IEC 60332-3-10

Edition 2.0 2018-07
REDLINE VERSION

INTERNATIONAL STANDARD

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GROUP SAFETY PUBLICATION

**Tests on electric and optical fibre cables under fire conditions –
Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus**

IEC 60332-3-10:2018-07 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TESTS ON ELECTRIC AND OPTICAL FIBRE CABLES UNDER FIRE CONDITIONS –

Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60332-3-10 has been prepared by IEC technical committee 20: Electric cables.

This second edition cancels and replaces the first edition published in 2000 and Amendment 1:2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) adjustments have been made to the title, and elsewhere, to emphasise the standard is applicable to optical fibre cables as well as metallic conductor types;
b) details of the way in which cables are mounted on the ladder have been better defined in order to improve repeatability and reproducibility;
c) the connection of the venturi mixer to the burner is better defined.

It has the status of a group safety publication in accordance with IEC Guide 104.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
20/1797/FDIS	20/1814/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60332 series, published under the general title *Tests on electric and optical fibre cables under fire conditions*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of October 2018 have been included in this copy.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

IEC 60332-3-10 is part of a series of publications dealing with tests on electric and optical fibre cables under fire conditions.

The IEC 60332-1 and IEC 60332-2 series specify methods of test for flame spread characteristics for a single vertical insulated wire or cable. It cannot be assumed that, because a wire or cable meets the requirements of the IEC 60332-1 and IEC 60332-2 series, a vertical bunch of similar cables or wires will behave in a similar manner. This is because flame spread along a vertical bunch of cables depends on a number of features, such as

a) the volume of combustible material exposed to the fire and to any flame which may be produced by the combustion of the cables;
b) the geometrical configuration of the cables and their relationship to an enclosure;
c) the temperature at which it is possible to ignite the gases emitted from the cables;
d) the quantity of combustible gas released from the cables for a given temperature rise;
e) the volume of air passing through the cable installation;
f) the construction of the cable, for example armoured or unarmoured, multi- or single-core.

All of the foregoing assume that the cables are able to be ignited when involved in an external fire.

The IEC 60332-3 series gives details of a test where a number of cables are bunched together to form various test sample installations. For easier use and differentiation of various test categories, the parts are designated as follows:

Part 3-10: Apparatus

Part 3-21: Category A F/R

Part 3-22: Category A

Part 3-23: Category B

Part 3-24: Category C

Part 3-25: Category D

Parts from 3-21 onwards define the various categories and the relevant procedures. The categories are distinguished by test duration, the volume of non-metallic material of the test sample and the method of mounting the sample for the test. In all categories, cables having at least one conductor of cross-sectional area greater than 35 mm^2 are tested in a spaced configuration, whereas cables of conductor cross-sectional area of 35 mm^2 or smaller and optical fibre cables are tested in a touching configuration.

The categories are not necessarily related to different safety levels in actual cable installations. The actual installed configuration of the cables may be a major determinant in the level of flame spread occurring in an actual fire.

The method of mounting described as category A F/R (Part 3-21) is intended for special cable designs used in particular installations.

Categories A, B, C and D (Part 3-22 to Part 3-25 respectively) are for general use where different non-metallic volumes are applicable.

~~Additional categories, especially to cover the use of small diameter communication cables in closely bunched configurations, will be further considered when more data are available.~~

TESTS ON ELECTRIC AND OPTICAL FIBRE CABLES UNDER FIRE CONDITIONS –

Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus

1 Scope

~~The series of International Standards covered by Parts 3-10, 3-21, 3-22, 3-23, 3-24 and 3-25~~ This part of IEC 60332 ~~specifies~~ details the apparatus and its arrangement and calibration for methods of test for the assessment of vertical flame spread of vertically-mounted bunched wires or cables, electrical or optical, under defined conditions.

NOTE For the purpose of this document the term "electric wire or cable" covers all insulated metallic conductor cables used for the conveyance of energy or signals.

2 Normative references

~~The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60332. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60332 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.~~

~~IEC 60695-4, *Fire hazard testing – Part 4: Terminology concerning fire tests*~~

~~IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*~~

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. ~~The definition is taken from IEC 60695-4.~~

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
ignition source
source of energy that initiates combustion

[SOURCE: ISO 13943:2017, 3.219]

4 Test environment

The test shall not be carried out if the external wind speed, measured by an anemometer fitted on the top of the test rig, is greater than 8 m/s and shall not be carried out if the temperature of the inside walls is below 5 °C or above 40 °C measured at a point approximately 1 500 mm above floor level, 50 mm from a side wall, and 1 000 mm from the door. The enclosure door shall be closed throughout the test.

5 Test apparatus

The test apparatus consists of the following.

5.1 Test chamber

The test rig (see Figures 1a) and 1b)) shall comprise a vertical test chamber having a width of (1 000 ± 100) mm, a depth of (2 000 ± 100) mm and a height of (4 000 ± 100) mm; the floor of the chamber shall be raised above ground level. The test chamber shall be nominally airtight along its sides, air being admitted at the base of the test chamber through an aperture of (800 ± 20) mm × (400 ± 10) mm situated (150 ± 10) mm from the front wall of the test chamber (see Figure 1).

An outlet (300 ± 30) mm x (1 000 ± 100) mm shall be made at the rear edge of the top of the test chamber. The back and sides of the test chamber shall be thermally insulated to give a coefficient of heat transfer of approximately 0,7 $W \cdot m^{-2} \cdot K^{-1}$. For example, a steel plate 1,5 mm to 2,0 mm thick covered with 65 mm of mineral wool with a suitable external cladding is satisfactory (see Figure 2). The distance between the ladder and the rear wall of the chamber is (150 ± 10) mm, and between the bottom rung of the ladder and the floor (400 ± 5) mm. The clearance between the lowest point of the test piece and the floor is approximately 100 mm (see Figure 3).

5.2 Air supply

A means of supplying a controlled air flow through the chamber shall be fitted.

~~NOTE 1 It is recommended that the air should be blown into the test chamber, via the air inlet, using a suitable fan.~~

Air shall be introduced into the test chamber through a box fitted directly underneath, and of approximately the same dimensions as the air inlet aperture. Air shall be blown into the box from a suitable fan through a straight section of duct which shall enter from the rear of the test chamber and be parallel to the floor and along the burner centre line as shown in Figure 1b). The duct shall be arranged to allow air into the box through an opening in the longest side.

A grille may be placed over the air inlet aperture to facilitate accessing the test chamber but should neither restrict the airflow nor modify its direction.

A duct of constant cross-section of approximately 240 cm^2 and minimum length of 60 cm is recommended.

Prior to burner ignition, the air flow shall be adjusted to a rate of (5 000 ± 500) l/min at a constant controlled temperature of (20 ± 10) °C and at atmospheric pressure and measured at the inlet side before the test commences. This air flow rate shall be maintained throughout the test until cable burning or glowing has ceased or for a maximum time of 1 h from completion of the test flame application period, after which period the flame or glowing shall be extinguished.

NOTE 2 In order to remove noxious gases, it is recommended to maintain the air flow for some minutes after the end of the test, before entering the test chamber.

5.3 Ladder types

There are two types of tubular steel ladder: a standard ladder of (500 ± 5) mm width and a wide ladder of (800 ± 10) mm width. Details of the types of ladder are given in Figures 4a) and 4b).

5.4 Effluent cleaning attachment

Legal requirements may make it necessary for equipment for collecting and washing the effluent to be fitted to the test chamber. This equipment shall not cause a change in the air flow rate through the test chamber.

6 Ignition source

6.1 Type

As required by the test procedure the ignition source shall be one or two ribbon-type propane gas burners complete with venturi mixer, and their own set of flowmeters.

The distance between venturi mixer and burner shall be at least 150 mm. The inner diameter of the tubing (piping or braided flexible hose) between venturi mixer and burner shall be at least equal to the 20 mm inner diameter of the outlet of the venturi mixer.

It is recommended that the distance between venturi mixer and burner does not exceed 900 mm.

Bends between venturi mixer and burner should be minimized.

The propane gas shall be technical grade propane of nominal 95 % purity. The flame-producing surface of the burner(s) shall consist of a flat metal plate through which 242 holes of 1,32 mm in diameter are drilled on 3,2 mm centres in three staggered rows of 81, 80 and 81 holes each to form an array having the nominal dimensions 257 mm × 4,5 mm. As the burner plate may be drilled without the use of a drilling jig, the spacing of the holes may vary slightly. Additionally, a row of small holes may be milled on each side of the burner plate to serve as pilot holes with the function of keeping the flame burning.

The burners are shown in Figures 5a) and 5b), and the placement of the holes in Figure 6.

NOTE 1 To ensure reproducibility between results from different testing stations, a burner, which is readily available, is recommended for use. For details, see Annex A.

Each burner shall be individually fitted with an accurate means of controlling the propane gas and air input flow rates, either by means of a rotameter-type flowmeter or mass flowmeter.

NOTE 2 Mass flowmeters are recommended for ease of use.

Figure 7 shows an example of a rotameter-type system.

SAFETY NOTE WARNING – The following precautions are recommended to ensure safe operation of the ignition source:

– the gas supply system should be equipped with flashback arresters;
– a flame failure protection device should be used;
– safe sequencing of the propane and air supply should be employed during ignition and extinguishing.

The calibration of the propane gas and air rotameter-type flowmeters shall be checked after installation to ensure that the pipework and venturi mixer have not affected the calibration.

Corrections for the variations in temperature and pressure from that specified on the propane gas and air rotameter-type flowmeters shall be applied when necessary, see Annex B.

Propane gas and air rotameter-type flowmeters shall be calibrated according to the following reference conditions.

Reference temperature and pressure are 20 °C and 1 bar (100 kPa).

For the purposes of this test, the air shall have a dew-point not higher than 0 °C.

The flow rates ~~at reference conditions (1 bar and 20 °C)~~ for the test shall be as follows:

Air (77,7 ± 4,8) l/min at reference conditions (1 bar and 20°C) or (1550 ± 95) mg/s;

Propane (13,5 ± 0,5) l/min at reference conditions (1 bar and 20°C) or (442 ± 11) mg/s;

to provide a nominal ~~(73,7 ± 1,68) × 10^6 J/h ((70 000 ± 1 600) Btu/h)[1)]~~ 73,7 x 10^6 J/h (20,5 kW)[2] to each burner.

~~NOTE 3 The net heat of combustion is used to calculate the propane flow rate.~~

6.2 Positioning

For the test, the burner shall be arranged horizontally at a distance of (75 ± 5) mm from the front surface of the cable sample, (630 ± 5) mm above the floor of the test chamber and approximately symmetrical with the axis of the ladder. The point of application of the burner flame shall lie ~~in the centre~~ between two cross-bars on the ladder ~~and at least 500 mm above the lower end of the sample~~ (see Figure 2 and Figure 3 ~~and figure 5a~~).

