UL 1666

STANDARD FOR SAFETY

Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

UL Standard for Safety for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666

Fifth Edition, Dated February 16, 2007

Summary of Topics

Revision pages have been issued for the Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666, to incorporate the proposal dated May 4, 2012, which includes the following:

- ***Revision to scope.***

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The revised requirements are substantially in accordance with Proposal(s) on this subject dated May 4, 2012.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

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Fifth Edition

February 16, 2007

This ANSI/UL Standard for Safety consists of the fifth edition, including revisions through June 27, 2012.

The most recent designation of ANSI/UL 1666 as an American National Standard (ANSI) occurred on June 27, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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 http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 This is a fire test for determining values of flame propagation height for electrical and optical-fiber cables that are for installation vertically in shafts or in vertical runs that penetrate one or more floors.

1.1 revised June 27, 2012

1.2 The purpose of this test is to determine whether the flame propagation characteristics of these ″riser″ cables are in accordance with the National Electrical Code.

1.3 This test does not investigate the toxicity or corrosivity of the products of combustion or decomposition.

1.4 This test does not cover the construction requirements for any cable or the electrical, optical, and other performance requirements for any cable.

2 Units of Measurement

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

PERFORMANCE

3 Fire Test Room

3.1 The fire test room in which the chamber is located is to have provision for a free inflow of air to maintain the room at a controlled pressure of 0 – 0.05 in (0 – 12 Pa) of water column with respect to barometric pressure and at a temperature of 73 ±5°F (23 ±3°C) and a relative humidity of 50 ±5 percent throughout each test.

