300 to 700 °F (149 to 371 °C) – 0.50 – 0.71 Btu · in/h · ft^2 °F (0.072 – 0.102 W/m · K); and

d) KpC[a] – 1 to 4 Btu^2 · in. ft^5 · h · °F^2 (1 × 10^4 to 4 × 10^4 W^2 · S · m^4 K^3).

The entire top assembly is to be protected with flat sections of high density (nominal 110 lb/ft^3 or 1762 kg/m^3) 1/4 inch (6.4 mm) inorganic reinforced-cement board[b], maintained in an unwarped and uncracked condition. This protective board is not required to be secured to the furnace lid. When in place, the top is to be completely sealed against the leakage of air into the fire test chamber during the test, such as by using a liquid seal as shown in Figure 12.2.

[a] KpC is equal to the thermal conductivity times the density times the specific heat.

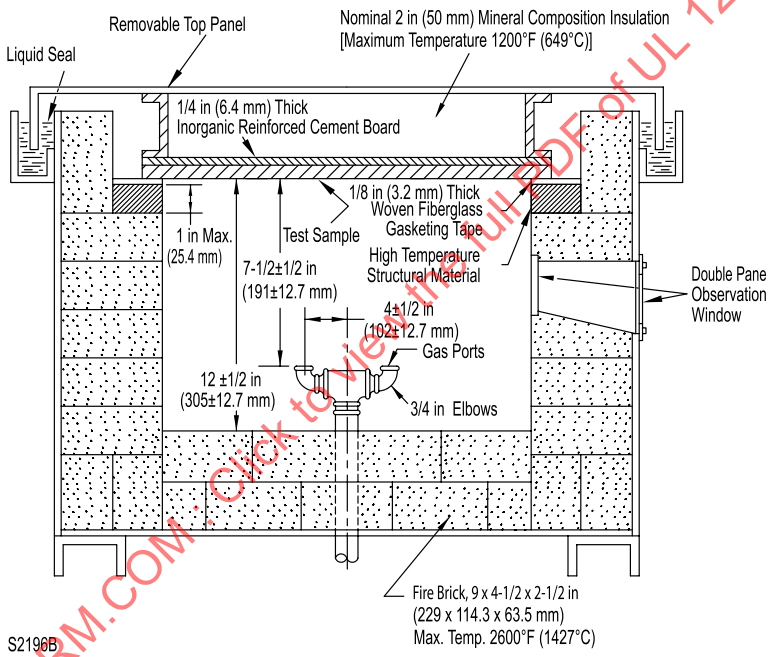
[b] Inorganic reinforced cement board such as Manville Building Materials Corp. Flexboard II and Tunnel Building Products Sterling Board have been successfully used for this purpose.

12.5 One end of the test chamber, designated as the "fire end," is to be provided with two gas burners delivering flames upward against the surface of the test sample. The burners are to be spaced 12 inches (305 mm) from the fire end of the test chamber and 7-1/2 ±1/2 inches (190 ±12.7 mm) below the under surface of the test sample. An air intake shutter is to be located 54 ±5 inches (1.37 ±0.1 m) upstream of the burner, as measured from the burner centerline to the outside surface of the shutter. Gas to the burners is to be provided through a single inlet pipe, distributed to each burner port through a tee section. The outlet is to be a 3/4-inch (19-mm) elbow. The plane of the port is to be parallel to the furnace floor, such that the gas is directed upward toward the specimen. Each port is to be positioned with its centerline 4 ±1/2 inches (102 ±12.7 mm) on each side of the centerline of the furnace so that the flame is evenly distributed over the width of the exposed specimen surface. See Figure 12.2. The controls used to provide constant flow of gas to the burners during periods of use are to consist of a pressure regulator, a gas meter calibrated to read in increments of no more than 0.1 cubic foot (2.8 liters), a manometer to indicate gas pressure in inches of water (Pa), a quick-acting gas shutoff valve, a gas metering valve, and an orifice plate in combination with a water 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 so as to provide an air inlet port 3 ±1/16 inches (76 ±2 mm) high measured from the floor level of the test chamber, at the air intake point.

