RAPORT TECHNIQUE

TECHNICAL REPORT

CEI
IEC
332-3

Deuxième édition
Second edition
1992-03

Essais des câbles électriques soumis au feu

Partie 3:
Essais sur des fils ou câbles en nappes

Tests on electric cables under fire conditions

Part 3:
Tests on bunched wires or cables

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

TESTS ON ELECTRIC CABLES UNDER FIRE CONDITIONS

Part 3: Tests on bunched wires or cables

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This Technical Report has been prepared by Sub-Committee 20C: Burning characteristics of electric cables, of IEC Technical Committee No. 20: Electric cables.

This second edition of IEC 332-3 replaces the first edition issued in 1982 and Amendment 2 (1987).

The text of this report is based on the following documents:

Six Months' Rule	Report on Voting
20C(CO)3	20C(CO)8

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

This report is a Technical Report of type 2. It is not to be regarded as an International Standard.

A review of this Technical Report will be carried out not later than three years after its publication with the options of: extension for another three years, conversion into an International Standard, or withdrawal.

INTRODUCTION

Parts 1 and 2 of IEC 332 specify methods of test for flame propagation characteristics for a single vertical insulated wire or cable. It cannot be assumed that, because a cable or wire meets the requirements of parts 1 and 2, a bunch of similar cables or wires will behave in a similar manner. This is because the propagation of flame along a 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, e.g. armoured or unarmoured.

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

This report gives details of a test where a number of cables are bunched together to form various test sample installations. Three sections, 3 to 5, provide details of different test categories having varying volumes of non-metallic material per metre of the test sample subjected to the test.

The method of mounting described as category A, designation F/R in section 3 is intended for special cable designs used in particular installations, e.g. power stations.

The method of mounting described as category A, designation F in section 3 is introduced so that a consistent comparison with sections 4 and 5 can be made on the effect of increased volume of non-metallic material and test duration.

TESTS ON ELECTRIC CABLES UNDER FIRE CONDITIONS

Part 3: Tests on bunched wires or cables

SECTION 1 : GENERAL

1.1 Scope

This Technical Report describes a method of type approval testing to define the ability of bunched cables to restrain flame propagation in defined conditions regardless of their application, i.e. power, telecommunications (including data transmission and optical fibre cables), etc.

Three categories are defined and distinguished by test duration, and the volume of non-metallic material of the sample under test (see table 1); they are not necessarily related to different safety levels in actual cable installations. Category A has two designations for the method of mounting.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 332-1: 1979, *Tests on electric cables under fire conditions - Part 1: Test on a single vertical insulated wire or cable.*

IEC 332-2: 1989, *Tests on electric cables under fire conditions - Part 2: Test on a single small vertical insulated copper wire or cable.*

IEC 811-1-3: 1985, *Common test methods for insulating and sheathing materials of electric cables - Part 1: Methods for general application - Section 3: Methods for determining the density - Water absorption tests - Shrinkage test.*

SECTION 2 : GENERAL DETAILS OF TEST PROCEDURES

2.1 Test sample and categories

The test sample should comprise a number of test pieces of cable from the same length, each having a minimum length of 3,5 m.

The total number of 3,5 m test pieces in the test sample should be in accordance with one of the three categories as follow:

Category A
The number of test pieces required to provide a nominal total volume of non-metallic material of 7 litres per metre.

Category B
The number of test pieces required to provide a nominal total volume of non-metallic material of 3,5 litres per metre.

Category C
The number of test pieces required to provide a nominal total volume of non-metallic material of 1,5 litres per metre.

2.2 Details of the test rig

2.2.1 *Enclosure and air supply*

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

The air flow should be adjusted to a rate of 5 000 l/min ± 500 l/min at a constant controlled temperature of (20 ± 10) °C and measured at the outlet or inlet side before the test commences. These parameters should be preferably regulated during the test.

An outlet 300 mm ± 30 mm x 1 000 mm ± 100 mm should be made at the rear edge of the top of the test chamber. The back and sides of the test chamber should be thermally insulated to give a coefficient of heat transfer of approximately 0,7 $W/(m^2 \cdot K)$. 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 1a). The distance between the ladder and the rear wall of the chamber is 150 mm ± 10 mm, and between the bottom rung of the ladder and the ground 400 mm ± 5 mm. The clearance between the lowest point of the test piece and the ground is approximately 100 mm (see figure 3).

2.2.2 *Ladder types*

There are two types of ladder; a standard ladder of 500 mm width and a wide ladder of 800 mm width. Details of the types of ladder and the methods of mounting to be used are provided in sections 3 to 5 of this report (see figures 2, 2a, 3, 3a, 3b, 3c and 3d).

