

INTERNATIONAL STANDARD

NORME INTERNATIONALE

GROUP SAFETY PUBLICATION
PUBLICATION GROUPEE 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**



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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.

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

IEC 60332-3-10 forms one of a series of publications dealing with tests on electric cables under fire conditions; the series supersedes IEC 60332-3 published in 1992. The parts of the series are described in the introduction.

All pre-existing categories of test are retained and updated. A new category (category D) has been added to cater for testing at very low non-metallic volumes.

This consolidated version of IEC 60332-3-10 consists of the first edition (2000) [documents 20/402/FDIS and 20/426/RVD] and its amendment 1 (2008) [documents 20/933/CDV and 20/982A/RVC].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

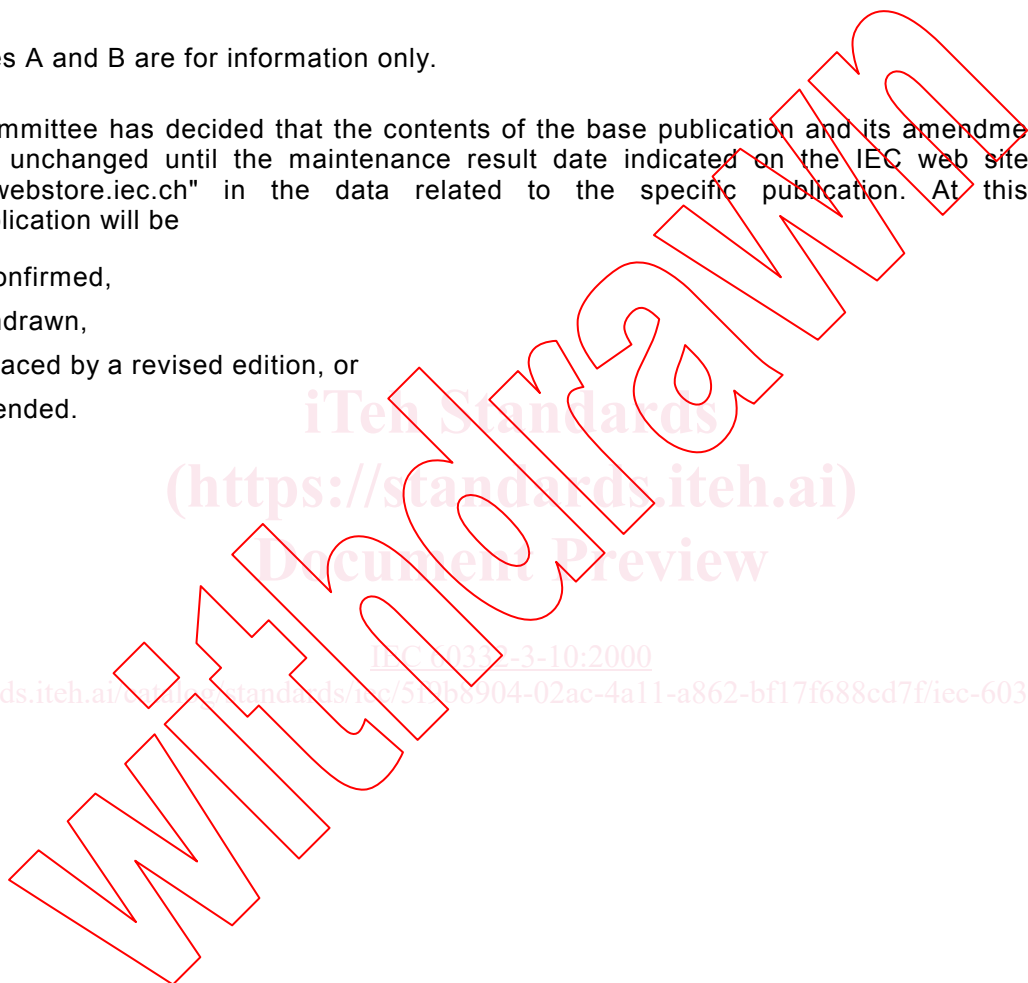
It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

Annexes A and B are for information only.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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- replaced by a revised edition, or
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INTRODUCTION

Parts 1 and 2 of IEC 60332 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 parts 1 and 2, 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.

Part 3 of IEC 60332 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 mm² are tested in a spaced configuration, whereas cables of conductor cross-sectional area of 35 mm² or smaller 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 in category A F/R (part 3-21) is intended for special cable designs used in particular installations.

Categories A, B, C and D (parts 3-22 to 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

The series of International Standards covered by Parts 3-10, 3-21, 3-22, 3-23, 3-24 and 3-25 of IEC 60332 specifies 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 standard the term “electric wire or cable” covers all insulated metallic conductor cables used for the conveyance of energy or signals.

This part of IEC 60332 details the apparatus and its arrangement and calibration.

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) applies.

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*

3 Definitions

For the purpose of this part of IEC 60332 the following definition applies. The definition is taken from IEC 60695-4.

3.1

ignition source

source of energy that initiates combustion

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 $(1\ 000 \pm 100)$ mm, a depth of $(2\ 000 \pm 100)$ mm and a height of $(4\ 000 \pm 100)$ 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 \times (400 ± 10) mm situated (150 ± 10) mm from the front wall of the test chamber (see figure 1).