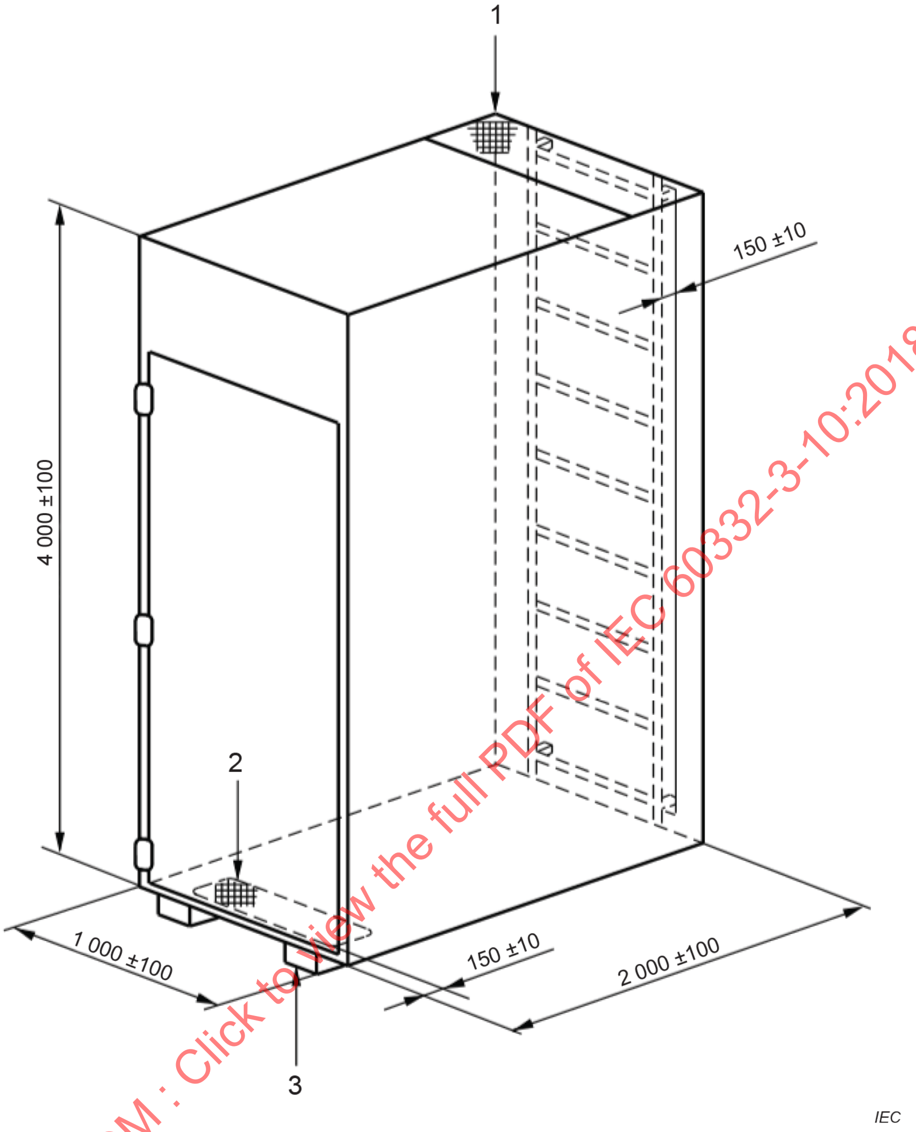
Adjustment of air and gas flows prior to the test may be carried out away from the test position.

Where two burners are used in combination with the wide ladder, they shall be arranged so as to be approximately symmetrical with the axis of the ladder, as shown in Figure 5b). The burner system shall be positioned such that the centre line of the burner system is approximately coincident with the centre of the ladder.

~~1) This is also equivalent to (20,5 ± 0,5) kW.~~

2 A net heat of combustion of 46,4 kJ/g is used to calculate the propane flow rate.

Dimensions in millimetres



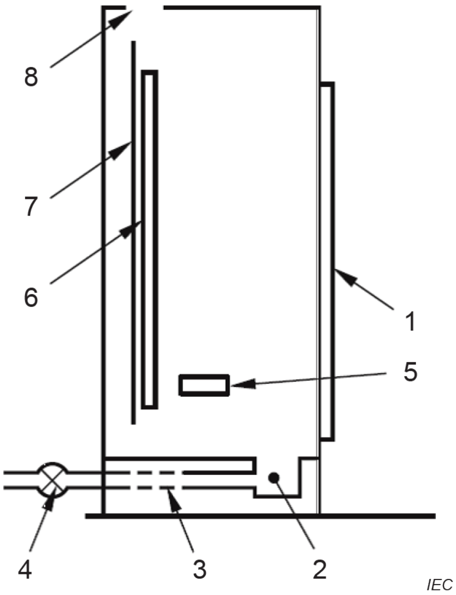
Key

1 smoke outlet (300 ± 30) × (1 000 ± 100)

2 air inlet (800 ± 20) × (400 ± 10)

3 rig raised above ground level

a) Test chamber



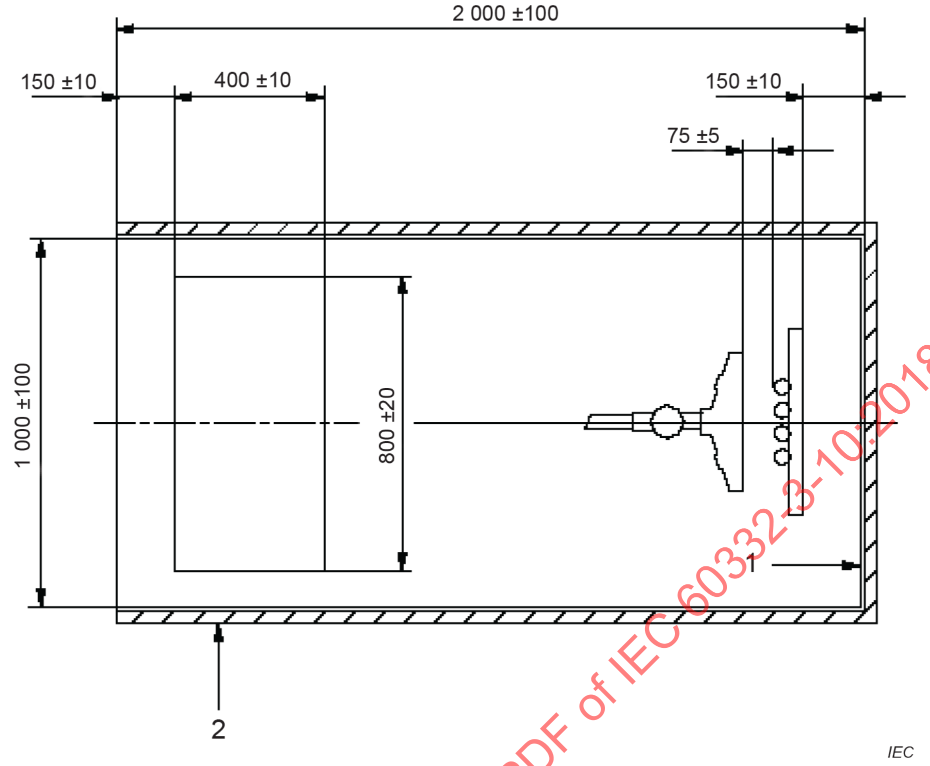
Key

1	door
2	air inlet box
3	air inlet duct
4	fan (illustrative position)
5	burner
6	cables tested
7	ladder
8	smoke outlet

b) Schematic side elevation of test chamber and air inlet arrangement

Figure 1 – Test chamber

Dimensions in millimetres



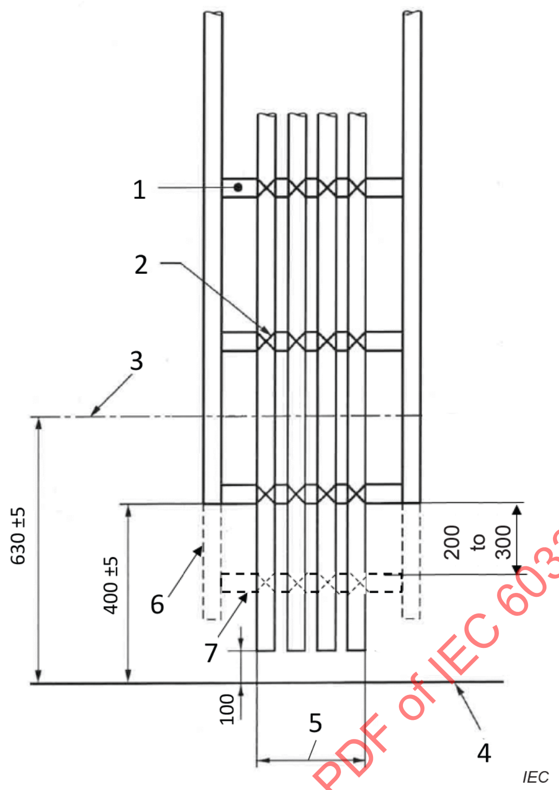
Key

1 steel plate, 1,5 mm to 2 mm thick

2 thermal insulation of mineral wool approximately 65 mm thick with suitable external cladding to give a coefficient of heat transfer of approximately 0,7 W × m^{-2} × K^{-1}

Figure 2 – Thermal insulation of back and sides of the test chamber

Dimensions in millimetres
(Dimensions are approximate except where toleranced)