2.2.3 *Smoke cleaning attachment*

Legal requirements may make it necessary for equipment for collecting and washing the smoke to be fitted to the test chamber. This equipment should be such as to collect the smoke leaving the chamber without causing a change in the air flow rate through the test chamber.

2.3 Determination of number of test pieces

In order to calculate the appropriate number of test pieces, it is necessary to determine the volume per metre of non-metallic material of one test piece.

A section of cable which should not be less than 0,3 m is carefully cut to ensure that the surfaces are at right angles to the cable axis, thus enabling precise measurements of its length.

Each non-metallic material C_i should be extracted from the test piece and weighed. Any less than 5 % of the total non-metallic weight should be discarded.

Where semi-conducting screens cannot be removed from the insulating material, the components may be considered as one for the purpose of measuring their weight and specific gravity.

The specific gravity of each non-metallic component (including cellular material) should be measured in an appropriate way, e.g. clause 8 of IEC 811-1-3, in order to obtain values expressed to the second decimal place. Tapes and fibrous components should be assumed to have an effective specific gravity of 1.

The volume V_i (litres per metre of cable) of each non-metallic material C_i is calculated as follows:

$$V_i = \frac{M_i}{\rho_i \times l}$$

where

M_i is the mass of the component C_i (kg)

ρ_i is the specific gravity of the component C_i (kg/dm³)

l is the length of the section of cable (m)

The total volume, V, of the non-metallic materials contained in one metre of cable is equal to the sum of the individual volumes V_1, V_2, etc.

The closest integer (0,5 and above corresponding to 1) of the number of test pieces to be mounted is obtained by dividing the volume per metre of the test category specified in clause 2.1 of this section by the total volume, V, of non-metallic material per metre of cable.

2.4 Mounting of the test sample

The methods of mounting the pre-determined number of test pieces to form the test sample are fully described in sections 3, 4 and 5.

Two methods of mounting (designations F/R and F) are applicable to category A. Only designation F applies to categories B and C.

For identification purposes the following abbreviated notations may be used:

Category A, designation F/R - 332-3A F/R

Category A, designation F - 332-3A F

Category B, designation F - 332-3B F

Category C, designation F - 332-3C F

2.5 Ignition source

The ignition source should be one or two ribbon-type propane gas burners and their own set of flow meters, complete with venturi mixer, and whose flame-producing surface consists of a flat metal plate 341 mm long and 30 mm wide 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 x 4,5 mm as shown in figure 4. 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.

NOTE - To ensure reproducibility between results from different testing stations, it is recommended that the proposed burner, which is readily available, be used. For details, see annex A.

Each burner should be fitted with an accurate means of controlling the fuel and air input flow rates. Figure 5 shows an example of a control system. The calibration of the propane rotameter should be checked after installation with a flow meter to ensure that the pipe-work and the venturi have not affected the calibration.

Corrections for the variations in temperature and pressure from that specified on the propane rotameter should be applied when necessary.

For the purpose of this test, the air should have a dew-point not higher than 0 °C and the input should be 76,7 l/min ± 4,7 l/min; the propane flow rate should be 13,3 l/min ± 0,5 l/min at one atmosphere and 20 °C to provide a nominal 73,7 ± 1,68 x 10^6 J/h (70 000 ± 1 600 Btu/h)* to each burner.

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

2.6 Positioning of ignition source

For the test the burner should be arranged horizontally at a distance of 75 mm ± 5 mm from the front surface of the cable sample and 600 mm ± 5 mm above the floor of the test chamber. The point of application of the burner flame should lie in the centre between two cross-bars on the ladder and at least 500 mm ± 5 mm above the lower end of the sample (see 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 tandem for the test category A designation F in combination with the wide ladder - see section 3 - they should be positioned as shown in figure 4a.

* This is also equivalent to 20,5 kW ± 0,5 kW.

2.7 Test procedure

2.7.1 *Test conditions*

The test should 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 should not be carried out if the temperature of the inside walls is below 5 °C or above 40 °C measured at a point approximately 1,5 m above floor level, 50 mm from a side wall, and 1,0 m from the door. The enclosure door shall be closed throughout the test.

The cables or test pieces forming the test sample should be conditioned at a temperature of (23 ± 5) °C for at least 16 h before commencing the test. The test chamber should be dry.

2.7.2 *Flame application times*

See sections 3, 4 and 5.

2.8 Performance requirements and retest procedure

2.8.1 *Performance requirement*

After burning has ceased, the test sample should be wiped clean. If burning has not ceased after a maximum time of 1 h from the completion of the test flame period, the flame should be extinguished.

All soot is to be ignored if, when wiped off, the original surface is undamaged. Softening or any deformation of the non-metallic material is also to be ignored. The maximum extent of the damage is measured to one decimal place from the bottom edge of the burner to the onset of char, which is defined as follows:

> Press against the cable surface with a sharp object, e.g. a knife blade. Where the surface changes from a resilient to a brittle (crumbling) surface, this indicates the onset of char.

