



# IEEE Standard for Flame-Propagation Testing of Wire and Cable

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**IEEE Power Engineering Society**

Sponsored by the  
Insulated Conductors Committee

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**IEEE Std 1202<sup>TM</sup>-2006**  
(Revision of  
IEEE Std 1202-1991)



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# **IEEE Standard for Flame-Propagation Testing of Wire and Cable**

Sponsor  
**Insulated Conductors Committee**  
of the  
**IEEE Power Engineering Society**

Approved 8 June 2006  
**IEEE-SA Standards Board**

**Abstract:** Standardization of cable flame propagation testing is beneficial to cable manufacturers, distributors, and users. Uniform procedures; consistent, repeatable results; and measurable test acceptance criteria are required to allow comparisons among competing products and to allow selection of the correct product for the application.

**Keywords:** 20 kW, 20 min, 70 000 Btu/h, after burn, cable, char, charring, flame propagation, test protocol, vertical cable tray, wire

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## Introduction

This introduction is not part of IEEE Std 1202-2006, IEEE Standard for Flame-Propagation Testing of Wire and Cable.

This standard provides a test procedure for determining wire and cable flame propagation characteristics due to ignition sources either outside of or within the cable system. The purpose of this revision is to update the standard to current industry practices and to harmonize this document with similar vertical tray flame test standards, such as UL 1685 and CSA C22.2 No. 22.2 No. 0.3-01 (R2005), FT4. This standard is not meant to determine circuit integrity or fire stop capability of wire or cable systems. This standard is also not meant to determine the protection afforded to cables by tray covers, conduits, or fire barrier materials. These considerations are covered in other more appropriate standards. This standard may be used to satisfy wire and cable flame propagation requirements identified in National Electrical Code® (NEC®) (NFPA 70-2005); CSA Standard C22.1-06, Canadian Electrical Code (CEC), Part I; or Mexican NOM-001 (MEC), Aparatos Electronicos de Uso Domestico Alimentados por Diferentes Fuentes de Energia Electrica. This standard is referenced in other standards such as IEEE Std 383™-2003 and IEEE Std 1580™-2001.

This standard has been coordinated with Underwriters Laboratories (UL), the Canadian Standards Association (CSA), and Mexico's SDO Association of Standardization and Certification (ANCE) as part of the tri-national harmonization process. Even though the IEEE is not formally part of the harmonization group, the content of this standard has been reviewed to achieve common technical requirements.

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The Wire and Cable Fire Propagation Working Group of the Maintenance, Operation & Safety Subcommittee of the Power Systems Engineering Committee of the Industrial and Commercial Power Systems Department of the IEEE Industrial Applications Society originally prepared this standard. The document was initially issued in 1991 and confirmed for use on a five-year period since. The standard was transferred to the Insulated Conductors Committee (ICC) of the Power Engineering Society in mid-2002 and revised by ICC working group D15W, which had the following membership:

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# IEEE Standard for Flame-Propagation Testing of Wire and Cable

## 1. Overview

### 1.1 Scope

This standard provides a protocol for exposing cable samples to a theoretical 20 kW (70 000 Btu/h) flaming ignition source for a 20-min test duration. The test determines the flame propagation tendency of single-conductor and multi-conductor cables intended for use in cable trays.

### 1.2 Purpose

The purpose of this standard is to establish a test protocol and performance criteria to determine the flame propagation tendency of cables in a vertical cable tray.

### 1.3 Applications

This standard shall apply to multi-conductor cables and single insulated conductors that are allowed to be installed in cable tray, or to other cables and conductors for which a flame rating to the requirements of this standard is desired.

### 1.4 Disclaimer

The results obtained using this test do not imply that cables of similar cable construction will necessarily perform the same way in other cable arrangements, other cable tray configurations, or other environments.

### 1.5 Test precautions

Fire testing of products and materials is inherently hazardous. Adequate safeguards for personnel and property shall be employed while conducting these tests.

## 2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI/ASTM D1835-2005, Specification for Liquefied Petroleum (LP) Gases.<sup>1</sup>

ASTM C90-2005, Standard Specification for Loadbearing Concrete Masonry Units.<sup>2</sup>

CAN/CSGB 3.14-06, Liquefied Petroleum Gas (Propane), Canadian General Standards Board.<sup>3</sup>

CSA Standard C22.2, No. 126.1-02, Metal Cable Tray Systems, Second Edition.<sup>4</sup>

IEC 60332-3-10-2000, Tests on Electric Cables under Fire Conditions—Part 3-10: Test for Vertical Flame Spread of Vertically-Mounted Bunched Wires or Cables—Apparatus, First Edition.<sup>5</sup>

NEMA VE 1-2002, Metal Cable Tray Systems.<sup>6</sup>

## 3. Definitions

For the purposes of this document, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standard Terms* [B3]<sup>7</sup> should be referenced for terms not defined in this clause.

**3.1 sample:** The insulated conductor or cable type and construction to be tested.

**3.2 specimen:** The individual length of cable or cable bundle to be placed in the cable tray for testing.

## 4. Flame test facility

### 4.1 Enclosure

Figure 1 provides a typical example of an enclosure in which the sample is tested. The inclusion of a baffle for safety purposes to protect the hood, duct, and fan (shown in Figure 1) is optional.