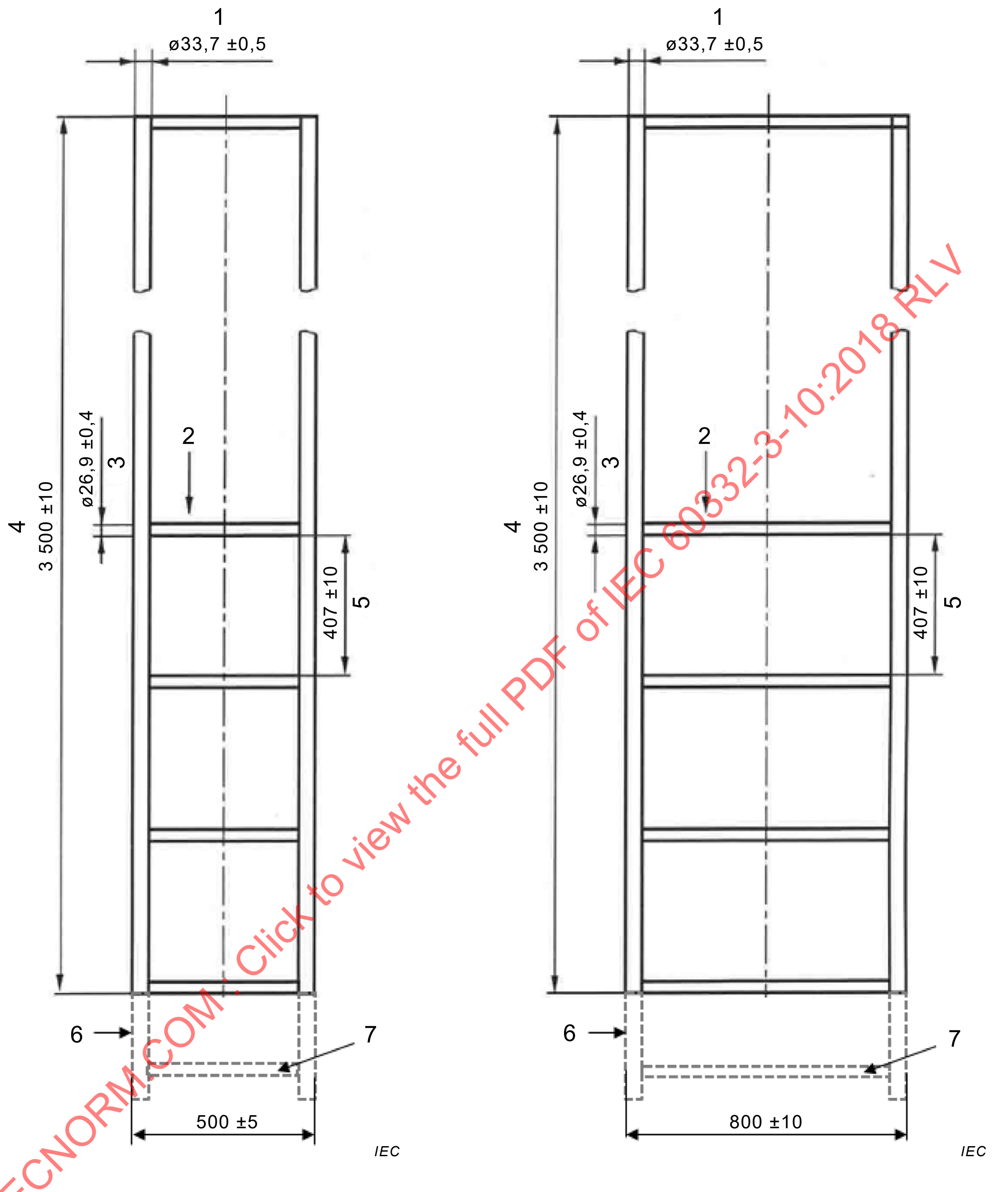


Key

1 round steel rungs	5 maximum width (according to test category)
2 metal wire ties	6 optional extensions of the steel legs
3 centre line of burner	7 optional steel rung
4 floor	

Figure 3 – Positioning of burner and typical arrangement of test sample on ladder

Dimensions in millimetres



a) **Standard ladder**

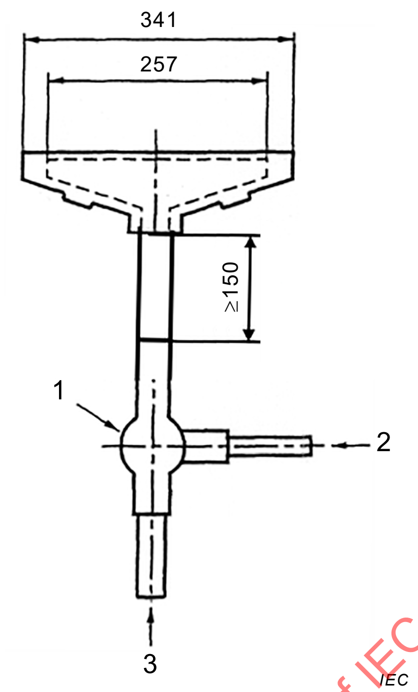
b) **Wide ladder**

Key

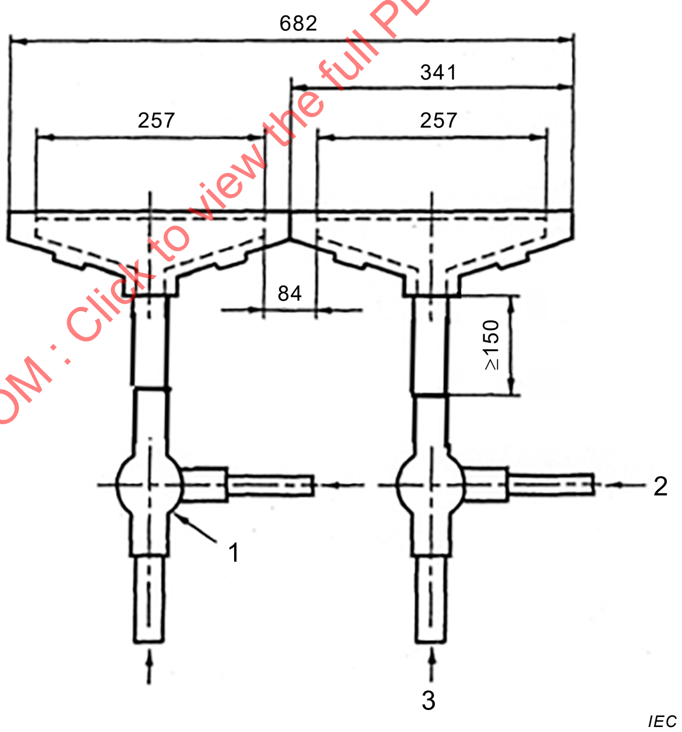
1	diameter of upright
2	number of rungs = 9
3	diameter of rungs
4	total height of ladder
5	distance between rungs
6	optional extensions of steel legs
7	optional steel rung

Figure 4 – Tubular steel ladders for cable test

Dimensions in millimetres



a) Single burner for use with standard ladder



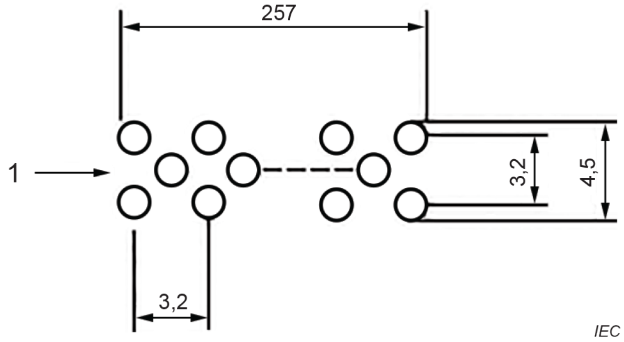
b) Two burner in combination for use with wide ladder

Key

1 venturi air-gas mixer
2 propane gas entry
3 compressed air entry

Figure 5 – Burner configurations

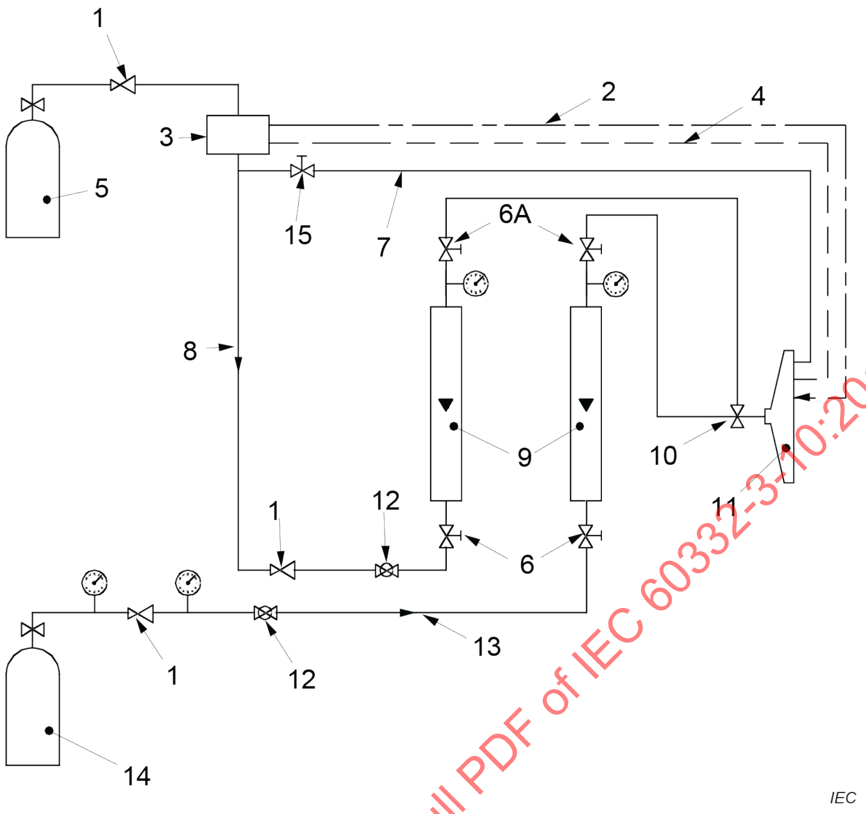
Dimensions in millimetres (approximate values)



Key

1 242 round holes, 1,32 mm in diameter on 3,2 mm centres, staggered in three rows of 81, 80 and 81 holes, centred on the face of the burner

Figure 6 – Arrangement of holes for burners



Key

1	regulator	9	~~rotameter-type~~ flowmeters
2	piezoelectric igniter	10	venturi mixer
3	flame failure device	11	burner
4	control thermocouples	12	ball valve
5	propane cylinder	13	air flow
6	screw valve (6a = alternative position)	14	compressed air cylinder
7	pilot feed	15	screw valve on pilot feed
8	gas flow		

Figure 7 – ~~Example of~~ Schematic diagram of an example of a burner control system~~s~~ using rotameters

Annex A
(informative)

Details of recommended burner and mass flowmeters[3]

A burner (catalogue number 10L11-55) and venturi mixer (catalogue number 14-18) complying with the requirements of Clause 6 can be obtained from:

~~American Gas Furnace~~
~~PO Box 496~~
~~140 Spring Street~~
~~Elizabeth, NJ 07207~~
~~USA~~

~~Tel: +1 201 352 2120~~
~~Telefax: +1 201 352 5174~~

AGF Burner, Inc.
814 Asbury Ave.
Asbury Park, NJ 07712
www.agfburner.com

Commercially available mass flowmeters suitable for use in carrying out tests according to this document are supplied by, amongst others:

– Brooks Instrument,
– KOBOLD Instruments AG.

[3] The information given in Annex A, covering named products and their suppliers, is given for the convenience of users of this document and does not constitute an endorsement by IEC of the products named. Equivalent products may be used if they can be shown to lead to the same results.

Annex B
(informative)

Flowmeter calibration correction factors

B.1 General

When using the rotameter type flowmeters to monitor the supply rate of the gases, two factors need to be considered in order to use them correctly. It is important

a) to know what the flowmeter is indicating when used under the actual operating conditions;

b) to know under what conditions of temperature and gas pressure the flowmeter was calibrated, and at what conditions it was designed to operate.

Considering point a), most flowmeters are designed to indicate the volumetric flow rate at atmospheric temperature and pressure, i.e. 20 °C and 1 bar. However, considering point b), not all flowmeters are calibrated and designed to work at the same temperature and pressure, and care should be taken to ensure that the temperature and pressure of the gas flowing through a flowmeter are correct for that particular meter. Working the flowmeter at temperatures and pressures different from these conditions requires application of a correction factor such as provided hereinafter.

B.2 Example

B.2.1 General

Assume that air flow rate of 77,7 l/min at 1 bar and 20 °C is required at the burner.

Flowmeter 1 is calibrated to operate at 2,4 bar absolute and 15 °C, but to indicate l/min at 1 bar and 15 °C.