The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2,5 m above the bottom edge of the burner, neither at the front nor the rear of the ladder.

2.8.2 *Retest procedure*

In the case of doubt, two further tests should be undertaken as detailed in clause 2.7. The test should be deemed as satisfactory if both tests meet the requirements of 2.8.1.

2.9 Measurement of oxygen index (OI)

If required, the oxygen index of all non-metallic materials should be measured in accordance with the procedure given in annex B. Components contributing less than 5 % of the non-metallic weight may be ignored.

The values of OI should be recorded and may be used as a basis for quality control of any subsequent production to ensure compliance with the type approval test.

Correlation of the OI values with propagation along the cables under fire conditions is not implied.

2.10 Guidance for cable selection for type approval test

The choice of conductor cross-section for type approval tests should be agreed between purchaser and manufacturer but it shall comply with the following restrictions:

The limited capacity of the ladders requires consideration of the conductor cross-section selected for testing to ensure that the volume of non-metallic material can be accommodated within the prescribed method of mounting. Moreover, the testing of a sample consisting of a single test piece shall also be avoided.

Category A, designation F/R

For cables having a conductor cross-section greater than 35 mm², the selection of cable shall not require the placement on each face of the ladder of more cables than the number necessary to form a single layer of 300 mm width on each side, allowing for a space between each cable equal to half the cable diameter but not exceeding 20 mm.

Category A, designation F

For cables having a conductor cross-section greater than 35 mm², the selection of cable shall not require the placement on a single face of the ladder of more cables than the number necessary to form a single layer of 600 mm width, allowing for a space between each cable equal to half the cable diameter but not exceeding 20 mm.

Category B, designation F

For cables having a conductor cross-section greater than 35 mm², the selection of cable shall not require the placement on a single face of the ladder of more cables than the number necessary to form a single layer of 300 mm width, allowing for a space between each cable equal to half the cable diameter but not exceeding 20 mm.

Category C, designation F

The size of cable selected shall require a sample of at least two test pieces to be mounted.

For cables having a conductor cross-section greater than 35 mm², the selection of cable shall not require the placement on a single face of the ladder of more cables than the number necessary to form a single layer of 300 mm width, allowing for a space between each cable equal to half the cable diameter but not exceeding 20 mm.

Where designation F is used for categories A, B and C, and where the cable size is 35 mm² or smaller, there is no restriction on the conductor cross-section selected. This applies also to telecommunication, data transmission and optical cables.

This information is summarized in table 2.

SECTION 3 : METHOD OF MOUNTING TEST SAMPLES AND FLAME APPLICATION TIMES, FOR CATEGORY A, DESIGNATION F/R OR F

3.1 Selection of test pieces

The number of test pieces should be selected to provide a nominal total non-metallic volume of 7 litres/metre calculated according to clause 2.3. A summary of the test conditions is given in table 1. For type approval test the cable conductor cross-sections should be chosen in accordance with clause 2.10 and table 2.

3.2 Method of attachment

For cables having a conductor cross-section exceeding 35 mm², each test piece should be attached individually to each rung of the ladder by means of a metal wire (steel or copper) between 0,5 mm and 1,0 mm in diameter.

For cables with a conductor cross-section of 35 mm² or less, the same method should be used whenever the test pieces are mounted in a single layer.

If several layers are required to make up a test sample, the test pieces should be attached in discrete bundles of a width equal to five test pieces using the specified metal wire, each separate bundle being attached to that adjacent by the outer test pieces. For consistency it is recommended that discrete bunches touching are secured together at every rung (see figure 3d).

3.3 Positioning of test samples

3.3.1 *Cables with a conductor cross-section not exceeding 35 mm²*

For such cables, only the method of mounting designation F is applicable. The test pieces should be placed touching on the front of the standard ladder in one or more layers so that the width of test sample does not exceed 300 mm. There should be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

3.3.2 *Cables with a conductor cross-section exceeding 35 mm²*

For such cables, two methods of mounting are given (see table 1).

3.3.2.1 *Designation F/R*

The test pieces should be attached to the front of the standard ladder in a single layer up to a total width of 300 mm with a space between each test piece of 0,5 x the cable diameter but not exceeding 20 mm. The remaining test pieces should be mounted on the rear of the ladder starting from the centre (see figure 3c) with a maximum width of 300 mm. There should be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

3.3.2.2 *Designation F*

The test pieces should be attached in a single layer to the front of the ladder with a space between each test piece of 0,5 x the cable diameter but not exceeding 20 mm. The ladder may be either standard or wide depending on whichever is necessary to ensure that the gap between the edges of the test sample and the inside of the ladder uprights is not less than 50 mm, i.e. the maximum width of the test sample for the standard ladder should be 300 mm and for the wide ladder 600 mm (see figures 3a and 3b).