12.6 The other end of the test chamber, designated as the "vent end," is to be fitted with a gradual rectangular-to-round transition piece, not less than 20 inches (508 mm) long with not less than 200 square inches (1290 cm^2) cross-section at any point. The transition piece is to be, in turn, fitted to a flue pipe 16 inches (406 mm) in diameter. The vent pipe is to be insulated with at least 2 inches (50.8 mm) of high temperature mineral composition material from the vent end of the chamber to the photometer location. The movement of air is to be by an induced draft system having a total draft capacity of at least 0.15 inch water column (37.4 Pa) with the sample in place, the shutter at the fire end open the nominal 3 ±1/16 inches (76 ±2 mm), and the damper in the fully-open position. A draft gauge connection, to indicate static pressure, is to be inserted through the top at the mid-width of the tunnel, 1 ±1/2 inch (25 ±13 mm) below the ceiling, and 15 ±1/2 inches (380 ±13 mm) downstream from the inlet shutter.

Figure 12.2

Section B-B of Figure 12.1



12.7 A photometer system[a] consisting of a light source and photocell is to be mounted on a horizontal section of the 16-inch (406-mm) diameter vent pipe at a point where it is preceded by a straight run of pipe at least 12 diameters or 16 feet (4.9 m) and not more than 30 diameters or 40 feet (12.2 m) from the vent end of the chamber, and with the light beam directed upward vertically through the center axis of the vent pipe. A photoelectric cell whose output is directly proportional to the amount of light received is to be mounted over the light source and connected to a recording device having a minimum operating chart width of 5 inches (127 mm) and an accuracy within ±1 % of full scale, for indicating changes in the attenuation of incident light resulting from the passage of smoke, particulate, and other effluent. The distance between the light source lens and the photocells lens is to be 36 ±4 inches (914 ±102 mm). The cylindrical light beam is to pass through 3-inch (76-mm) diameter openings at the top and bottom of the 16-inch diameter duct, with the resultant light beam centered on the photo cell.

[a] A system found capable of being used for this purpose consists of a Weston Instruments No. 856BB photronic cell and 12-volt sealed beam, clear lens, auto spot lamp.

12.8 Linearity of the photometer system is to be verified periodically by interrupting the light beam with calibrated neutral density filters. The filters are to cover the full range of the recording instrument. Transmittance values measured by the photometer, using neutral density filters, are to be ±3 % of the calibrated value for each filter.

12.9 An automatically controlled damper is to be installed in the vent pipe downstream of the smoke-indicating attachment. The damper is to be provided with a manual override.

12.10 Other manual or automatic regulation devices are not prohibited from being used to maintain fan characterization and air flow throughout test periods.

12.11 A 18 AWG (0.82 mm^2) thermocouple having 3/8 ±1/8 inch (9.5 ±3 mm) of the junction end exposed to the air is to be inserted through the floor of the test chamber so that the tip is 1 ±1/32 inch (25.4 ±1 mm) below the top surface of the woven fiberglass gasketing tape and 23 feet ±1/2 inch (7.01 m ±13 mm) from the centerline of the burner ports, at the center of the chamber's width.

12.12 Two 18 AWG (0.82 mm^2) thermocouples embedded 1/8 inch (3.2 mm) below the floor surface of the test chamber are to be mounted in refractory or Portland cement that has been carefully dried to avoid cracking, at distances of 13 feet ±1/2 inch (3.96 m ±13 mm) and 23-1/4 feet ±1/2 inch (7.01 m ±13 mm), respectively, from the centerline of the burner ports.

12.13 The room in which the test chamber is located is to have provision for a free inflow of air during test, to maintain the room at atmospheric pressure during the test.

13 Calibration of Test Equipment

13.1 A 1/4-inch (6.4-mm) thick inorganic reinforced cement board is to be placed on the ledge of the furnace chamber. The top of the test chamber then is to be placed in position.

13.2 With the 1/4-inch (6.4-mm) inorganic reinforced cement board in position on top of the ledge of the furnace chamber, and with the removable lid in place, a draft is to be established so as to produce a 0.15-inch water-column (37.4 Pa) reading on the draft manometer, with the fire end shutter open 3 ±1/16 inch (76.2 ±1.6 mm), by manually setting the damper as a characterization of fan performance. Then the fire-end shutter is to be closed and sealed. The manometer reading is to increase to at least 0.375-inch water column (93.4 Pa), indicating that no excessive leakage exists.

13.3 In addition, a supplemental leakage test is to be conducted periodically by sealing the fire end shutter and exhaust duct beyond the photometer system and placing a smoke bomb in the chamber. The bomb is to be ignited and the chamber pressurized to 0.375 ±0.15-inch water column (93.4 ±37.0 Pa). All points of leakage observed in the form of escaping smoke particles are to be sealed.