Flowmeter 2 is calibrated to operate at 1 bar absolute and 20 °C, but to indicate l/min at 1 bar and 20 °C.

Assume that the air supply pressure up to and including the flowmeters is alternatively at 1 bar (see B.2.2) or at 2,4 bar (see B.2.3) and 20 °C.

The calibration correction factor is given as follows:

$$C = \sqrt{\frac{P_1}{P_2} \times \frac{T_2}{T_1}}$$

where

T is the absolute temperature, in kelvins (K);

P is the absolute pressure, in bars (bar);

P_1, T_1 are the calibration conditions;

P_2, T_2 are the operating conditions.

B.2.2 Air supplied at 1 bar

Flowmeter 1

This will require a correction factor to be used since the meter is operating in conditions removed from its designed operating conditions.

P_1 = 2,4 bar T_1 = 15 °C = 288 K

P_2 = 1 bar T_2 = 20 °C = 293 K

Substituting these values:

$$C = \sqrt{\frac{2,4}{1} \times \frac{293}{288}} = 1,56$$

Thus, to set a flow rate of 77,7 l/min at reference conditions, a reading on this flowmeter of 121,2 l/min (77,7 × 1,56) is required.

Flowmeter 2

Since this meter is operating under its design conditions, the required flow rate of 77,7 l/min can be read directly from the meter with no correction factor necessary.

B.2.3 Air supplied at 2,4 bar

Flowmeter 1

This will require a correction factor for temperature, but not for pressure since the meter is operating at its design pressure.

P_1 = 2,4 bar T_1 = 15 °C = 288 K

P_2 = 2,4 bar T_2 = 20 °C = 293 K

Substituting these values:

$$C = \sqrt{\frac{2,4}{2,4} \times \frac{293}{288}} = 1,01$$

Thus, to set a flow rate of 77,7 l/min at reference conditions, a reading of 78,5 l/min (77,7 × 1,01) on this flowmeter is required.

Flowmeter 2

This will also require a correction factor since it is operating in conditions removed from its design conditions.

P_1 = 1 bar T_1 = 20 °C = 293 K

P_2 = 2,4 bar T_2 = 20 °C = 293 K

Substituting these values:

$$C = \sqrt{\frac{1}{2,4} \times \frac{293}{293}} = 0,65$$

Thus, to set a flow rate of 77,7 l/min at reference conditions, a reading of 50,5 l/min (77,7 × 0,65) on this flowmeter is required.

Bibliography

ISO 13943:2017, *Fire safety – Vocabulary*

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GROUP SAFETY PUBLICATION

PUBLICATION GROUPÉE DE SÉCURITÉ

**Tests on electric and optical fibre cables under fire conditions –
Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus**

**Essais des câbles électriques et des câbles à fibres optiques soumis au feu –
Partie 3-10: Essai de propagation verticale de la flamme des fils ou câbles montés en nappes en position verticale – Appareillage**

IEC 60332-3-10:2018-07(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

TESTS ON ELECTRIC AND OPTICAL FIBRE CABLES UNDER FIRE CONDITIONS –

Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus

FOREWORD

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International Standard IEC 60332-3-10 has been prepared by IEC technical committee 20: Electric cables.

This second edition cancels and replaces the first edition published in 2000 and Amendment 1:2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) adjustments have been made to the title, and elsewhere, to emphasise the standard is applicable to optical fibre cables as well as metallic conductor types;
b) details of the way in which cables are mounted on the ladder have been better defined in order to improve repeatability and reproducibility;

c) the connection of the venturi mixer to the burner is better defined.

It has the status of a group safety publication in accordance with IEC Guide 104.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
20/1797/FDIS	20/1814/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60332 series, published under the general title *Tests on electric and optical fibre cables under fire conditions*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of October 2018 have been included in this copy.

INTRODUCTION

IEC 60332-3-10 is part of a series of publications dealing with tests on electric and optical fibre cables under fire conditions.

The IEC 60332-1 and IEC 60332-2 series specify methods of test for flame spread characteristics for a single vertical insulated wire or cable. It cannot be assumed that, because a wire or cable meets the requirements of the IEC 60332-1 and IEC 60332-2 series, a vertical bunch of similar cables or wires will behave in a similar manner. This is because flame spread along a vertical bunch of cables depends on a number of features, such as

a) the volume of combustible material exposed to the fire and to any flame which may be produced by the combustion of the cables;
b) the geometrical configuration of the cables and their relationship to an enclosure;
c) the temperature at which it is possible to ignite the gases emitted from the cables;
d) the quantity of combustible gas released from the cables for a given temperature rise;
e) the volume of air passing through the cable installation;
f) the construction of the cable, for example armoured or unarmoured, multi- or single-core.

All of the foregoing assume that the cables are able to be ignited when involved in an external fire.

The IEC 60332-3 series gives details of a test where a number of cables are bunched together to form various test sample installations. For easier use and differentiation of various test categories, the parts are designated as follows:

Part 3-10: Apparatus

Part 3-21: Category A F/R

Part 3-22: Category A

Part 3-23: Category B

Part 3-24: Category C

Part 3-25: Category D

Parts from 3-21 onwards define the various categories and the relevant procedures. The categories are distinguished by test duration, the volume of non-metallic material of the test sample and the method of mounting the sample for the test. In all categories, cables having at least one conductor of cross-sectional area greater than 35 mm^2 are tested in a spaced configuration, whereas cables of conductor cross-sectional area of 35 mm^2 or smaller and optical fibre cables are tested in a touching configuration.

The categories are not necessarily related to different safety levels in actual cable installations. The actual installed configuration of the cables may be a major determinant in the level of flame spread occurring in an actual fire.

The method of mounting described as category A F/R (Part 3-21) is intended for special cable designs used in particular installations.

Categories A, B, C and D (Part 3-22 to Part 3-25 respectively) are for general use where different non-metallic volumes are applicable.

TESTS ON ELECTRIC AND OPTICAL FIBRE CABLES UNDER FIRE CONDITIONS –

Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus

1 Scope

This part of IEC 60332 details the apparatus and its arrangement and calibration for methods of test for the assessment of vertical flame spread of vertically-mounted bunched wires or cables, electrical or optical, under defined conditions.

NOTE For the purpose of this document the term "electric wire or cable" covers all insulated metallic conductor cables used for the conveyance of energy or signals.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
ignition source
source of energy that initiates combustion

[SOURCE: ISO 13943:2017, 3.219]

4 Test environment

The test shall not be carried out if the external wind speed, measured by an anemometer fitted on the top of the test rig, is greater than 8 m/s and shall not be carried out if the temperature of the inside walls is below 5 °C or above 40 °C measured at a point approximately 1 500 mm above floor level, 50 mm from a side wall, and 1 000 mm from the door. The enclosure door shall be closed throughout the test.

5 Test apparatus

The test apparatus consists of the following.

5.1 Test chamber

The test rig (see Figures 1a) and 1b)) shall comprise a vertical test chamber having a width of (1 000 ± 100) mm, a depth of (2 000 ± 100) mm and a height of (4 000 ± 100) mm; the floor of the chamber shall be raised above ground level. The test chamber shall be nominally airtight along its sides, air being admitted at the base of the test chamber through an aperture of (800 ± 20) mm × (400 ± 10) mm situated (150 ± 10) mm from the front wall of the test chamber (see Figure 1).

An outlet (300 ± 30) mm x (1 000 ± 100) mm shall be made at the rear edge of the top of the test chamber. The back and sides of the test chamber shall be thermally insulated to give a coefficient of heat transfer of approximately 0,7 $W \cdot m^{-2} \cdot K^{-1}$. For example, a steel plate 1,5 mm to 2,0 mm thick covered with 65 mm of mineral wool with a suitable external cladding is satisfactory (see Figure 2). The distance between the ladder and the rear wall of the chamber is (150 ± 10) mm, and between the bottom rung of the ladder and the floor (400 ± 5) mm. The clearance between the lowest point of the test piece and the floor is approximately 100 mm (see Figure 3).

5.2 Air supply

A means of supplying a controlled air flow through the chamber shall be fitted.

Air shall be introduced into the test chamber through a box fitted directly underneath, and of approximately the same dimensions as the air inlet aperture. Air shall be blown into the box from a suitable fan through a straight section of duct which shall enter from the rear of the test chamber and be parallel to the floor and along the burner centre line as shown in Figure 1b). The duct shall be arranged to allow air into the box through an opening in the longest side.

A grille may be placed over the air inlet aperture to facilitate accessing the test chamber but should neither restrict the airflow nor modify its direction.

A duct of constant cross-section of approximately 240 cm^2 and minimum length of 60 cm is recommended.

Prior to burner ignition, the air flow shall be adjusted to a rate of (5 000 ± 500) l/min at a constant controlled temperature of (20 ± 10) °C and at atmospheric pressure and measured at the inlet side before the test commences. This air flow rate shall be maintained throughout the test until cable burning or glowing has ceased or for a maximum time of 1 h from completion of the test flame application period, after which period the flame or glowing shall be extinguished.

In order to remove noxious gases, it is recommended to maintain the air flow for some minutes after the end of the test, before entering the test chamber.

5.3 Ladder types

There are two types of tubular steel ladder: a standard ladder of (500 ± 5) mm width and a wide ladder of (800 ± 10) mm width. Details of the types of ladder are given in Figures 4a) and 4b).

5.4 Effluent cleaning attachment

Legal requirements may make it necessary for equipment for collecting and washing the effluent to be fitted to the test chamber. This equipment shall not cause a change in the air flow rate through the test chamber.

6 Ignition source

6.1 Type

As required by the test procedure the ignition source shall be one or two ribbon-type propane gas burners complete with venturi mixer, and their own set of flowmeters.

The distance between venturi mixer and burner shall be at least 150 mm. The inner diameter of the tubing (piping or braided flexible hose) between venturi mixer and burner shall be at least equal to the 20 mm inner diameter of the outlet of the venturi mixer.

It is recommended that the distance between venturi mixer and burner does not exceed 900 mm.

Bends between venturi mixer and burner should be minimized.

The propane gas shall be technical grade propane of nominal 95 % purity. The flame-producing surface of the burner(s) shall consist of a flat metal plate through which 242 holes of 1,32 mm in diameter are drilled on 3,2 mm centres in three staggered rows of 81, 80 and 81 holes each to form an array having the nominal dimensions 257 mm × 4,5 mm. As the burner plate may be drilled without the use of a drilling jig, the spacing of the holes may vary slightly. Additionally, a row of small holes may be milled on each side of the burner plate to serve as pilot holes with the function of keeping the flame burning.

The burners are shown in Figures 5a) and 5b), and the placement of the holes in Figure 6.

To ensure reproducibility between results from different testing stations, a burner, which is readily available, is recommended for use. For details, see Annex A.

Each burner shall be individually fitted with an accurate means of controlling the propane gas and air input flow rates, either by means of a rotameter-type flowmeter or mass flowmeter.

Mass flowmeters are recommended for ease of use.

Figure 7 shows an example of a rotameter-type system.