An outlet (300 ± 30) mm \times $(1\ 000 \pm 100)$ 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 $0,7\ \text{W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$. 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.

NOTE 1 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.

NOTE 2 A duct of constant cross-section of approximately $240\ \text{cm}^2$ and minimum length of 60 cm is recommended.

Prior to burner ignition, the air flow shall be adjusted to a rate of $(5\ 000 \pm 500)$ 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 3 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 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 – 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 purpose 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 $(77,7 \pm 4,8)$ l/min at reference conditions (1 bar and 20 °C) or $(1\,550 \pm 140)$ mg/s

Propane $(13,5 \pm 0,5)$ l/min at reference conditions (1 bar and 20 °C) or (442 ± 10) mg/s

to provide a nominal $(73,7 \pm 1,68) \times 10^6$ J/h ($(70\,000 \pm 1\,600)$ Btu/h). ¹⁾

NOTE 3 A net heat of combustion of 46,4 kJ/g is used to calculate the propane flow rate.

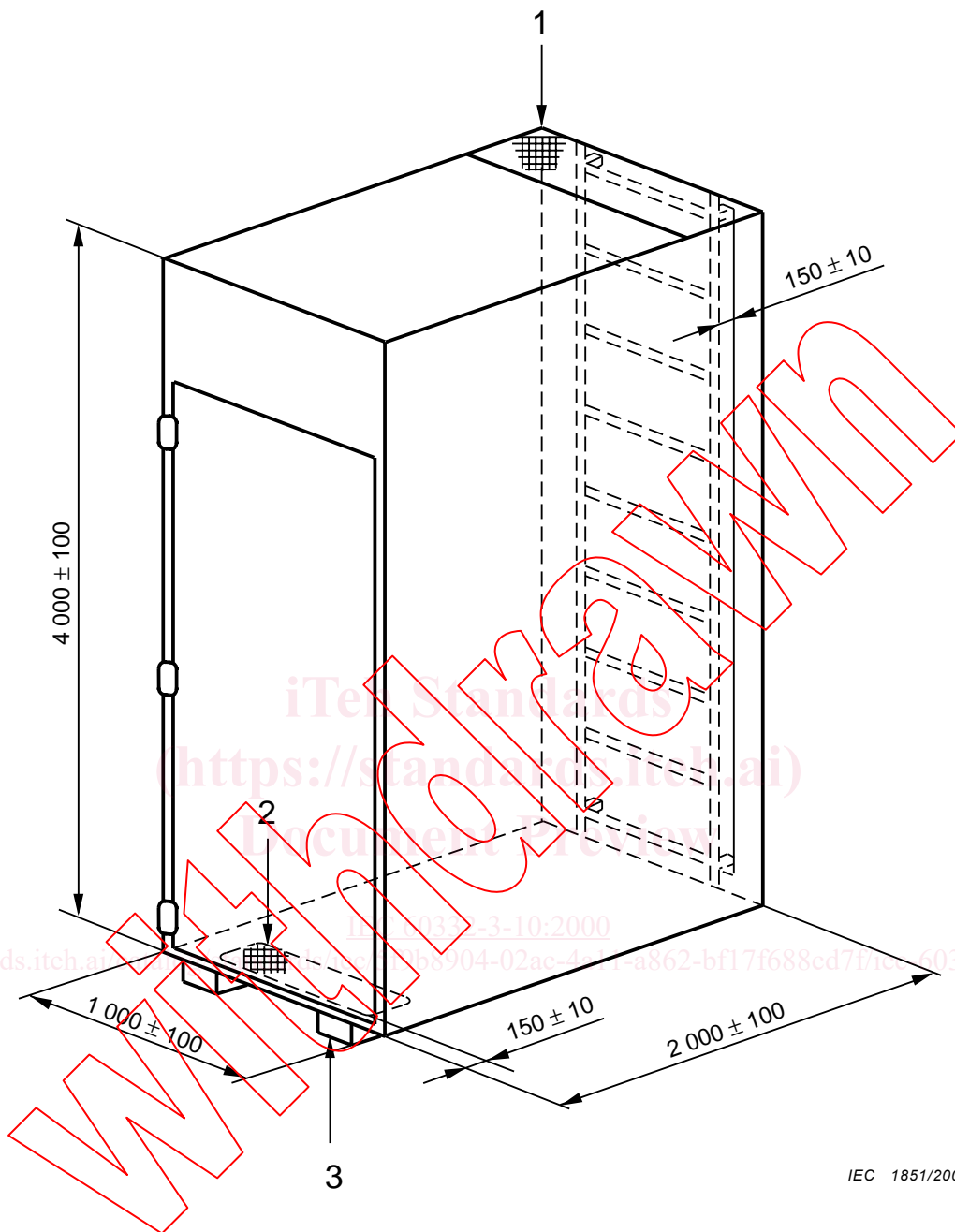
6.2 Positioning

For the test, the burner shall be arranged horizontally at a distance of (75 ± 5) mm from the front surface of the cable sample, (600 ± 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⁾ This is also equivalent to $(20,5 \pm 0,5)$ kW.



Key

- 1 Smoke outlet $(300 \pm 30) \times (1\,000 \pm 100)$
- 2 Air inlet $(800 \pm 20) \times (400 \pm 10)$
- 3 Rig raised above ground level

IEC 1851/2000

Dimensions in millimetres

Figure 1a – Test chamber