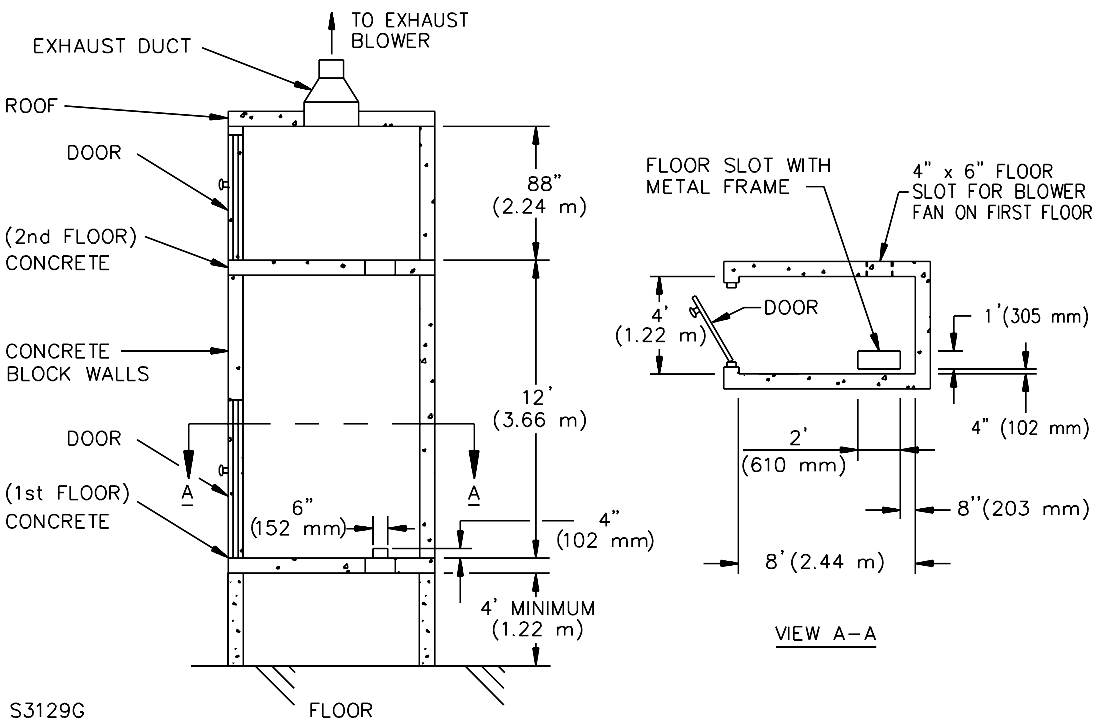
4 Fire Test Apparatus

4.1 Fire test chamber

4.1.1 The test chamber is to be as shown in Figure 4.1. The test chamber, all equipment, and the cable specimens are to be protected from the wind and other conditions of weather that could affect the test results. The walls of the structure are to be of standard concrete masonry nominally 8 in (203 mm) thick. The first and second floors shall be constructed of reinforced normal-weight concrete nominally 5 – 8 in (127 – 203 mm) thick. The roof shall be constructed of a suitable building construction capable of providing a tight seal with the walls of the structure. A slot measuring 1 ft by 2 ft (305 mm by 610 mm) is to be located in the first floor, and an identical slot is to be located directly above in the second floor. As shown in Figure 4.1, each slot is to be 8 in (203 mm) from the back wall of the room and 4 in (102 mm) from the side wall of the room. The slots are to be oriented adjacent to either side wall of the room based on installation and position of the fire test chamber. Windows are to be positioned as needed for observation.

4.1.2 The test chamber is to contain steel access doors located on the first and second floors as shown in Figure 4.1 or positioned in any of the other walls. Positioning the second floor door or an additional access hatch in the wall opposite the slot is advantageous as this allows for ease of installation of the cable specimens and positioning of second floor slot thermocouples. The size of each access is not specified. The edges of the door frames are to use an inorganic gasketing material to ensure a tight fit of each door when closed to prevent excessive drafts in the chamber.

Figure 4.1
Fire test chamber



4.2 Burner apparatus

4.2.1 The burner is to consist of 1/2-in steel pipe with a 1/2-in pipe elbow, plus a steel burner diffusion plate as shown in Figure 4.2. The plate is to be located as shown in Figure 4.3. An electronic-spark igniter is to be positioned adjacent to the outlet of the gas-piping outlet for ignition of the pilot flame.

4.2.2 A propane-gas flowmeter is to be installed in the piping feeding the burner for measuring the flow rate of gas during the test. The flowmeter is to be capable of measuring a gas flow rate of 222 SCFH (standard cubic feet per hour) (1743 cm^3/s). Measurements are to be accurate within 3 percent.