3.4 Flame application time

For both F and F/R designations, and all sizes of conductor cross-section, the test flame should be applied for 40 min.

SECTION 4 : METHOD OF MOUNTING TEST SAMPLES AND FLAME APPLICATION TIMES, FOR CATEGORY B, DESIGNATION F

4.1 Selection of test pieces

The number of test pieces should be selected to provide a nominal total non-metallic volume of 3,5 litres per metre calculated according to clause 2.3. A summary of the test conditions is given in table 1. For type approval tests, the cable conductor cross-sections should be chosen in accordance with clause 2.10 and table 2.

4.2 Method of attachment

For cables having a conductor cross-section exceeding 35 mm², each test piece should be attached individually to each rung of the ladder by means of a metal wire (steel or copper) between 0,5 mm and 1,0 mm in diameter.

For cables with a conductor cross-section of 35 mm² or smaller, the same method should be used whenever the test pieces are mounted in a single layer.

If several layers are required to make up a test sample, the test pieces should be attached in discrete bundles of a width equal to five test pieces using the specified metal wire, each separate bundle being attached to that adjacent by the outer test pieces. For consistency it is recommended that discrete bunches touching are secured together at every rung (see figure 3d).

4.3 Positioning of test samples

4.3.1 *Cables with a conductor cross-section not exceeding 35 mm²*

The test pieces should be placed touching on the front of the standard ladder in one or more layers so that the width of the test sample does not exceed 300 mm. There should be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

4.3.2 *Cables with any conductor cross-section exceeding 35 mm²*

The test pieces should be attached in a single layer to the front of the standard ladder with a space between each test piece of 0,5 x cable diameter but not exceeding 20 mm. The maximum width of test sample should be 300 mm (see figure 3a). There should be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

4.4 Flame application time

For all sizes of conductor cross-section, the test flame should be applied for 40 min.

SECTION 5 : METHOD OF MOUNTING TEST SAMPLES AND FLAME APPLICATION TIMES, FOR CATEGORY C, DESIGNATION F

5.1 Selection of test pieces

The number of test pieces should be selected to provide a nominal total non-metallic volume of 1,5 litres per metre calculated according to clause 2.3. A summary of test conditions is given in table 1. For type approval tests the cable conductor cross-sections should be chosen in accordance with clause 2.10 and table 2.

5.2 Method of attachment

For cables having a conductor cross-section exceeding 35 mm², each test piece should be attached individually to each rung of the ladder by means of a metal wire (steel or copper) between 0,5 mm and 1,0 mm in diameter.

For cables with conductor cross-section 35 mm² or smaller, the same method should be used whenever the test pieces are mounted in a single layer.

If several layers are required to make up a test sample, the test pieces should be attached in discrete bundles of a width equal to five test pieces using the specified metal wire, each separate bundle being attached to that adjacent by the outer test pieces. For consistency it is recommended that discrete bundles touching are secured together at every rung (see figure 3d).

5.3 Positioning of test samples

5.3.1 *Cables with a conductor cross-section not exceeding 35 mm²*

The test pieces should be placed touching on the front of the standard ladder in one or more layers so that the width of test sample does not exceed 300 mm. There should be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

5.3.2 *Cables with a conductor cross-section exceeding 35 mm^2*

The test pieces should be attached in a single layer to the front of the standard ladder with a space between each test piece of 0,5 x the cable diameter but not exceeding 20 mm. The maximum width of the test sample should be 300 mm (see figure 3a). There should be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

5.4 Flame application time

For all sizes of conductor cross-section, the test flame should be applied for 20 min.

Table 1 - Summary of test conditions

Category and designation	A F/R	A F			B F		C F	
Range of conductor cross-sections (mm²)	> 35 [1]	≤ 35 [2]	> 35 [1]		≤ 35 [2]	> 35 [1]	≤ 35 [2]	> 35 [1]
Non-metallic volume per metre of test sample (l)	7	7	7	7	3,5	3,5	1,5	1,5
Number of layers: For the standard ladder: Maximum width of test sample: 300 mm	2 (front and rear of ladder)	≥ 1	1	–	≥ 1	1	≥ 1	1
For the wide ladder: Maximum width of test sample: 600 mm	-	-	-	1	-	-	-	-
Positioning of test pieces	spaced	touching	spaced		touching	spaced	touching	spaced
Flame application time (min)	40	40	40		40		20	
Number of burners	1	1	1	2	1	1	1	1

[1] At least one conductor greater than 35 mm²

[2] No conductor cross-section exceeding 35 mm²

Table 2 - Summary of guidance data for the selection of cables for type approval tests