13.4 A draft reading is to be established within the range of 0.55 – 0.100-inch water column (137.0 – 25.0 Pa). The required draft gauge reading is to be maintained throughout the test by the automatically controlled damper. The air velocity is to be recorded at seven points 23 feet (7.0 m) from the centerline of the burner ports and 6 ±1/4 inch (152 ±7 mm) below the plane of the specimen mounting ledge. These points are to be determined by dividing the width of the tunnel into seven equal sections and recording the velocity at the geometrical center of each section. During the measurement of velocity, the turbulence bricks are to be removed and 24-inch (670-mm) long straightening vanes are to be placed 16 to 18 feet (4.9 to 5.5 m) from the burners. The straightening vanes are to divide the chamber cross section into nine equal sections. The air temperature is to be 73.4 ±5 °F (23 ±2.8 °C). The determinations are to be made using a velocity transducer[a]. The velocity, determined as the arithmetic average of the seven readings, is to be 240 ±5 fpm (1.22 ±0.025 m/s).

[a] A Thermo Systems Inc. Model 1610 velocity transducer (thermal anemometer) or equivalent using a readout device accurate to 1 millivolt has been found capable of being used for the purpose.

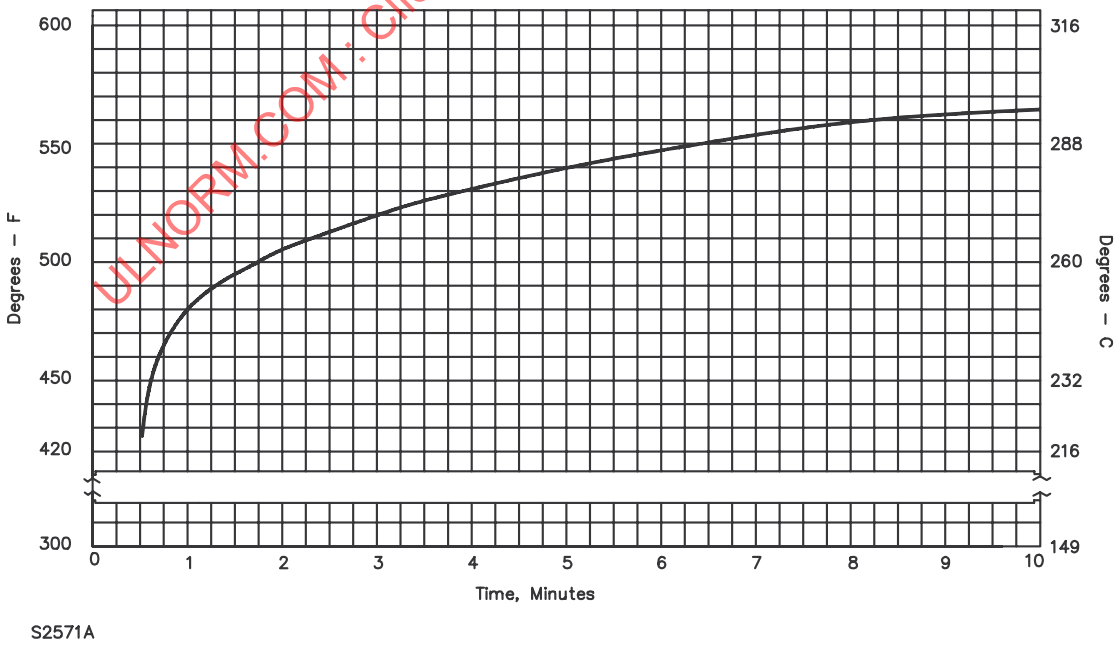
13.5 The air supply is to be maintained at 73.4 ±5 °F (23 ±2.8 °C) and at 50 ±5 % relative humidity.

13.6 The fire test chamber is to be supplied with natural (city) or methane (bottled) gas fuel of uniform quality with a nominal heating value of 1000 Btu per cubic foot (37.3 MJ/m^3). The gas supply is to be initially adjusted at 5000 Btu per minute (87.8 kW). The gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test are to be recorded. Unless otherwise corrected for, when bottled methane is employed, a length of coiled copper tubing is to be inserted into the gas line between the supply and metering connection to compensate for possible errors in the flow indicated due to reductions in gas temperature associated with the pressure drop and expansion across the regulator. With the draft and gas supply adjusted as indicated in 13.4 and 13.5, the test flame is to extend downstream to a distance 4-1/2 feet (1.37 m) over the specimen surface, with negligible upstream coverage.