WARNING – The following precautions are recommended to ensure safe operation of the ignition source:

– the gas supply system should be equipped with flashback arresters;
– a flame failure protection device should be used;
– safe sequencing of the propane and air supply should be employed during ignition and extinguishing.

The calibration of the propane gas and air rotameter-type flowmeters shall be checked after installation to ensure that the pipework and venturi mixer have not affected the calibration.

Corrections for the variations in temperature and pressure from that specified on the propane gas and air rotameter-type flowmeters shall be applied when necessary, see Annex B.

Propane gas and air rotameter-type flowmeters shall be calibrated according to the following reference conditions.

Reference temperature and pressure are 20 °C and 1 bar (100 kPa).

For the purposes of this test, the air shall have a dew-point not higher than 0 °C.

The flow rates for the test shall be as follows:

Air (77,7 ± 4,8) l/min at reference conditions (1 bar and 20°C) or (1550 ± 95) mg/s;

Propane (13,5 ± 0,5) l/min at reference conditions (1 bar and 20°C) or (442 ± 11) mg/s;

to provide a nominal 73,7 x 10^6 J/h (20,5 kW)[1] to each burner.

6.2 Positioning

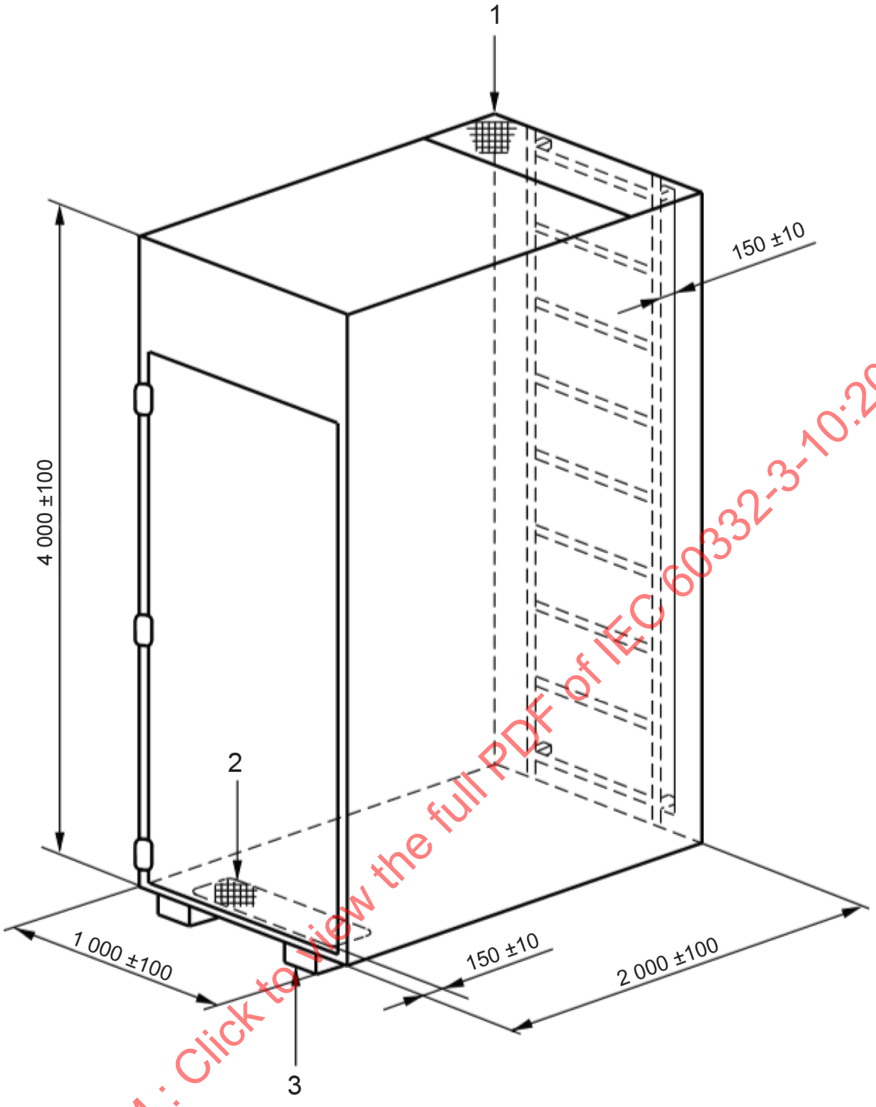
For the test, the burner shall be arranged horizontally at a distance of (75 ± 5) mm from the front surface of the cable sample, (630 ± 5) mm above the floor of the test chamber and approximately symmetrical with the axis of the ladder. The point of application of the burner flame shall lie between two cross-bars on the ladder (see Figure 2 and Figure 3).

Adjustment of air and gas flows prior to the test may be carried out away from the test position.

Where two burners are used in combination with the wide ladder, they shall be arranged so as to be approximately symmetrical with the axis of the ladder, as shown in Figure 5b). The burner system shall be positioned such that the centre line of the burner system is approximately coincident with the centre of the ladder.

1 A net heat of combustion of 46,4 kJ/g is used to calculate the propane flow rate.

Dimensions in millimetres



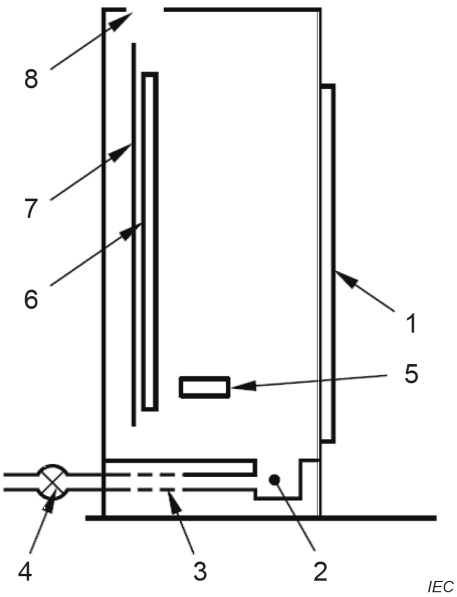
Key

1 smoke outlet (300 ± 30) × (1 000 ± 100)

2 air inlet (800 ± 20) × (400 ± 10)

3 rig raised above ground level

a) Test chamber



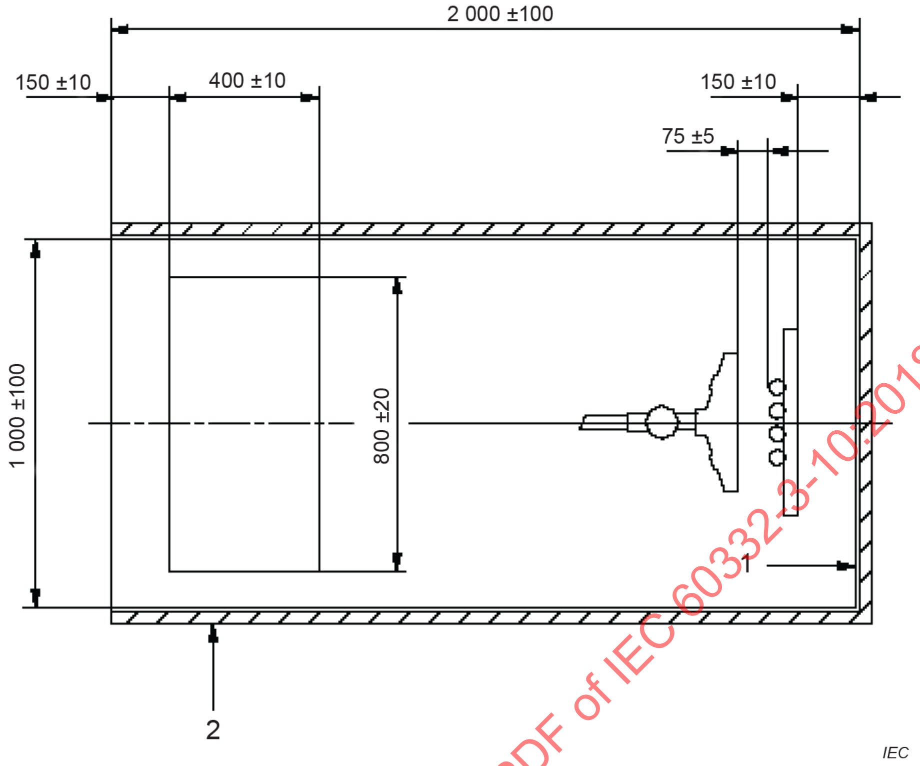
Key

1	door	5	burner
2	air inlet box	6	cables tested
3	air inlet duct	7	ladder
4	fan (illustrative position)	8	smoke outlet

b) Schematic side elevation of test chamber and air inlet arrangement

Figure 1 – Test chamber

Dimensions in millimetres



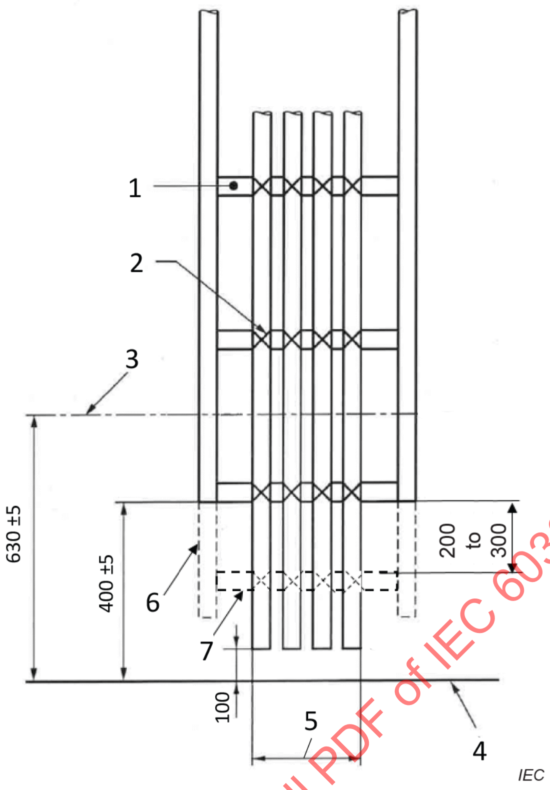
Key

1 steel plate, 1,5 mm to 2 mm thick

2 thermal insulation of mineral wool approximately 65 mm thick with suitable external cladding to give a coefficient of heat transfer of approximately 0,7 W × m^{-2} × K^{-1}

Figure 2 – Thermal insulation of back and sides of the test chamber

Dimensions in millimetres
(Dimensions are approximate except where toleranced)