Size of cable cross–section	Cables with conductors having cross–sections ≤ 35 mm² and telecommunication cables			Cables having conductors with at least one cross-section > 35 mm²			
Category and designation	A F	B F	C F	A F/R	A F	B F	C F
Limitation on cable choice to provide the required nominal volume of non-metallic material	*At least two test pieces*			*Maximum two layers* (front and rear) 300 mm wide including specified gaps	*Maximum one layer* 600 mm wide including specified gaps*	*Maximum one layer* 300 mm wide including specified gaps *At least two test pieces*	*Maximum one layer* 300 mm wide including specified gaps *At least two test pieces*

* *Examples for category A, designation F:*

Example 1: Single core cable, 1 x 70 mm² conductor cross-section; outside diameter 17 mm; 0,2 litres per metre of non-metallic material.

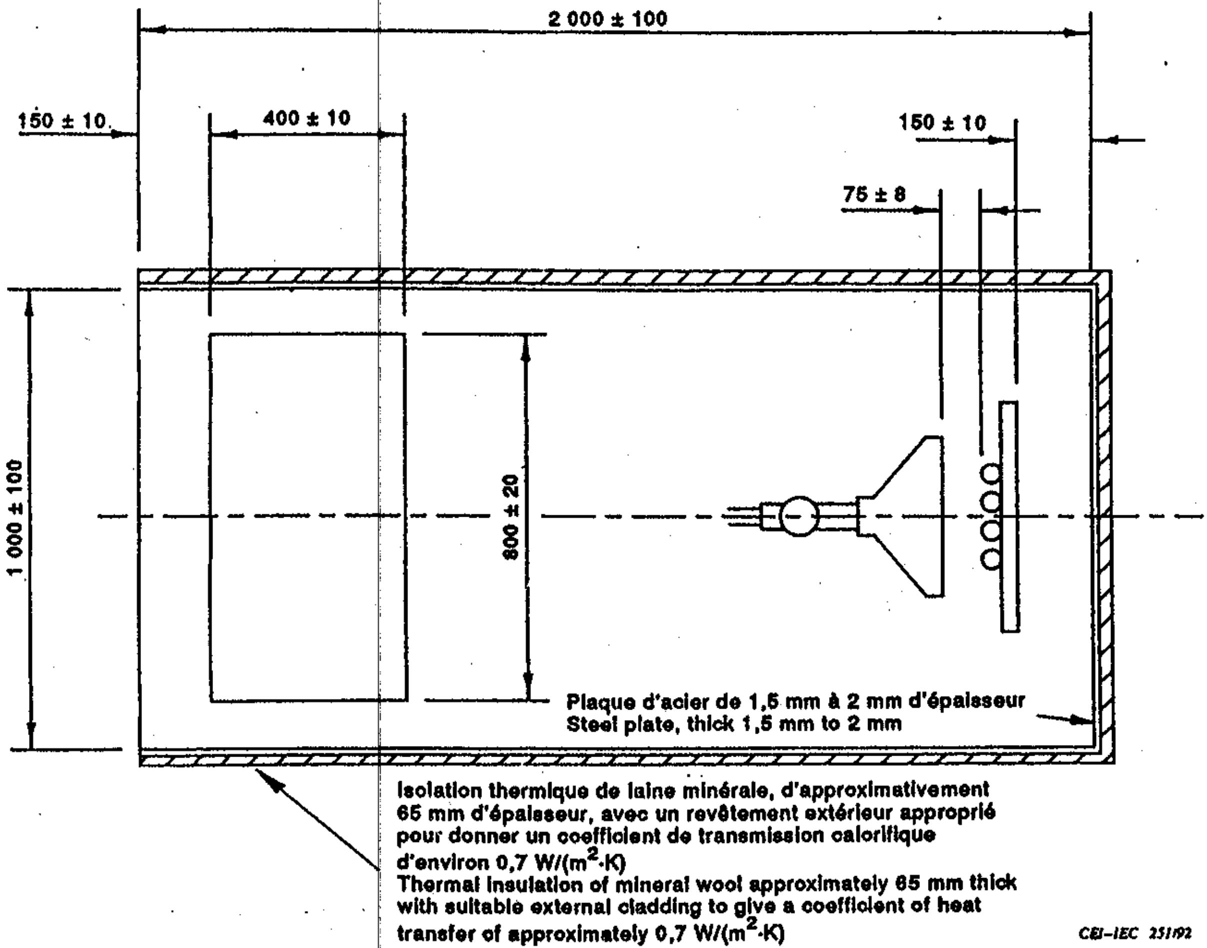
Maximum width available for test sample = 600 mm. To achieve 7 litres per metre would require 35 test pieces giving a total width of: 35 x 17 mm + 34 x 8,5 mm = 884 mm.

This cable cannot comply with the limitations on choice. Type approval testing arrangements should therefore be made by agreement between the manufacturer and customer or test authority.