13.7 The test chamber is to be preheated with the 1/4-inch (6.4-mm) inorganic reinforced 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 23-1/4 feet (7.09 m) is 150 ±5 °F (66 ±2.8 °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 or less and compared to the preheat temperature shown in the time-temperature curve, Figure 13.1. The preheating is to establish 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 is observed, the fuel supply is to be adjusted as required based on red-oak calibration tests.

Figure 13.1

Time-Temperature Curve – Preheat



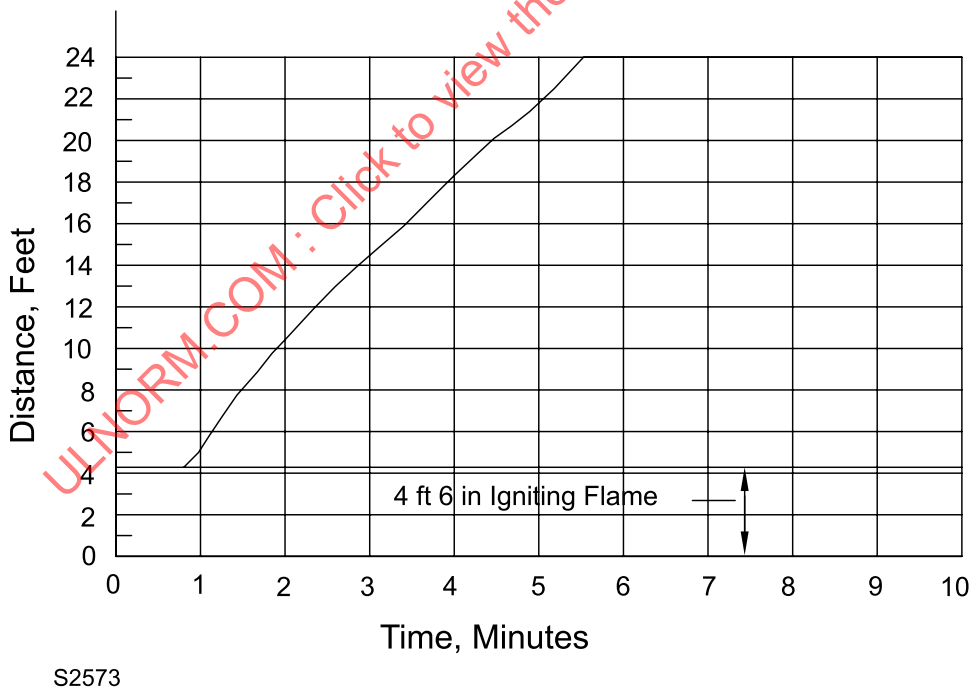
13.8 The fire test chamber is to cool after each test. When the floor thermocouple at 13 feet (3.96 m) indicates a temperature of 105 ±5 °F (40.5 ±2.8 °C), the next specimen is to be placed in position for test.

13.9 With the test equipment adjusted and conditioned as described in 13.2, 13.4, 13.5, and 13.7, a test or series of tests are to be made, using nominal 23/32 inch (18.3 mm) select-grade red-oak flooring as the sample, conditioned to 6 – 8 % moisture content as determined by the 221 °F (105 °C) oven dry method described in ASTM D4442. Observations are to be made at distance intervals not in excess of 2 feet (0.61 m) and time intervals not in excess of 30 seconds, and the time is to be recorded when the flame reaches the end of the specimen, that is, 19-1/2 feet (5.9 m) from the end of the ignition fire. The end of the ignition fire is to be 4-1/2 feet (1.37 m) from the burners. The flame is to reach the end point in 5-1/2 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 15 seconds during the test. The photoelectric-cell output is to be recorded immediately prior to the test and at least every 15 seconds during the test.

13.10 The flame-spread distance, temperature, and change in photoelectric cell readings as a function of time are to be plotted separately on coordinate paper. Figure 13.2 – Figure 13.4 are representative curves for red-oak flame spread, time-temperature development, and smoke density, respectively. Flame spread distance is to be determined as the observed distance minus 4-1/2 feet (1.37 m).