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<sup>1</sup> ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

<sup>2</sup> ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (<http://www.astm.org/>).

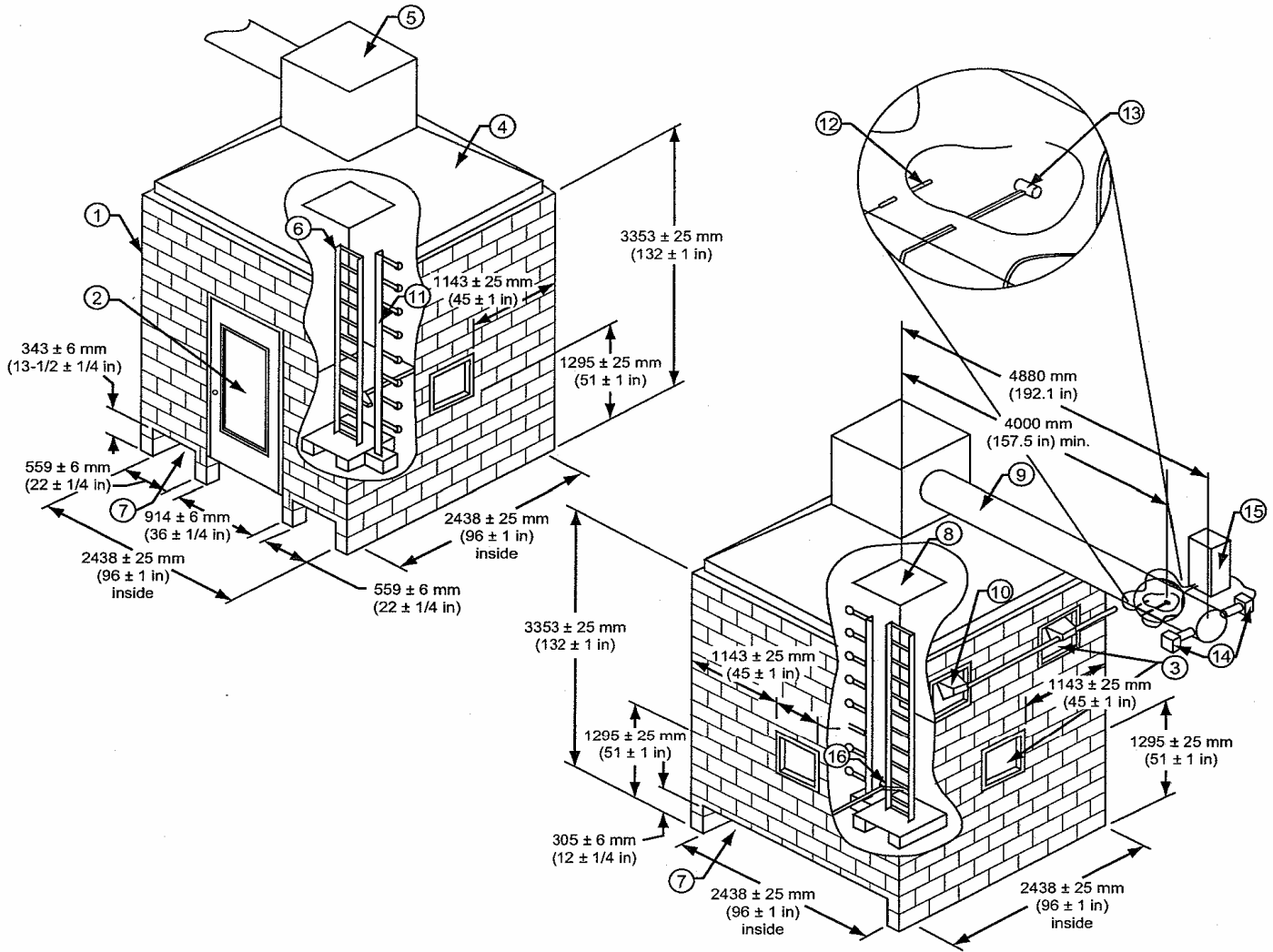
<sup>3</sup> Canadian General Standards are available from the Canadian General Standards Board, Place du Portage III, 6B1, 11 Laurier Street, Gatineau, Quebec, Canada K1A 1G6 (<http://www.pwgsc.gc.ca/cgsb/home/contact-e.html>).

<sup>4</sup> CSA publications are available from the Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada, L4W 5N6.

<sup>5</sup> IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

<sup>6</sup> NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>).

<sup>7</sup> The numbers in brackets correspond to those in the bibliography in Annex B.