Example 2: Three-core cable: 3 x 50 mm² conductor cross-section; outside diameter 29 mm; 0,55 litres per metre of non-metallic material.

Maximum width available for test sample = 600 mm. To achieve 7 litres per metre would require 12,7 test pieces. 13 test pieces give a total width of: 13 x 29 mm + 12 x 14,5 mm = 551 mm.

This cable complies with the limitations on choice.



Dimensions en millimètres *Dimensions in millimetres*

Figure 1a – Isolation thermique de l'arrière et des côtés de la chambre d'essai
Thermal insulation of back and sides of the test chamber

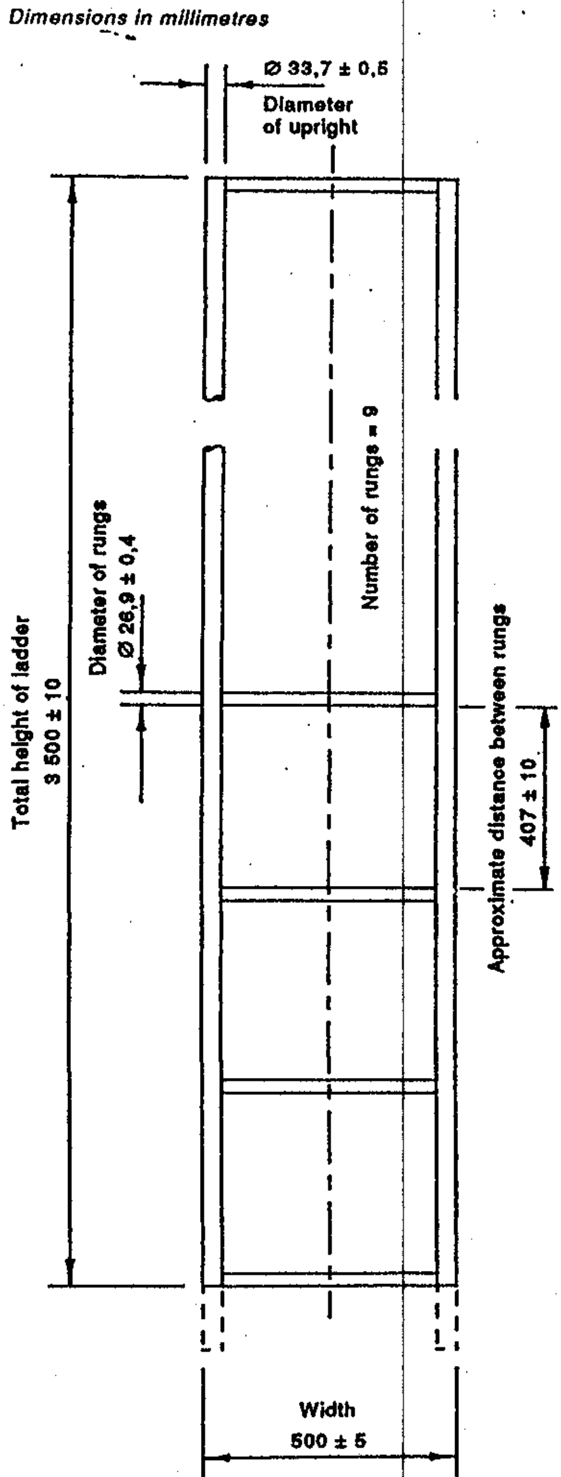


Figure 2 - Standard tubular ladder for cable test

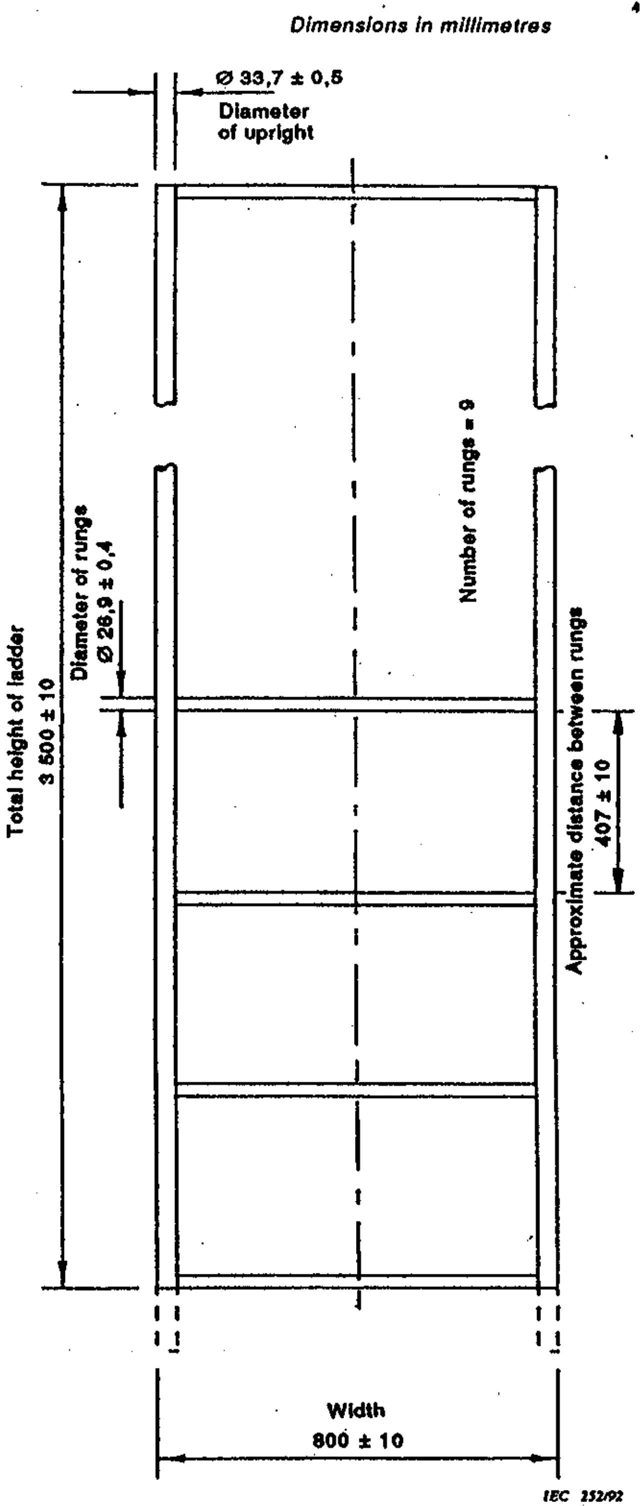
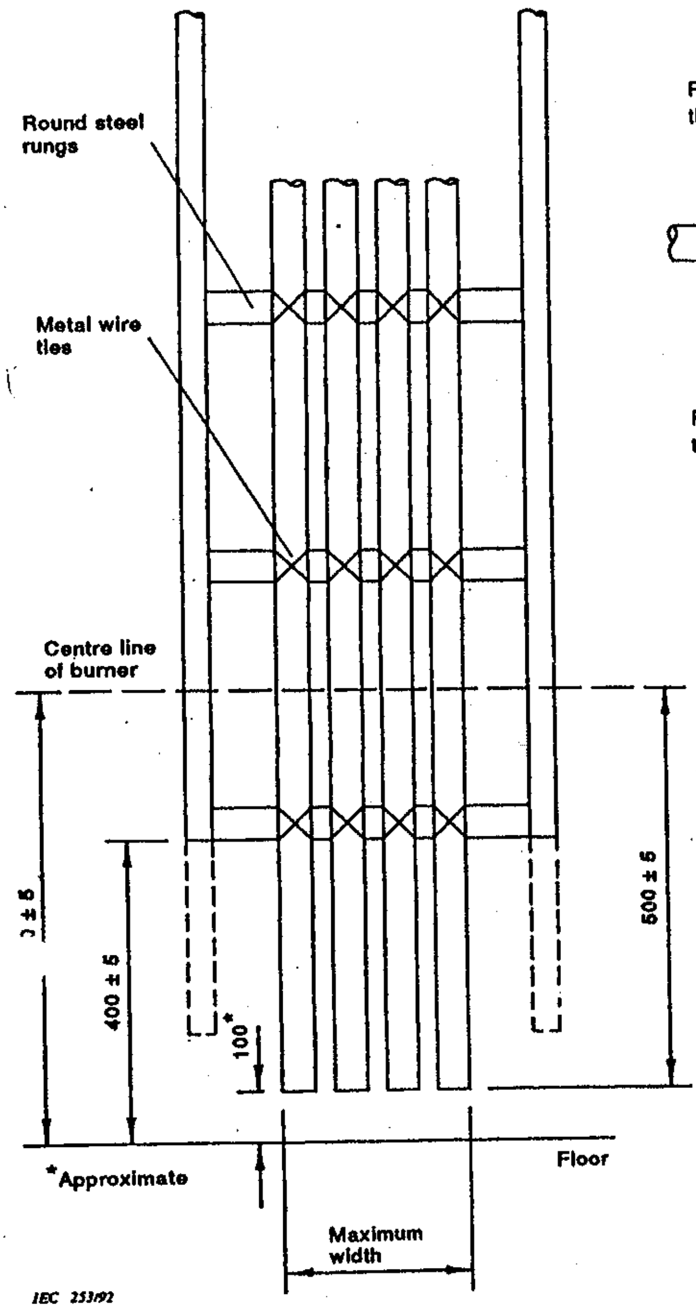