Figure 4.2
Burner diffusion plate

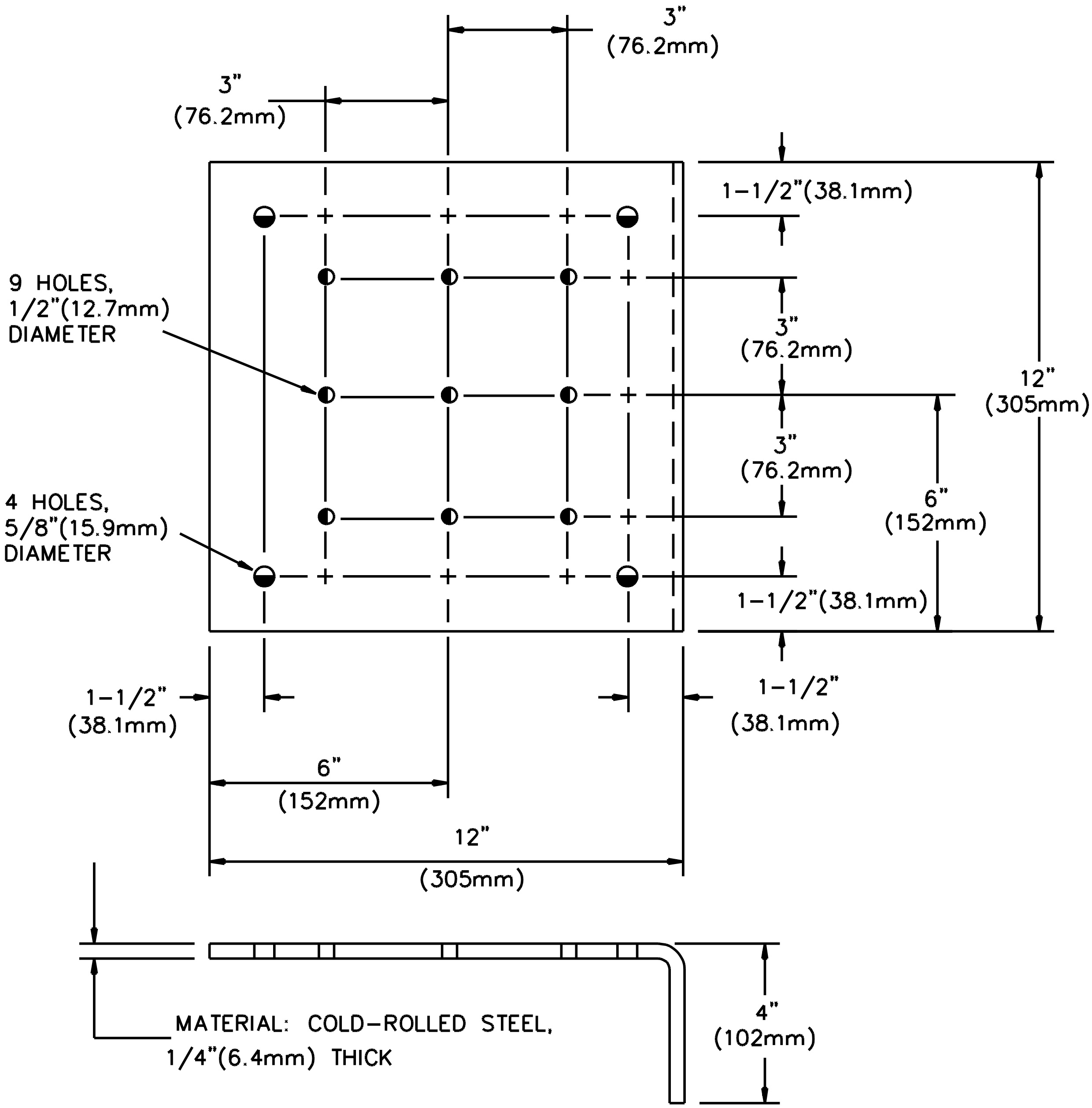


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