Legend:

- 1—Enclosure. Concrete blocks, if used, should be the standard commercial size available such as trade size 8 in × 16 in × 6 in or the equivalent in metric trade size such as 200 mm × 400 mm × 150 mm. (The exact block size is not significant to the test results; however, the air intake opening size is critical.)
- 2—Steel-framed door with wired-glass window for access and observation. The size of the door should be a standard commercial door size such as trade size 36 × 84 in or the equivalent metric trade size such as 1 × 2 m.
- 3—Steel-framed wired-glass observation window(s) nominally 450 mm (18 in) square, located on a side wall of the chamber (see 4.1.2).
- 4—Truncated-pyramid stainless-steel hood; each side is sloped approximately 40°.
- 5—Collection box with exhaust duct centered on one side. The box shall be a cube with each face a 910 mm ± 15 mm (36 in ± 0.5 in) square.
- 6—Tray mounted vertically in the center of the enclosure.
- 7—Air-intake openings.
- 8—Steel baffle that is nominally 610 mm × 610 mm (24 in × 24 in) and 3.2 mm (0.125 in) thick.
- 9—Duct that is 405 mm ± 15 mm (16 in ± 0.5 in) inside diameter.
- 10—Lighting (optional).
- 11—Flame height gauge (optional).
- 12—Temperature probe (Type K thermocouple with inconel sheath).
- 13—Bidirectional velocity probe.
- 14—Photoelectric cell and light source for smoke density measurement (optional).
- 15—Control cabinet(s) for bidirectional velocity probe, thermocouple, light source, and photoelectric cell (optional).
- 16—Ribbon burner.

Figure 1—Flame test enclosure

The enclosure shown in Figure 1 is recommended for new construction. Other enclosures shall be permitted to be used if they are shown to provide equivalent results and are of a size such that the internal volume of the enclosure, exclusive of the pyramid hood, shall not be less than 14.5 m<sup>3</sup> (512 ft<sup>3</sup>) nor greater than 36 m<sup>3</sup> (1272 ft<sup>3</sup>), the floor area shall not be less than 6 m<sup>2</sup> (64 ft<sup>2</sup>) nor greater than 9 m<sup>2</sup> (97 ft<sup>2</sup>), and the maximum air movement within the enclosure complies with 4.3.

In the event of dispute, the results of tests conducted in an enclosure sized as shown in Figure 1 shall be final.

#### **4.1.1 Enclosure walls**

The walls of the enclosure should be constructed of concrete masonry materials complying with ASTM C90-2005.<sup>8</sup> The interior surface of the walls shall be painted flat black.

Alternative construction materials are acceptable for the enclosure walls provided the construction materials are capable of withstanding the high temperatures and open flame within the test enclosure.

#### **4.1.2 Windows**

For observation of the fire test, windows should be located in the walls and door, as shown in Figure 1. The exact location, size, and number of windows are not critical to test performance provided that all windows are air-tight. It is suggested that the total surface area of the windows should not exceed 1.8 m<sup>2</sup> (20.0 ft<sup>2</sup>). Exercise caution in selecting the window materials and construction to withstand the high temperatures and open flame within the test enclosure.

#### **4.1.3 Air intakes**

Air intakes shall be provided at the base of two opposite walls. The total cross-sectional area of the air intakes shall be 1.45 m<sup>2</sup> ± 0.03 m<sup>2</sup> (15.63 ft<sup>2</sup> ± 35 ft<sup>2</sup>), and the intake areas shall be divided approximately equal. Figure 1 shows dimensions for the air intakes installed in walls with and without an access door. Air intakes shall not be permitted in either of the other two walls.

#### **4.1.4 Access door**

The enclosure shall contain an access door, typically constructed of steel, located as shown in Figure 1. The door shall be permitted to be located in any of the four walls. The sides and top of the door shall be adequately sealed to prevent drafts. The bottom of the door shall also be sealed to prevent drafts if it is not located in a wall containing an air intake.

#### **4.1.5 Exhaust hood**

A hood, formed as shown in Figure 1, shall be located on top of the enclosure walls. The area between the hood and the walls shall be sealed.

#### **4.1.6 Collection box**

A 910 mm × 910 mm × 910 mm with tolerance of ±15 mm on each side (36 in × 36 in × 36 in with a tolerance of 0.5 in on each side) stainless steel collection box shall be located on top of the exhaust hood as shown in Figure 1.

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<sup>8</sup> Information on references can be found in Clause 2.

## 4.2 Exhaust duct

The exhaust duct connected to the collection box on top of the hood shall be a 405 mm  $\pm$  15 mm (16 in  $\pm$  0.5 in) nominal inside diameter steel pipe installed horizontally.

A variable-speed exhaust fan shall be located at the exhaust end of the duct. The exhaust duct shall be provided with instruments to measure gas velocity and temperature. A bidirectional probe or an equivalent measuring system shall be used to measure pressure in the duct. The probe shall be located in the exhaust duct at least 4.9 m (16 ft) but not more than 13.7 m (45 ft) from the centerline of the collection box. The minimum length between any bend and the probe shall be at least 10 times the inside diameter of the duct. The probe, shown in Figure 2, shall consist of a stainless steel cylinder with a solid diaphragm in the center that divides the probe into two chambers. The probe shall have a length nominally two times the outside diameter of the cylinder with a minimum length of 25.4 mm (1.0 in) and a maximum length of 51 mm (2.0 in). The pressure taps on either side of the diaphragm support the probe. The axis of the probe shall be along the centerline of the duct. The taps shall be connected to a pressure transducer that shall be able to resolve pressure differences of 0.25 Pa (0.001 in of water). A bare bead, high-temperature Type K thermocouple, 0.51 mm (20 mils) in diameter, shall be located 152 mm (6 in) upstream from the bidirectional probe.