Figure 13.2

Representative Time-Distance Curve for Flame Spread of Red Oak



S2573

13.11 Following the calibration tests for red oak, a similar test(s) is to be conducted on samples of 1/4-inch (6.4-mm) thick inorganic reinforced cement board. The results represent an index of zero. The temperature readings, as a function of time, are to be plotted separately on coordinate paper. Figure 13.5 is a representative curve for time-temperature development of inorganic reinforced cement board.

Figure 13.3

Time-Temperature Curve – Red Oak

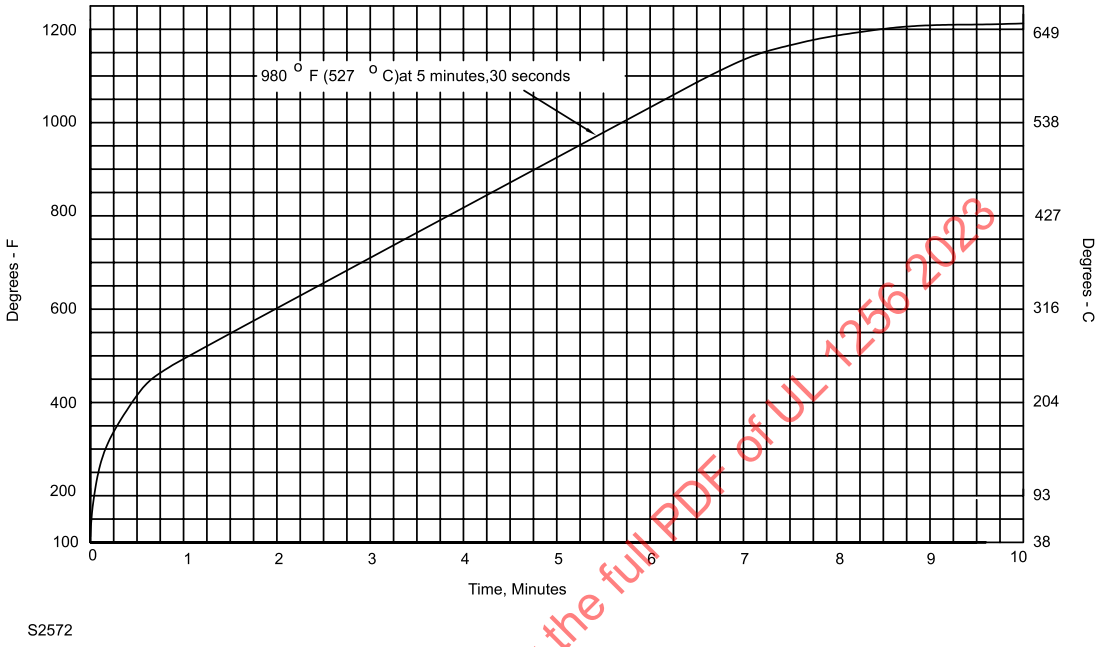


Figure 13.4

Smoke Density – Red Oak

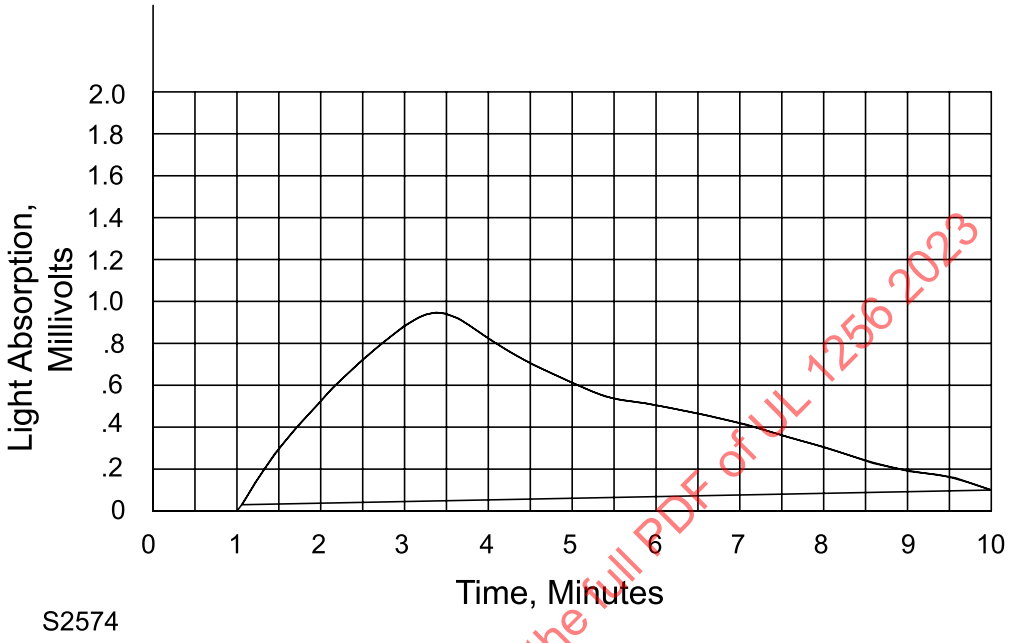
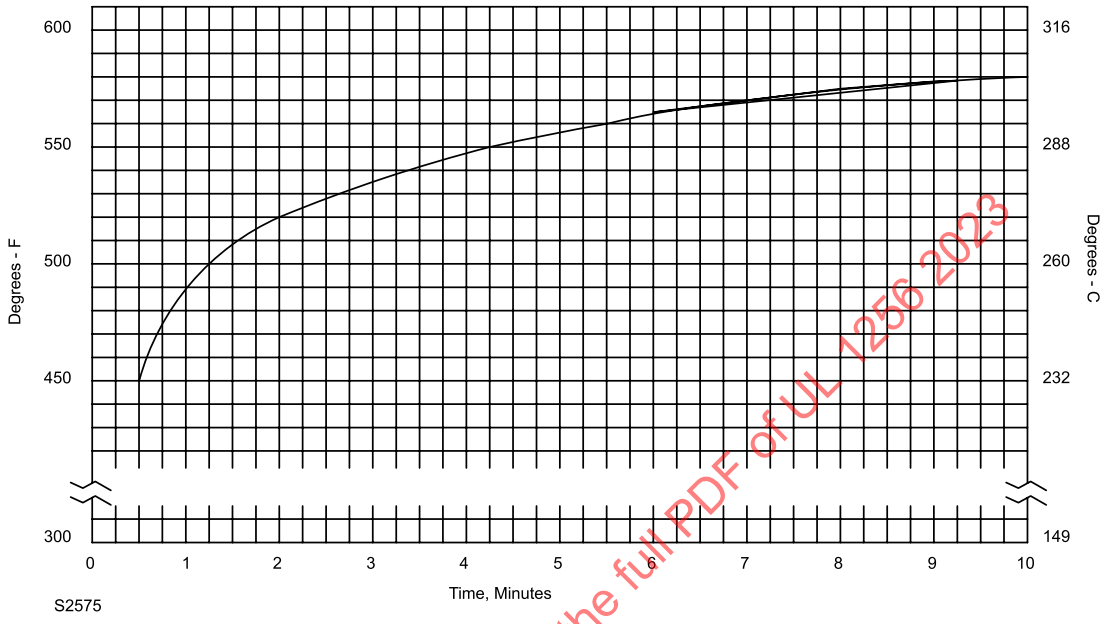


Figure 13.5

Time-Temperature Curve – Inorganic Reinforced Cement Board



14 Test Method

14.1 Each test sample, assembled as described in 15.1, is to be subjected to the test described in 14.2 – 14.6.

14.2 The test equipment is to be adjusted and conditioned as described in 13.2 – 13.11.

14.3 The test assembly is to be placed across the ledges of the test chamber.

14.4 The assembly and removable top are to be placed in position and all joints sealed against infiltration of air.

14.5 The gas pressure, the pressure differential across the orifice plate, and the volume of gas used are to be recorded in each test.

14.6 The test assembly is to be subjected to a continuous 30-minute fire exposure. All flame propagation including time of occurrence and distance is to be recorded. At the conclusion of the 30-minute exposure period, the assembly is to be examined for thermal degradation and combustive damage. See Conditions of Acceptance, Section 16.

15 Test Assembly

15.1 The test assembly is to be at least 2 inches (50.8 mm) wider [nominally 20-1/4 ±3/4 inch (514 ±19.1 mm)] than the interior width of the tunnel and a total of 24 feet ±1/2 inch (7.32 m ±12.7 mm) in length. The assembly shall consist of a continuous, unbroken length, or of sections joined end-to-end. A 14 ±1/8-inch (356 ±3-mm) length of uncoated No. 16 gage [nominal 0.060 inch (1.52 mm) thick] sheet steel is to be