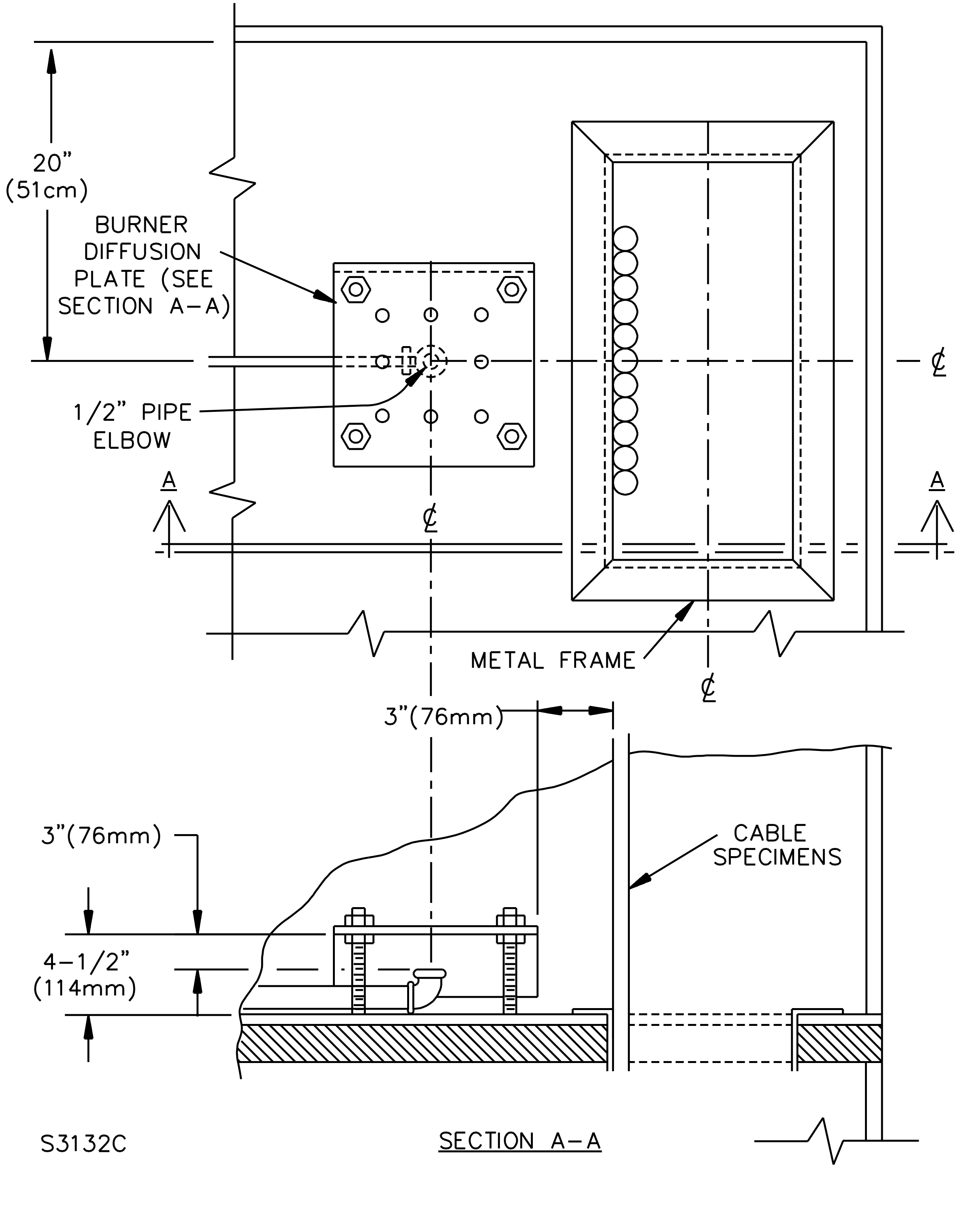
Figure 4.3
Location of ignition burner relative to floor slot and cables