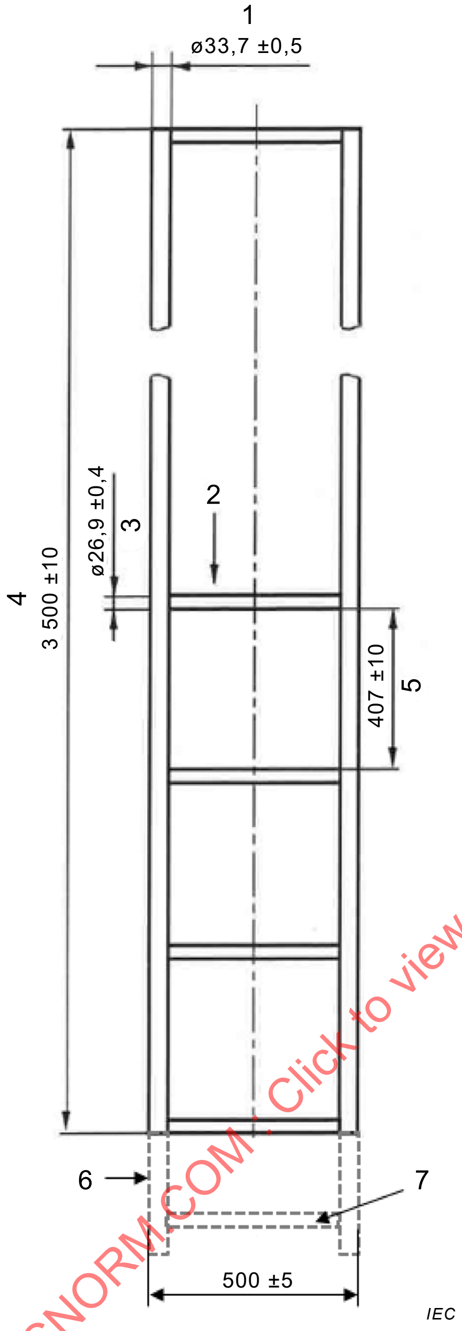


Key

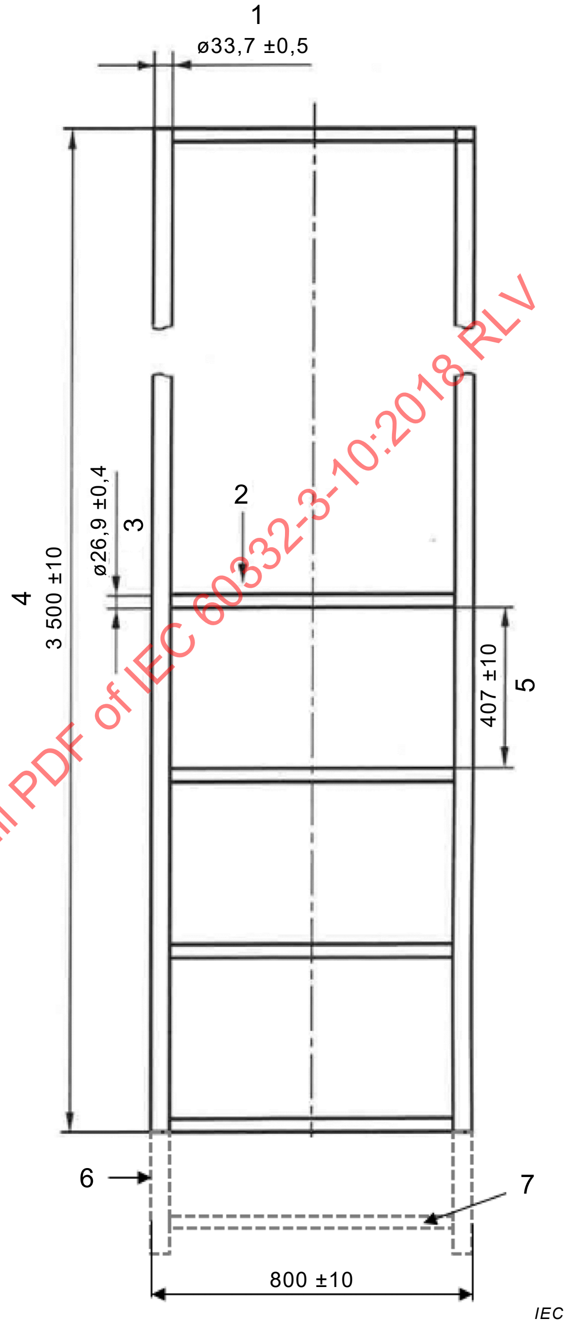
1	round steel rungs
2	metal wire ties
3	centre line of burner
4	floor
5	maximum width (according to test category)
6	optional extensions of the steel legs
7	optional steel rung

Figure 3 – Positioning of burner and typical arrangement of test sample on ladder

Dimensions in millimetres



a) **Standard ladder**



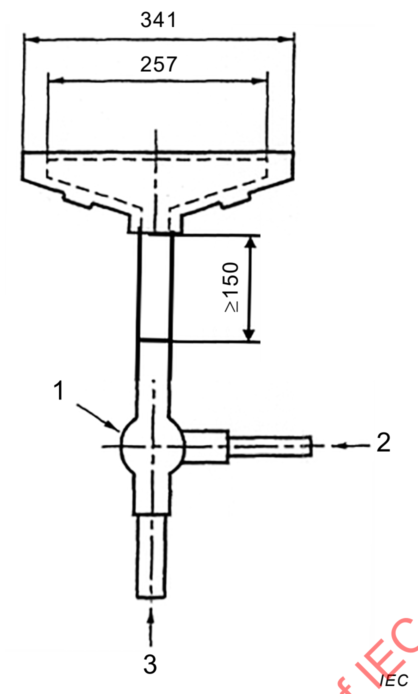
b) **Wide ladder**

Key

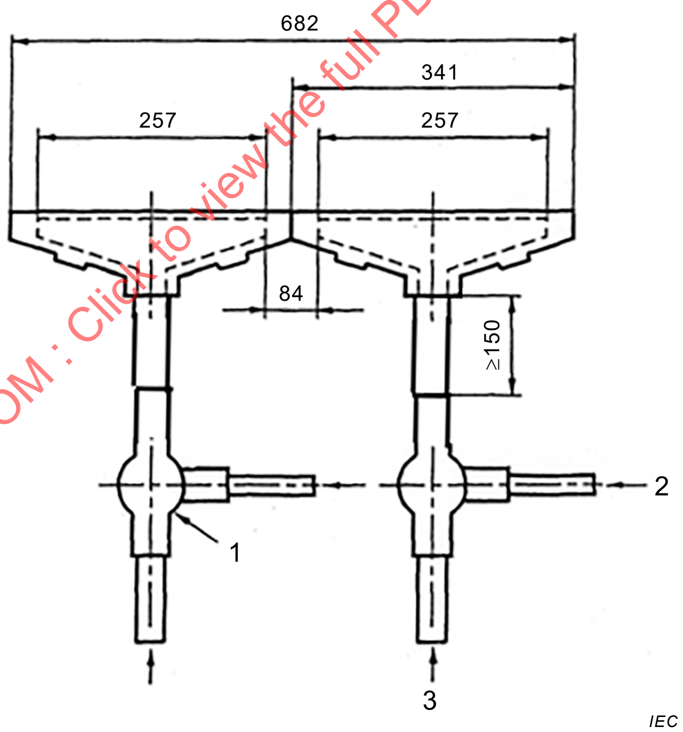
1	diameter of upright	5	distance between rungs
2	number of rungs = 9	6	optional extensions of steel legs
3	diameter of rungs	7	optional steel rung
4	total height of ladder		

Figure 4 – Tubular steel ladders for cable test

Dimensions in millimetres



a) Single burner for use with standard ladder



b) Two burner in combination for use with wide ladder

Key

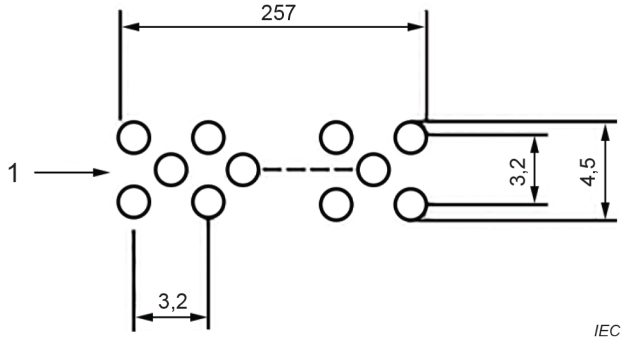
1 venturi air-gas mixer

2 propane gas entry

3 compressed air entry

Figure 5 – Burner configurations

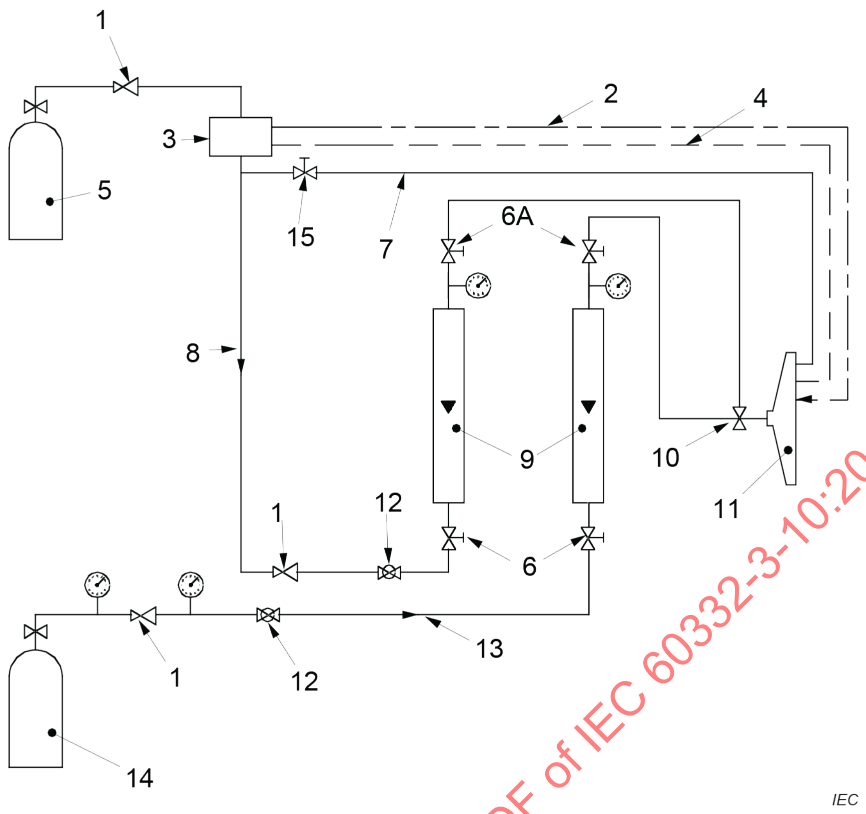
Dimensions in millimetres (approximate values)



Key

1 242 round holes, 1,32 mm in diameter on 3,2 mm centres, staggered in three rows of 81, 80 and 81 holes, centred on the face of the burner

Figure 6 – Arrangement of holes for burners



Key

1	regulator	9	flowmeters
2	piezoelectric igniter	10	venturi mixer
3	flame failure device	11	burner
4	control thermocouples	12	ball valve
5	propane cylinder	13	air flow
6	screw valve (6a = alternative position)	14	compressed air cylinder
7	pilot feed	15	screw valve on pilot feed
8	gas flow		

Figure 7 – Schematic diagram of an example of a burner control system using rotameters

Annex A
(informative)

Details of recommended burner and mass flowmeters[2]

A burner (catalogue number 10L11-55) and venturi mixer (catalogue number 14-18) complying with the requirements of Clause 6 can be obtained from:

AGF Burner, Inc.
814 Asbury Ave.
Asbury Park, NJ 07712
www.agfburner.com

Commercially available mass flowmeters suitable for use in carrying out tests according to this document are supplied by, amongst others:

– Brooks Instrument,
– KOBOLD Instruments AG.