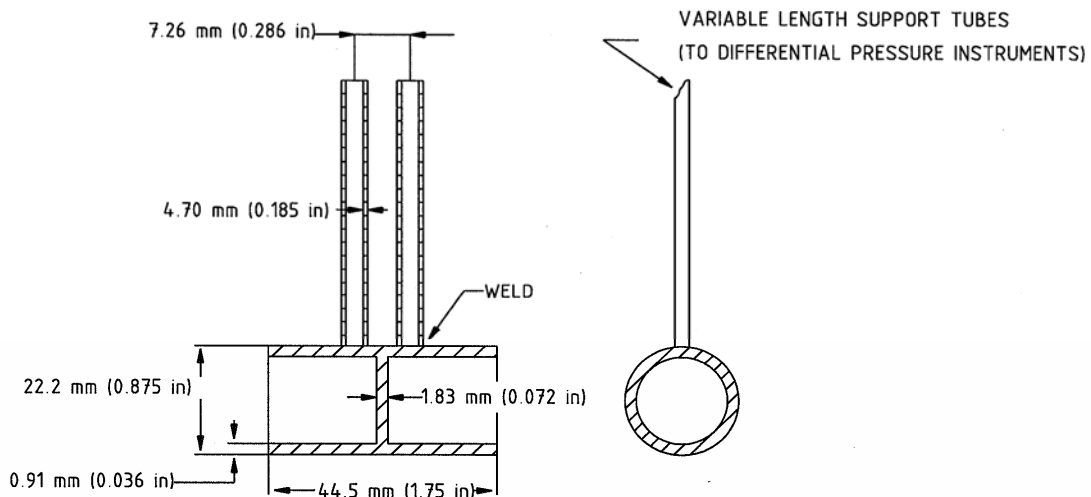


Figure 2—Bidirectional probe

## 4.3 Air movement within the enclosure

The maximum air movement within the enclosure, with only the intake and exhaust openings open, the exhaust fan on, if applicable, and the burner off, shall not exceed 1 m/s (3.3 ft/s), as measured by a vane-type anemometer in the following areas:

- At the floor level where the burner will be positioned during the test
- 1.5 m (4.9 ft) above the enclosure floor where the cable tray will be positioned during the test

#### 4.4 Cable tray

A steel ladder cable tray, as shown in Figure 3, shall be used. The cable tray shall comply with NEMA VE 1-2002 or CSA Standard C22.2, No. 126.1-02. The rungs shall be attached to the inside of the side channels.

The tray shall be located so the burner flame will impinge on the cable midway between rungs.

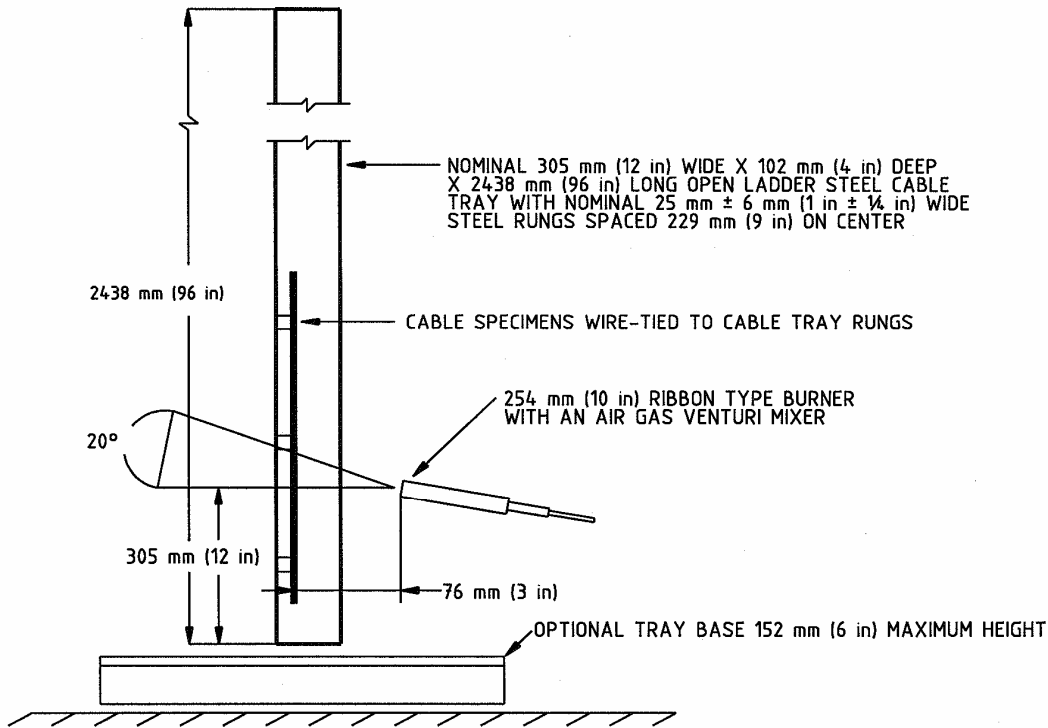


Figure 3—Cable tray, specimen, and burner details

#### 4.5 Burner and mixer

The ribbon burner shall be a nominal 254 mm (10 in) strip- or ribbon-type propane-gas burner with an air/gas venturi mixer as shown in Annex A or IEC 60332-3-10.<sup>9</sup>

The burner shall be mounted on a stand and placed  $20^\circ \pm 2^\circ$  from the horizontal with the burner ports up (see Figure 3). The top of the burner shall be located  $305 \text{ mm} \pm 25 \text{ mm}$  ( $12 \text{ in} \pm 1 \text{ in}$ ) above the base of the cable tray and parallel to the cable tray rungs.