4.3 Burner fan

4.3.1 An electric blower fan capable of providing an air velocity across the burner outlet as specified in 8.3 is to be positioned outside the chamber perpendicular to the centerline of the burner as shown in Figure 4.1. A slot that is 6 in wide by 4 in high (152 mm by 102 mm) is to be provided in the wall of the test chamber at the first floor level to enable the fan to move air across the burner.

4.4 Propane

4.4.1 The gas supplied to the burner is to be CP-grade propane having a nominal heating value of 2500 Btu (thermochemical) per cubic foot [93.0 MJ/m^3 or 22.2 kilocalories (thermochemical) per cubic meter].

4.5 Exhaust blower and duct

4.5.1 A steel exhaust duct is to be positioned in the center of the roof of the fire test chamber as shown in Figure 4.1. An exhaust blower is to be connected to the exhaust duct. The blower is to have the capacity to maintain the required air velocity specified in 8.2 throughout the duration of the test.

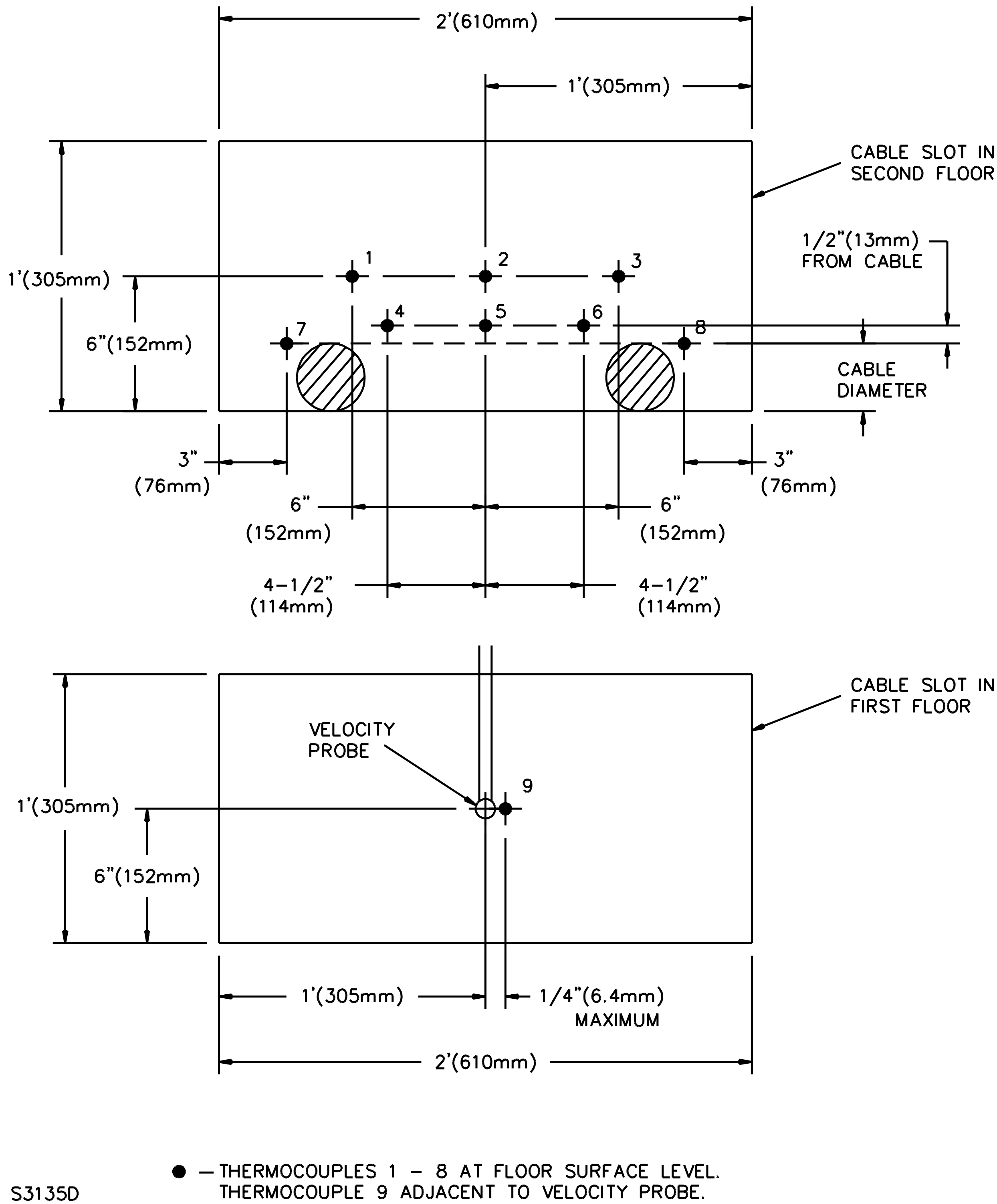
4.6 Temperature and flow measurement instrumentation

4.6.1 Eight 28 AWG Type K thermocouples with an inconel sheath are to be located in the slot in the second floor, and one thermocouple is to be located in the first floor slot, as shown in Figure 4.4.

4.6.2 One 28 AWG Type K thermocouple with an inconel sheath is to be located at the centerpoint of the first floor chamber ceiling and is to extend downward 1 ±1/16 in (25.4 ±1.6 mm) perpendicular to the ceiling. This thermocouple is used to determine the test chamber temperature prior to conducting a test.

4.6.3 A bi-directional air-velocity probe is to be located at the horizontal and vertical center (]·[) of the first floor slot as shown in Figure 4.4. The velocity probe for flow measurements is to be connected to an electronic pressure gauge to obtain differential pressure.

Figure 4.4
Location of thermocouples in slot



4.7 Data acquisition equipment

4.7.1 A digital data acquisition system shall be used to collect and record the air inlet slot velocity and second floor slot thermocouple temperature at intervals of 5 seconds or less.

5 Specimen Conditioning

5.1 Prior to testing, all cable specimens are to be conditioned for a minimum of 24 h in a controlled environment of 73 ±5°F (23 ±3°C) and relative humidity of 50 ±5 percent. Samples which are supplied on reels shall have any wrapping materials removed before conditioning.

6 Determination of Specimen Diameter

6.1 Use either a diameter tape, vernier caliper, or a micrometer with an accuracy of 0.001 in (0.025 mm) to measure the specimen diameter.