2 The information given in Annex A, covering named products and their suppliers, is given for the convenience of users of this document and does not constitute an endorsement by IEC of the products named. Equivalent products may be used if they can be shown to lead to the same results.

Annex B
(informative)

Flowmeter calibration correction factors

B.1 General

When using the rotameter type flowmeters to monitor the supply rate of the gases, two factors need to be considered in order to use them correctly. It is important

a) to know what the flowmeter is indicating when used under the actual operating conditions;

b) to know under what conditions of temperature and gas pressure the flowmeter was calibrated, and at what conditions it was designed to operate.

Considering point a), most flowmeters are designed to indicate the volumetric flow rate at atmospheric temperature and pressure, i.e. 20 °C and 1 bar. However, considering point b), not all flowmeters are calibrated and designed to work at the same temperature and pressure, and care should be taken to ensure that the temperature and pressure of the gas flowing through a flowmeter are correct for that particular meter. Working the flowmeter at temperatures and pressures different from these conditions requires application of a correction factor such as provided hereinafter.

B.2 Example

B.2.1 General

Assume that air flow rate of 77,7 l/min at 1 bar and 20 °C is required at the burner.

Flowmeter 1 is calibrated to operate at 2,4 bar absolute and 15 °C, but to indicate l/min at 1 bar and 15 °C.

Flowmeter 2 is calibrated to operate at 1 bar absolute and 20 °C, but to indicate l/min at 1 bar and 20 °C.

Assume that the air supply pressure up to and including the flowmeters is alternatively at 1 bar (see B.2.2) or at 2,4 bar (see B.2.3) and 20 °C.

The calibration correction factor is given as follows:

$$C = \sqrt{\frac{P_1}{P_2} \times \frac{T_2}{T_1}}$$

where

T is the absolute temperature, in kelvins (K);

P is the absolute pressure, in bars (bar);

P_1, T_1 are the calibration conditions;

P_2, T_2 are the operating conditions.

B.2.2 Air supplied at 1 bar

Flowmeter 1

This will require a correction factor to be used since the meter is operating in conditions removed from its designed operating conditions.

P_1 = 2,4 bar T_1 = 15 °C = 288 K

P_2 = 1 bar T_2 = 20 °C = 293 K

Substituting these values:

$$C = \sqrt{\frac{2,4}{1} \times \frac{293}{288}} = 1,56$$

Thus, to set a flow rate of 77,7 l/min at reference conditions, a reading on this flowmeter of 121,2 l/min (77,7 × 1,56) is required.

Flowmeter 2

Since this meter is operating under its design conditions, the required flow rate of 77,7 l/min can be read directly from the meter with no correction factor necessary.

B.2.3 Air supplied at 2,4 bar

Flowmeter 1

This will require a correction factor for temperature, but not for pressure since the meter is operating at its design pressure.

P_1 = 2,4 bar T_1 = 15 °C = 288 K

P_2 = 2,4 bar T_2 = 20 °C = 293 K

Substituting these values:

$$C = \sqrt{\frac{2,4}{2,4} \times \frac{293}{288}} = 1,01$$

Thus, to set a flow rate of 77,7 l/min at reference conditions, a reading of 78,5 l/min (77,7 × 1,01) on this flowmeter is required.

Flowmeter 2

This will also require a correction factor since it is operating in conditions removed from its design conditions.

P_1 = 1 bar T_1 = 20 °C = 293 K

P_2 = 2,4 bar T_2 = 20 °C = 293 K

Substituting these values:

$$C = \sqrt{\frac{1}{2{,}4} \times \frac{293}{293}} = 0{,}65$$

Thus, to set a flow rate of 77,7 l/min at reference conditions, a reading of 50,5 l/min (77,7 × 0,65) on this flowmeter is required.

Bibliography

ISO 13943:2017, *Fire safety – Vocabulary*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

ESSAIS DES CÂBLES ÉLECTRIQUES ET DES CÂBLES À FIBRES OPTIQUES SOUMIS AU FEU –

Partie 3-10: Essai de propagation verticale de la flamme des fils ou câbles montés en nappes en position verticale – Appareillage

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La Norme internationale IEC 60332-3-10 a été préparée par le comité d'études 20 de l'IEC: Câbles électriques.

Cette deuxième édition annule et remplace la première édition parue en 2000 et l'Amendement 1:2008. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) des ajustements ont été apportés au titre, et ailleurs, afin de souligner que la Norme s'applique aux câbles à fibre optique, ainsi qu'aux types de conducteurs métalliques ;

b) les détails sur la manière dont les câbles sont montés sur l'échelle ont été mieux définis afin d'améliorer la répétabilité et la reproductibilité;

c) la connexion du mélangeur venturi au brûleur est mieux définie.

Elle a le statut d’une publication groupée de sécurité conformément au Guide IEC 104.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
20/1797/FDIS	20/1814/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60332, publiées sous le titre général *Essais des câbles électriques et des câbles à fibres optiques soumis au feu*, peut être consultée sur le site web de l'IEC.

Les futures normes de cette série porteront dorénavant le nouveau titre général cité ci-dessus. Le titre des normes existant déjà dans cette série sera mis à jour lors de la prochaine édition.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

Le contenu du corrigendum d'octobre 2018 a été pris en considération dans cet exemplaire.

INTRODUCTION

L'IEC 60332-3-10 fait partie d'une série de publications traitant des essais des câbles électriques et des câbles à fibres optiques soumis au feu.

Les séries IEC 60332-1 et IEC 60332-2 spécifient des méthodes d'essai pour caractériser la propagation de la flamme sur un fil isolé ou un câble seul en position verticale. On ne peut pas présumer que lorsqu'un fil ou câble satisfait aux exigences des séries IEC 60332-1 et IEC 60332-2, des fils ou câbles similaires disposés en nappe en position verticale se comporteront de la même façon. Cela est dû au fait que la propagation de la flamme le long d'une nappe de câbles en position verticale dépend d'un certain nombre de paramètres, tels que

a) le volume des matériaux combustibles exposés au feu et aux flammes qui peuvent être produites par la combustion des câbles;
b) la configuration géométrique des câbles et leur situation par rapport à leur environnement;
c) la température à laquelle il est possible d'enflammer les gaz émis par les câbles;
d) la quantité de gaz combustible émis par les câbles pour une élévation de température donnée;
e) le volume d'air passant à travers l'installation des câbles;
f) la construction des câbles, par exemple armés ou non armés, mono ou multiconducteurs.

Tout ce qui précède présume que les câbles peuvent être enflammés lorsqu'ils sont impliqués dans un incendie externe.

La série IEC 60332-3 donne les détails d'un essai où un certain nombre de câbles sont disposés en nappes pour constituer différentes installations des échantillons. Pour être d'un usage plus facile et pour différencier les différentes catégories d'essais, les parties sont désignées comme suit.

Partie 3-10: Appareillage

Partie 3-21: Catégorie A F/R

Partie 3-22: Catégorie A

Partie 3-23: Catégorie B

Partie 3-24: Catégorie C

Partie 3-25: Catégorie D

Les Parties 3-21 et au-delà définissent les différentes catégories et les procédures qui s'y rapportent. Les catégories sont différenciées par la durée de l'essai, le volume de matériaux non métalliques de l'échantillon d'essai et la méthode de montage de l'échantillon pour l'essai. Dans toutes les catégories, les câbles ayant au moins un conducteur de section supérieure à 35 mm^2 sont soumis à l'essai dans une configuration espacée, tandis que les câbles dont les conducteurs sont d'une section inférieure ou égale à 35 mm^2 et les câbles à fibres optiques sont soumis à l'essai dans une configuration jointive.

Les catégories ne sont pas nécessairement liées à différents niveaux de sécurité dans les installations de câbles réelles. La configuration réelle des câbles installés peut être un élément déterminant majeur dans le niveau de propagation de la flamme survenant dans un incendie réel.

La méthode de montage décrite dans la catégorie A F/R (Partie 3-21) est destinée aux câbles spéciaux utilisés dans des installations particulières.

Les catégories A, B, C et D (Parties 3-22 à 3-25 respectivement) sont pour un usage général là où des volumes de matériaux non métalliques différents sont impliqués.

ESSAIS DES CÂBLES ÉLECTRIQUES ET DES CÂBLES À FIBRES OPTIQUES SOUMIS AU FEU –

Partie 3-10: Essai de propagation verticale de la flamme des fils ou câbles montés en nappes en position verticale – Appareillage

1 Domaine d'application

La présente partie de l'IEC 60332 précise l'appareillage ainsi que sa disposition et son étalonnage pour les méthodes d'essai pour l'évaluation de la propagation verticale de la flamme des fils ou câbles, électriques ou optiques, disposés en nappes en position verticale, dans des conditions définies.

NOTE Pour les besoins du présent document, le terme «fils ou câbles électriques» couvre tous les câbles isolés à conducteur métallique utilisés pour le transport d'énergie ou de signaux.

2 Références normatives

Le présent document ne contient aucune référence normative.

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
source d'allumage
source d'énergie qui provoque une combustion

[SOURCE: ISO 13943:2017, 3.219]

4 Environnement de l'essai

L'essai ne doit pas être entrepris si la vitesse du vent à l'extérieur de la cabine, mesurée au moyen d'un anémomètre fixé au sommet de l'équipement d'essai, est supérieure à 8 m/s ainsi que lorsque la température des parois internes mesurée en un point situé approximativement à 1 500 mm au-dessus du niveau du plancher, 50 mm d'une paroi latérale et 1 000 mm de la porte est inférieure à 5 °C ou supérieure à 40 °C. La porte de l'enceinte doit être fermée tout au long de l'essai.

5 Appareillage d'essai

L'appareillage d'essai est constitué comme suit.

5.1 Chambre d'essai

L'équipement d'essai (voir Figures 1a) et 1b)) doit comprendre une chambre d'essai verticale d'une largeur de (1 000 ± 100) mm, une profondeur de (2 000 ± 100) mm et une hauteur de (4 000 ± 100) mm; le plancher de la chambre doit être surélevé par rapport au niveau du sol. La chambre d'essai doit être pratiquement étanche sur ses côtés, l'air étant admis à la base de la chambre d'essai à travers une ouverture de (800 ± 20) mm × (400 ± 10) mm située à (150 ± 10) mm de la face avant de la chambre (voir Figure 1).