A guide shall be attached to the burner or stand so the leading edge of the burner face can be accurately placed  $76 \text{ mm} \pm 5 \text{ mm}$  ( $3 \text{ in} \pm 0.2 \text{ in}$ ) horizontally from the nearest surface of the cables.

<sup>9</sup>NOTE—See Annex A for information on burner and mixer.

## 4.6 Flowmeters

A flowmeter shall be located in the propane line and in the air line feeding the burner to measure the flow rates of these gases during the test. The propane flowmeter shall be capable of measuring a flow rate of 230 cm<sup>3</sup>/s (29 ft<sup>3</sup>/h). The air flowmeter shall be capable of measuring a flow rate of 1360 cm<sup>3</sup>/s (173 ft<sup>3</sup>/h). Measurements shall be accurate within 3%. A mass flow controller with an output that can be recorded should be used; however properly calibrated volumetric flow meters are also acceptable.

## 4.7 Supply air

The air supplied to the burner shall be compressed air, either bottled or supplied through a compressed air system. The air supply shall be filtered, when necessary, to eliminate contaminants that could affect the test results.

## 4.8 Propane

The propane gas supplied to the burner shall be equivalent to Propane HD-5 as specified in ANSI/ASTM D1835-2003 or CAN/CGSB 3.14-06 (Grade 1). The gas shall have a nominal heating value of 93.0 MJ/m<sup>3</sup> (2500 Btu/ft<sup>3</sup>). The temperature of the propane gas shall be 25 °C ± 5 °C (77 °F ± 9 °F).

## 5. Test sample requirements

### 5.1 Cable samples

Unless otherwise specified by the user, recognized testing laboratory, or the inspection authority having jurisdiction, the minimum conductor size construction for each cable design shall be tested to qualify all larger sizes using identical materials. Addition or deletion of a cable component or a change in material(s) shall constitute a new cable design, except that deletion of fillers or a strand separator shall not constitute a new cable design for power or control cable which has metal conductors.

Cable constructions shall consist of single-insulated conductors or multi-conductor cables within all applicable voltage classes, as follows:

- a) Multi-conductor cables: The smallest conductor size in the cable design with the fewest conductors, e.g., 2 conductor 18 AWG (0.823 mm<sup>2</sup>).
- b) Single-insulated conductors: The smallest single conductor in the cable design.

NOTE—Practical experience within the cable industry has shown that passing the test with the smallest conductor qualifies larger conductors within the same voltage class of the same cable design.<sup>10</sup>

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<sup>10</sup> Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

## 5.2 Tests required

Each cable design shall be subjected to two flame tests. A third and final test shall be performed if one of the first two tests results in a failure.

## 6. Flame test procedure

### 6.1 Cable mounting

The length of each cable specimen or each cable bundle shall be  $2.4 \text{ m} \pm 0.1 \text{ m}$  ( $8 \text{ ft} \pm 0.3 \text{ ft}$ ). Depending on the outside diameter of the individual cable, the test specimen shall be either an individual length or a bundle of individual lengths. The specimens or specimen bundles shall be centered between the side rails in a single layer. The lower end of each specimen or specimen bundle shall be located not more than 100 mm (4 in) above the bottom end of the cable tray. Each specimen or specimen bundle shall be separately attached to each rung of the cable tray using one wrap of a copper or steel wire tie not larger than 14 AWG ( $2.08 \text{ mm}^2$ ).

#### 6.1.1 Cables smaller than 13 mm (0.51 in)

For cables smaller in diameter than 13 mm (0.51 in), the specimens shall be grouped into untwisted bundles (nominally circular) as specified in Table 1 or Table 2. The bundles shall be spaced one-half bundle diameter apart on the cable tray as measured at the point of attachment to the cable tray.

NOTE—For the purposes of this standard, a cable is any single-insulated conductor or assembly of insulated conductors. The cable OD is the outside diameter of a cable including any overall jacket or sheath.

**Table 1—Tray loading for circular cables smaller than 13 mm in diameter**

Cable diameter (mm)		Number of cables in each bundle	Number of bundles in the tray
From	But less than		
	3	19	13
3	5	19	8
5	6	7	9
6	9	3	10
9	11	3	8
11	13	3	7

**Table 2—Tray loading for circular cables smaller than 0.51 in diameter**

Cable diameter (in)		Number of cables in each bundle	Number of bundles in the tray
From	But less than		
	0.12	19	13
0.12	0.20	19	8
0.20	0.24	7	9
0.24	0.35	3	10
0.35	0.43	3	8
0.43	0.51	3	7

### 6.1.2 Cables 13 mm (0.51 in) and larger

For cables 13 mm (0.51 in) in diameter and larger, the individual specimens shall be attached to the cable tray with a separation of one-half cable diameter or 15 mm (0.6 in), whichever is less. The tray loading shall comply with Table 3 or Table 4.