6.2 The diameter tape is appropriate for specimens that are uniformly round. Ensure that the tape is wrapped tightly around the specimen, but not so tight that the specimen is compressed. Use an arithmetic average of three readings over a 1 ft (0.3 m) length of the specimen as the specimen diameter.

6.3 The vernier caliper is appropriate for all sizes of cable specimens, and is especially useful for small diameter cables which are not uniform in cross section.

6.4 If the specimen is round, close the caliper gently around the cable being careful not to compress it and take the reading. Repeat the measurement a minimum of five times over a length of 1 ft (0.3 m) of cable. The arithmetic average of the five readings is used as the diameter of the cable specimen.

6.5 If the specimen is not uniform in cross section, with the width to thickness ratio less than 2:1, take three measurements at the wide points, and three measurements at the narrow points of the specimen. The diameter is an arithmetic average of the six readings.

6.6 If the width to thickness ratio of the specimen is greater than 2:1, then the width of the specimen is taken as the specimen diameter. Measure the width of the specimen at six locations on a 1 ft (0.3 m) length of the cable. The specimen diameter is an arithmetic average of the six readings.

6.7 The micrometer is appropriate for a cable specimen with a uniform cross section. Take five measurements of the specimen diameter over a 1 ft (0.3 m) length of the cable. The arithmetic average of the five readings is the diameter of the cable specimen.

7 Number of Cable Lengths

7.1 The number (N) of cable lengths (rounded to the next lower whole number) to be used in a given test is to be determined by means of the following formula,

$$N = 12/D$$

in which:

for round cables, D is the outside diameter of the cable in inches, and

for non-round cables, D is the largest dimension of the cable diameter.

7.2 A guide for mounting cables is given in 11.1 – 12.5.

8 Test Procedure

8.1 Prior to testing each day, the test chamber is to be preheated by activating the exhaust blower and providing a propane ignition flame for 30 min using the specifications in 8.5.

8.2 After preheating, and with the exhaust flow established, the temperature in the chamber is to be 100 ±20.0°F (38 ±11°C) as measured by the thermocouple positioned at the centerpoint of the first floor chamber ceiling. The incoming air is to be at a temperature of 73 ±5°F (23 ±3°C) with a relative humidity of 50 ±5 percent. The cable specimens are to be installed and an exhaust air flow as measured at the slot in the first floor is to be established at 3.5 ±0.5 m/s (11.5 ±1.6 ft/s). The air velocity in the slot is to be calculated as follows:

$$V = k(\Delta P \times T)^{1/2}$$

in which:

k is a constant for the bi-directional probe determined experimentally by calibrating the probe with a standard flow-measuring device,

ΔP is the pressure difference (Pascals) recorded across the bi-directional probe, and

T is the air flow temperature (K).

8.3 The air velocity along the floor under the diffuser plate is to be established at 1.6 ±0.1 m/s (4.8 ±0.3 ft/s) as measured horizontally along the perpendicular centerline of the slot at a point 3 in (76 mm) in front of the exposed face of the cable specimens and 2 in (51 mm) above the floor. A vane type of anemometer is to be used for this measurement.

8.4 Two sets of specimens of each cable construction are to be tested (see 9.1 concerning test of a third set). Each set is to consist of multiple 17-1/2-ft (5.33 m) specimen lengths of cable. The cable lengths are to be installed through both slots against the long sides of the slots that are closest to the ignition flame. The cable lengths are to be in a single layer that fills the center 12 in (305 mm) of the long side.

8.5 The test is to be started no later than 5 min after installation of the cable specimens. A pilot flame is to be lit and the propane gas flow rate is to be increased to 211 ±11 SCFH (standard cubic feet per hour) (1657 ±86 cm^3/s) to start the test. The test flame is to produce 527,500 ±25,500 Btu (thermochemical) per hour (154.5 ±8.1 kW).

8.6 The maximum flame propagation height with reference to the first-floor level is to be observed at intervals of 60 s or less. The thermocouple temperatures at the 12 ft, 0 in (3 m, 66 cm) level and at the air-velocity probe are to be recorded at intervals of 5 s or less.