Une ouverture de (300 ± 30) mm × (1 000 ± 100) mm doit être pratiquée sur la partie arrière du plafond de la chambre d'essai. L'arrière et les côtés de la chambre d'essai doivent être isolés thermiquement de telle façon que le coefficient de transmission thermique soit d'environ 0,7 $W \cdot m^{-2} \cdot K^{-1}$. Par exemple, une plaque d'acier de 1,5 mm à 2,0 mm d'épaisseur recouverte avec 65 mm de laine minérale, avec un revêtement externe approprié, donne satisfaction (voir Figure 2). La distance entre l'échelle et la paroi arrière de la chambre est de (150 ± 10) mm, et la distance entre le plancher de la chambre et le barreau inférieur de l'échelle est de (400 ± 5) mm. L'espace libre entre le point le plus bas de l'échantillon en essai et le plancher est approximativement de 100 mm (voir Figure 3).

5.2 Arrivée d'air

Un dispositif doit être adapté afin de fournir un débit d'air contrôlé à travers la chambre.

L'air doit être introduit dans la chambre d'essai en passant à travers une boîte de répartition montée directement au-dessous de la chambre et ayant approximativement les mêmes dimensions que l'ouverture pour l'entrée de l'air. L'air doit être soufflé dans la boîte de répartition au moyen d'un ventilateur approprié, en passant à travers un conduit de section droite constante qui doit entrer par l'arrière de la chambre et être parallèle au sol et le long de la ligne centrale du brûleur, comme présenté en Figure 1b). Le conduit doit être disposé de façon à faire entrer l'air dans la boîte de répartition par une ouverture dans son côté le plus long.

Une grille peut être placée sur l'ouverture de l'entrée d'air pour faciliter l'accès à la chambre d'essai, mais il convient que la grille ne dévie pas le flux d'air ni le réduise.

Un conduit de section constante d'environ 240 cm^2 et de longueur minimum de 60 cm est recommandé.

Avant d'allumer le brûleur, le débit d'air doit être réglé à une valeur de (5 000 ± 500) l/min à une température constante contrôlée de (20 ± 10) °C et à la pression atmosphérique, et mesuré à l'entrée avant le début de l'essai. Cette valeur du débit d'air doit être maintenu tout au long de l'essai jusqu'à ce que la combustion du câble ou son incandescence ait cessé, ou pendant une durée maximale d'une heure à partir de la fin de la période d'application de la flamme d'essai, période après laquelle la flamme ou l'incandescence doit être éteinte.

De façon à éliminer les gaz nocifs, il est recommandé de poursuivre la ventilation d'air pendant quelques minutes après la fin de l'essai avant d'entrer dans la chambre d'essai.

5.3 Type d'échelles

Il y a deux types d'échelles en tube d'acier: une échelle standard de largeur (500 ± 5) mm et une échelle large de largeur (800 ± 10) mm. Les détails des types d'échelles sont donnés aux Figures 4a) et 4b).

5.4 Accessoire de lavage des effluents

Certaines exigences légales peuvent rendre nécessaire l'adaptation à la chambre d'essai d'un équipement pour la captation et le lavage des effluents. Cet équipement ne doit pas occasionner de modification dans le débit d'air traversant la chambre d'essai.

6 Source d'allumage

6.1 Type

Selon les exigences de la procédure d'essai, la source d'allumage doit être constituée par un ou deux brûleurs du type ruban à gaz propane complet avec mélangeur venturi, et leur jeu complet de débitmètres.

La distance entre le mélangeur venturi et le brûleur doit être d'au moins 150 mm. Le diamètre intérieur du tube (canalisation ou tuyau flexible tressé) entre le mélangeur venturi et le brûleur doit être au moins égal au diamètre intérieur de 20 mm de l'ouverture du mélangeur venturi.

Il est recommandé que la distance entre le mélangeur venturi et le brûleur ne dépasse pas 900 mm.

Il convient de réduire au maximum les courbures entre le mélangeur venturi et le brûleur.

Le gaz propane doit être de grade technique d'une pureté nominale de 95 %. La surface productrice de flamme du ou des brûleurs doit consister en une plaque plate métallique percée de 242 trous de 1,32 mm de diamètre, placés en quinconce à 3,2 mm de distance, sur trois rangées de 81, 80 et 81 trous inscrits dans un rectangle de dimensions 257 mm × 4,5 mm. Comme la surface du brûleur peut être percée sans utiliser de gabarit de perçage, la distance entre les trous peut varier légèrement. En outre, une rangée de petits trous peut être percée de chaque côté de la surface du brûleur pour servir de trous pilotes ayant pour fonction de garder la flamme allumée.

Les brûleurs sont représentés aux Figures 5a) et 5b), et l'emplacement des trous à la Figure 6.

Pour s'assurer de la reproductibilité des résultats provenant des différents laboratoires d'essai, il est recommandé d'utiliser un brûleur aisément disponible. Pour les détails, voir l'annexe A.

Chaque brûleur doit être muni individuellement d'un système précis de contrôle des débits de gaz propane et d'air, au moyen soit d'un débitmètre à flotteur soit d'un débitmètre massique.

Il est recommandé d'utiliser des débitmètres massiques en raison de leur facilité d'emploi.

La Figure 7 montre un exemple de système de contrôle par débitmètre à flotteur.

AVERTISSEMENT – Il est recommandé de prendre les précautions suivantes pour s'assurer d'un fonctionnement sans danger de la source d'allumage:

– équiper le système d'alimentation en gaz avec des dispositifs d'arrêt en cas de retour de flamme;
– utiliser un système de protection en cas d'arrêt de la flamme;
– utiliser une séquence sans danger pour l'alimentation en propane et en air lors de l'allumage et lors de l'extinction du brûleur.

L'étalonnage des débitmètres à flotteur du propane et de l'air doit être vérifié après installation afin de s'assurer que la canalisation et le venturi n'ont pas modifié l'étalonnage.

Si nécessaire, des facteurs de correction de température et de pression doivent être appliqués par rapport à ce qui est spécifié pour les débitmètres à flotteur du propane et de l'air; voir Annexe B.

Les débitmètres à flotteur du gaz et de l'air doivent être étalonnés conformément aux conditions de référence suivantes.

Température et pression de référence: 20 °C et 1 bar (100 kPa).

Pour les besoins de cet essai, l'air doit avoir un point de rosée au plus égal à 0 °C.

Les débits pour l'essai doivent être comme suit:

Air	(77,7 ± 4,8) l/min dans les conditions de référence (1 bar et 20 °C) ou (1 550 ± 95) mg/s;
Propane	(13,5 ± 0,5) l/min dans les conditions de référence (1 bar et 20 °C) ou (442 ± 11) mg/s;

pour fournir une puissance nominale de 73,7 x 10^6 J/h (20,5 kW)[1] à chaque brûleur.

6.2 Positionnement

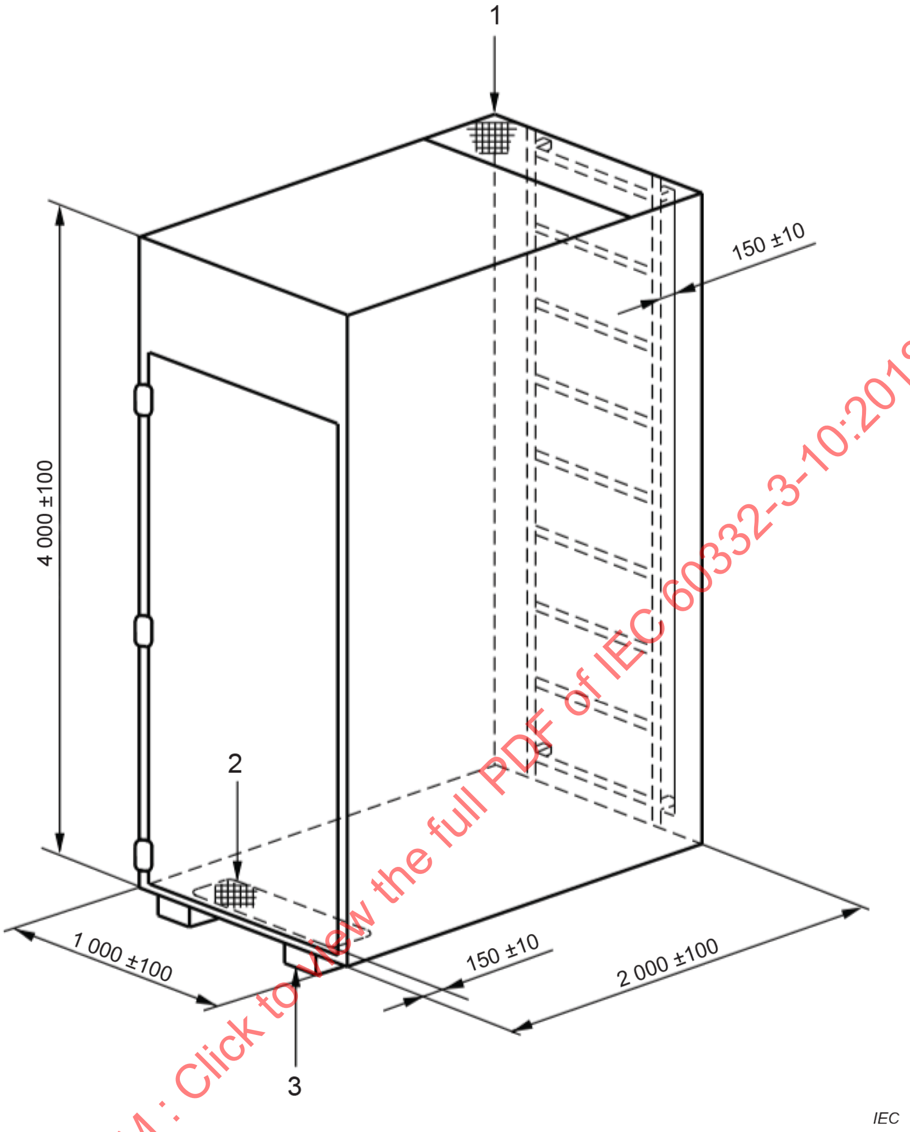
Pour l'essai, le brûleur doit être placé horizontalement à une distance de (75 ± 5) mm de la face avant de la nappe de câbles, à (630 ± 5) mm au-dessus du plancher de la chambre d'essai et approximativement symétrique par rapport à l'axe de l'échelle. Le point d'application de la flamme du brûleur doit se situer entre deux barreaux de l'échelle (voir Figure 2 et Figure 3).

Le réglage des débits d'air et de gaz avant l'essai peut être effectué hors de la position d'essai.

Lorsque deux brûleurs sont utilisés en combinaison avec l'échelle large, ils doivent être positionnés de façon à être approximativement symétriques par rapport à l'axe de l'échelle, comme indiqué sur la Figure 5b). Le système de brûleurs doit être positionné de telle façon que la ligne médiane du système de brûleurs coïncide approximativement avec le centre de l'échelle.

1 Un pouvoir calorifique de 46,4 kJ/g est utilisé pour calculer le débit du propane.

Dimensions en millimètres



Légende

1 sortie de fumées (300 ± 30) × (1 000 ± 100)

2 entrée d'air (800 ± 20) × (400 ± 10)

3 équipement surélevé par rapport au niveau du sol

a) Chambre d'essai