NOTE—For the purposes of this standard, a cable is any single-insulated conductor or assembly of insulated conductors. The cable OD is the outside diameter of a cable including any overall jacket or sheath.

**Table 3—Tray loading for cables 13 mm in diameter and larger**

Cable diameter (mm)		Number of cables in tray
From	But less than	
13	15	11
15	19	9
19	21	8
21	26	7
26	28	6
28	39	5
39	52	4
52	73	3
73	120	2

**Table 4—Tray loading for cables 0.51 in diameter and larger**

Cable diameter (mm)		Number of cables in tray
From	But less than	
0.51	0.59	11
0.59	0.75	9
0.75	0.83	8
0.83	1.00	7
1.00	1.10	6
1.10	1.50	5
1.50	2.00	4
2.00	2.90	3
2.90	4.70	2

### 6.1.3 Flat cables

For flat cables, the equivalent cable diameter shall be calculated using the following formula:

$$D = 1.128\sqrt{TW} \tag{1}$$

where

- D* is the calculated cable diameter, mm (in)
- T* is the thickness or minor axis of the cable, mm (in)
- W* is the width or major axis of the cable, mm (in)

For ribbon cables, the spacing between adjacent cables shall not be less than 3.2 mm (1/8 in). The full width of the tray may be used.

## 6.2 Test procedure

### 6.2.1 Cables and cable tray

The cables mounted on the cable tray shall be conditioned at a temperature of  $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  ( $77\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$ ) for at least 3 h immediately before commencing the test. The dew point of the air inside the enclosure does not need to be measured.

The prepared cable tray shall be positioned vertically in the enclosure (as shown in Figure 1) so that the rungs of the cable tray are parallel to the walls containing the ventilation openings. The lower end of the cable specimens shall be positioned so that the bottom of the specimens is at least 203 mm (8 in) below the top of the burner. The cable tray shall be firmly fixed in position.

### 6.2.2 Exhaust duct flow rate

The initial volumetric flow rate of air through the duct shall be  $0.65\text{ m}^3/\text{s} \pm 0.05\text{ m}^3/\text{s}$  ( $23\text{ ft}^3/\text{s} \pm 1.8\text{ ft}^3/\text{s}$ ). The volumetric flow rate of the air in the duct shall be calculated from Equation (2) (Crocker [B1]). Once the initial flow rate has been established, the fan speed shall not be reduced. The fan speed shall be increased if the flow rate falls below the initial set value to maintain the initial volumetric flow rate.

$$V_S = C_v kA \sqrt{\frac{2\Delta_p}{\rho_o} \times \frac{T}{T_o}} = 0.069685kA \sqrt{\Delta_p T} \text{ m}^3/\text{s} \quad (\text{metric})$$

$$V_S = C_v kA \sqrt{\frac{2\Delta_p}{\rho_o} \times \frac{T}{T_o}} = 0.005002kA \sqrt{\Delta_p T} \text{ ft}^3/\text{s} \quad (\text{English}) \quad (2)$$

where

$C_v$	is 0.926—the calibration factor for bidirectional probe based on air velocities in excess of 3.0 m/s (10 ft/s) in a 405 mm $\pm$ 2 mm (16 in $\pm$ 0.06 in) diameter duct
$k$	is the ratio of the average duct gas mass flow per unit area, as determined by measuring the velocity and temperature profiles across the stack, and the velocity and temperature at the center line where the bidirectional probe is located during the test
$A$	is the cross-sectional area of the duct at the location of the probe, $\text{m}^2$ ( $\text{in}^2$ )
$\Delta_p$	is the differential pressure measured with the probe, Pa (psi)
$\rho_o$	is 1.1845 $\text{kg}/\text{m}^3$ ( $4.2793 \times 10^{-5}\text{ lbs}_m/\text{in}^3$ )—the density of air in the exhaust duct at the reference temperature $T_o$
$T$	is the duct gas temperature, K ( $^{\circ}\text{R}$ )
$T_o$	is the reference temperature—298.15 K (536.7 $^{\circ}\text{R}$ )

NOTE—Care must be taken when applying the above formula to use correct units in either the metric or the English versions.

### 6.2.3 Burner

The burner shall be ignited, and gas flows shall be adjusted to the values specified below. The burner, at an angle of  $20^{\circ}$  from the horizontal, shall be positioned in front of the cable tray and 75 mm  $\pm$  5 mm (3 in  $\pm$  0.2 in) from the nearest cable surface as shown in Figure 3.