8.7 The test flame is to be applied to the cable specimens for 30 min unless the nonmetallic cable parts are completely consumed for the full length of the set of specimens in less time. In the latter case, the test flame is to be extinguished after the nonmetallic cable parts are consumed. In any case, after the test flame is extinguished and any flaming of the cable specimens ceases, the maximum height of continuous cable damage is to be measured and recorded. A coating of soot on the cable specimens is to be ignored when wiping the soot off leaves the original surface of the cables unblemished. Damage occurs anywhere that a cable specimen shows evidence of its combustible material having been softened (recorded as ″melt″), having been partially consumed (recorded as ″char″), or having been completely consumed (recorded as ″ash″).

REQUIREMENTS AND REPORT

9 Acceptance Criteria

9.1 In order to determine acceptance for each cable construction, two tested specimens from a sample lot shall comply with the following criteria. If the maximum flame propagation distances of the two sets of specimens for a cable construction have a difference greater than 5 ft (1.52 m), a third set of specimens shall be tested. A maximum of three tests shall be performed. If acceptance is not achieved with the three test limits, an additional sample lot of the cable construction must be submitted for evaluation.

a) The flame propagation height of each set of cable specimens shall not equal or exceed 12 ft, 0 in (3 m, 66 cm).

b) The temperature of any thermocouple shall not exceed 850.0°F (454.4°C).

10 Report

10.1 The report shall include, and is not limited to, the following items for each test:

a) A detailed description (construction) of the test cable, including the cable diameter.

b) The number of cable lengths that constitute the set of test specimens.

c) The maximum flame propagation height observed rounded to the nearest 6 in (15 cm) is the flame propagation height for the set of cable specimens tested.

d) The maximum continuous damage height on the cable specimens and the kinds of cable damage as defined in 8.7.

e) The maximum temperature (°F) recorded by the eight thermocouples in the second floor slot.

f) A graph of temperature (°F) versus time of exposure (minutes) of the eight thermocouples in the second floor slot.

g) A graph of the first floor slot velocity (m/s) versus time of exposure (minutes).

GUIDE TO MOUNTING METHODS

11 Introduction

11.1 This guide is an aid in determining the method of mounting various cable types in the fire test chamber. These methods are described for test-method uniformity and convenience. They do not imply restrictions in the specific details of field installation.

11.2 Where the methods described are not applicable to an unusual cable construction, other appropriate means of support are to be devised.

12 Method

12.1 The individual specimen cable lengths are to be suspended from a support system on the second floor and held in place just below the support system and at the first-floor slot.

12.2 The support frame is to consist of a steel bar located on the second floor above the slot opening. The individual cable lengths are to be suspended from the support frame by one of the following methods:

a) The cables are to be draped over the support frame.

b) The cables are to be arranged in a clamping device that is suspended from the support frame by two hooks.

c) In the case of large-diameter cables, each individual cable specimen is to be placed in a wire-mesh grip. Each grip is to be attached to a hook that is suspended from the support frame.

12.3 The cables are to be held in place just below the support frame by means of a clamping device. This device is to consist of two metal C-channels that sandwich the single layer of parallel cable specimens between them. The ends of the channels are to be secured with C-clamps or with threaded rods and nuts. The channels are to be suspended from the support frame by two hooks. In the case of large-diameter cables, nails are to be driven through each individual cable length to keep the specimen from slipping out of the clamps. The nails are to be driven horizontally through the cable, above and perpendicular to the clamp.

12.4 The cables are also to be held in place at the first-floor slot with a clamping device. This device is to consist of one metal C-channel, which is to be placed across the face of the single layer of parallel cable specimens. The ends of the plate are to be secured to the wall of the slot by means of threaded rods and nuts.

12.5 The cables are to be restrained from lateral movement during the test by positioning four steel wires supported horizontally behind and adjacent to the cable specimens at levels of 1, 2, 4, and 6 ft (305, 610, 1219, and 1829 mm) above the first floor. The steel wires are to be 18 AWG in size and are to extend between two fixed, vertical steel poles. The poles are to be 1 in (25 mm) in diameter. One pole is to be permanently mounted on each side of the layer of cables and slightly behind the cables so that the vertical plane that is tangent to the front surfaces of the poles also is tangent to the rear surfaces of the cable specimens. Provision is to be made for expansion when securing the poles.