The propane flow rate shall be  $220 \text{ cm}^3/\text{s} \pm 8 \text{ cm}^3/\text{s}$  ( $28 \text{ ft}^3/\text{h} \pm 1 \text{ ft}^3/\text{h}$ ) when corrected to standard temperature and pressure  $20 \text{ }^\circ\text{C}$ ,  $101 \text{ kPa}$  ( $68 \text{ }^\circ\text{F}$ ,  $14.6 \text{ psia}$ ). This propane flow rate provides a theoretical heat output of  $20 \text{ kW}$  ( $70\,000 \text{ Btu/h}$ ). The actual heat output may be less, due to incomplete combustion of the propane at the burner.

When propane other than the grade specified in 4.8 is used, the propane flow rate shall be adjusted to maintain the  $20 \text{ kW}$  ( $70\,000 \text{ Btu/h}$ ) heat input. In the event of dispute, the test results obtained using the propane specified in 4.8 shall be final.

#### **6.2.4 Airflow and air temperature**

The airflow rate shall be  $1280 \text{ cm}^3/\text{s} \pm 8 \text{ cm}^3/\text{s}$  ( $163 \text{ ft}^3/\text{h} \pm 10 \text{ ft}^3/\text{h}$ ) when corrected to standard temperature and pressure. The temperature of the air feeding the burner shall be  $25 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$  ( $77 \text{ }^\circ\text{F} \pm 9 \text{ }^\circ\text{F}$ ). The dew point of the air shall not be greater than  $0 \text{ }^\circ\text{C}$  ( $32 \text{ }^\circ\text{F}$ ).

The temperature of the ambient air entering and inside the enclosure shall be greater than  $5 \text{ }^\circ\text{C}$  ( $41^\circ\text{F}$ ). The dew point of the air does not need to be measured.

#### **6.2.5 Test duration**

The burner flame shall impinge on the specimens for a continuous period of 20 min.

At the end of the 20-min period, the burner flame shall be extinguished and the cable fire (if any) allowed to self-extinguish. The time of after burn shall be recorded.

#### **6.2.6 Supplemental information**

During the flame exposure, visual flame height may be recorded for informational purposes.

Pictures or video of the flame propagation testing may be made for informational purposes.

### **7. Test evaluation**

#### **7.1 Evaluation of damage**

After burning has ceased, the cables shall be wiped clean, and the maximum extent of cable damage shall be determined. Soot that can be removed with a cloth shall be ignored. It is not necessary to require the cable tray assembly to cool to room temperature before evaluating flame propagation or taking measurements of cable damage. However, proper safety precautions shall be taken.

##### **7.1.1 Cable char damage**

The limit of charring shall be determined by pressing against the cable surface with a sharp object. In places where the surface of the cable changes from a resilient to a brittle or crumbling surface, the limit of charring has been identified. Cable damage shall then be documented by measuring the distance of the charred height on the most centrally located specimens above the horizontal line from the lower edge of the burner face to the nearest  $25 \text{ mm}$  ( $1 \text{ in}$ ).

##### **7.1.2 Non-cable char damage**

Certain cable constructions may not “char” upon exposure to flame due to the characteristics of jacket/insulation compounds used. For these constructions, the limit for the affected cable damage shall be defined as the point where the overall diameter is visibly reduced or increased. Affected cable damage shall

then be documented by measuring the distance from this point to the horizontal line at the lower edge of the burner face to the nearest 25 mm (1 in).

In addition, other cable degradation evidence such as melting or blistering maybe recorded for informational purposes.

## 7.2 Performance criteria

The sample shall have complied with this standard and met the performance criteria if the length of cable damage does not exceed 1.5 m  $\pm$  25 mm (4.9 ft  $\pm$  1 in), when measured in accordance with 7.1, in two tests.

## 7.3 Test report

A Test Record Data Sheet shall be completed for each flame test. The following information shall be recorded for each test:

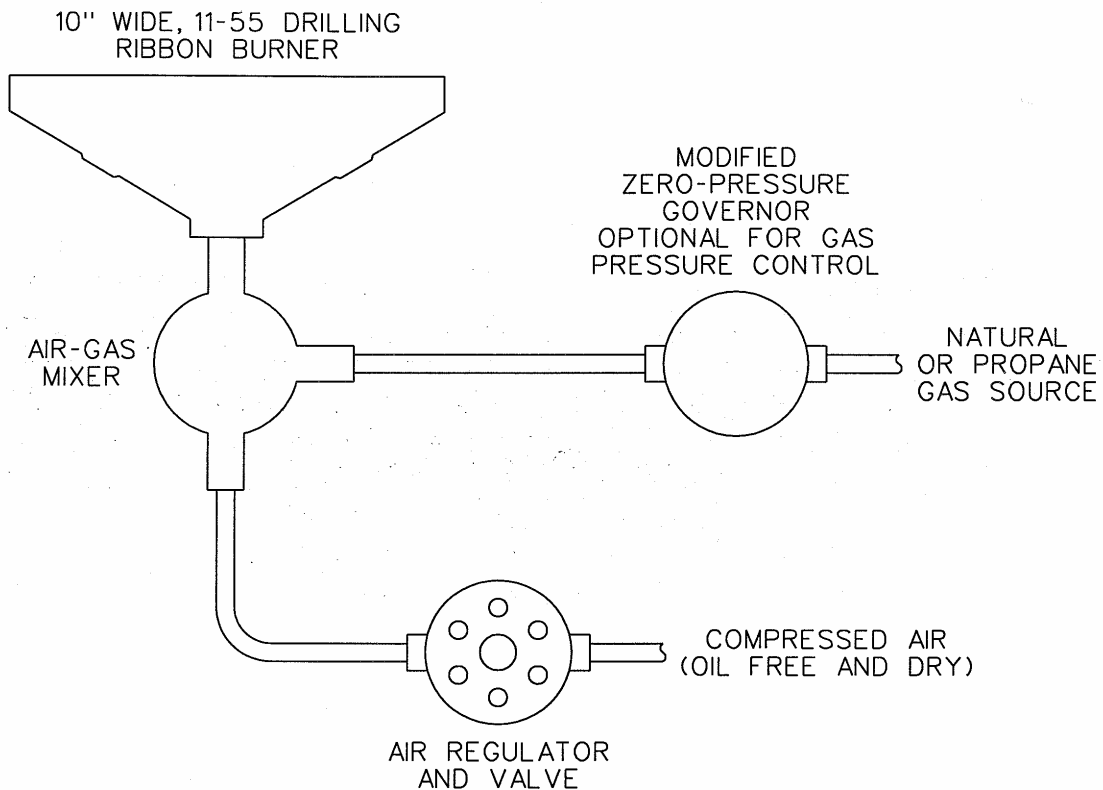
- a) Date of testing
- b) Location of testing
- c) Test number
- d) Test leader/supervisor
- e) Test observer(s), if any
- f) Inside dimensions of enclosure, if not in accordance with this standard
- g) Cable manufacturer's name
- h) Cable identification/type and catalog number
- i) Complete description of the cable construction, including outside diameter
- j) NEC, CEC, or MEC type designation, as applicable
- k) Number of cable specimens or bundles in the cable tray
- l) Temperature of air outside enclosure
- m) Temperature inside enclosure prior to starting test
- n) Airflow rate at the floor level
- o) Airflow rate at 1.5 m (4.9 ft) above the floor
- p) Propane flow rate
- q) Airflow rate into the burner
- r) Airflow rate through the exhaust duct
- s) Maximum length of cable damage
- t) Time of after burn
- u) Test results—pass or fail
- v) Comments

## Annex A

(normative)

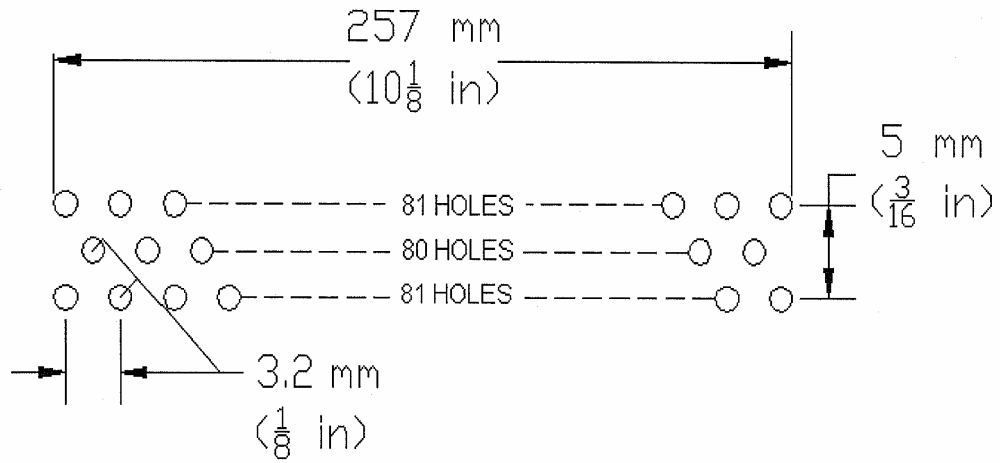
### Burner and mixer information

The burner number 10L1155 and venturi mixer number 14-18 for use in this standard is as shown in Figure A.1.



**Figure A.1—Burner and mixer configuration**

The ribbon burner shall have a flame-producing surface (face) consisting of a flat metal plate that is 341 mm (13-7/16 in) long and 30 mm (1-5/32 in) wide. The plate shall have an array of 242 holes drilled in it (see Figure A.2). All dimensions are nominal. Holes shall be centered on the plate and 1.35 mm [0.052 in (No. 55 drill)] in diameter.



**Figure A.2—Burner hole arrangement**

NOTE—At the time of publication of this standard, the information provided in this annex regarding the burner and mixer numbers is based on information provided by the users of this standard, and it is shown for the convenience of the users of this standard and does not constitute an endorsement by the IEEE. Equivalent products may be used if they can be shown to yield the same results.

## Annex B

(informative)

### Bibliography

- [B1] Crocker, S., *Piping Handbook*, New York: McGraw-Hill, 1945.
- [B2] CSA Standard C22.1-06, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, 20th ed.
- [B3] IEEE 100, *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition, New York, Institute of Electrical and Electronics Engineers, Inc.
- [B4] NFPA 70-2005, National Electrical Code® (NEC®).<sup>11</sup>

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<sup>11</sup> NFPA publications are available from Publication Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA (<http://nfpa.org/codes/index.html>).