Figure 2a - Wide tubular ladder for cable test

Dimensions in millimetres



IEC 253/92

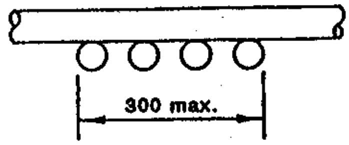


Figure 3a - Spaced cables mounted on front side of the standard ladder

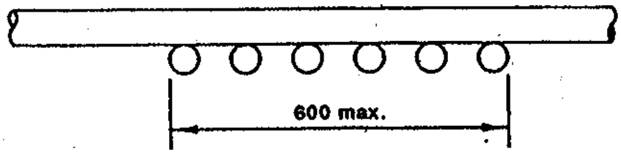


Figure 3b - Spaced cables mounted on front side of the wide ladder (i.e. A F > 35 mm²)

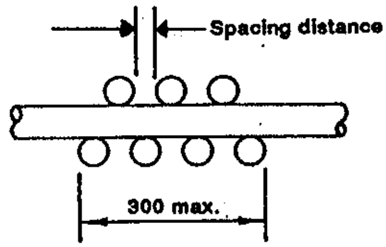


Figure 3c - Spaced cables mounted on both sides of the standard ladder (i.e. A F/R > 35 mm²)

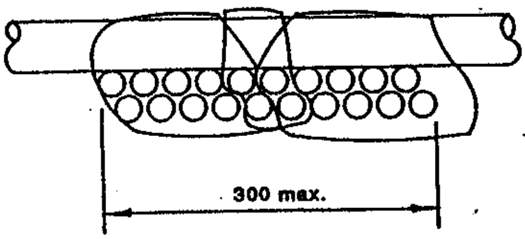
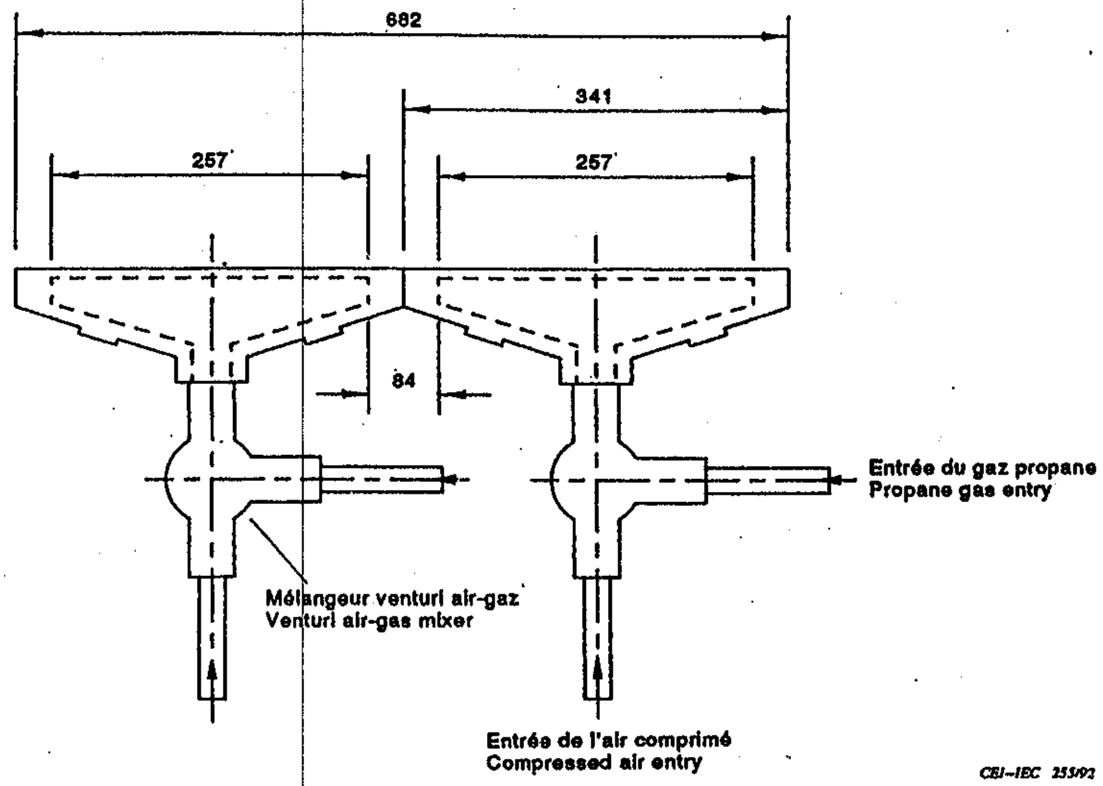


Figure 3d - Small cables mounted on front side of the standard ladder (i.e. A F discrete bundles in contact)

Figure 3 - Arrangement of test sample on ladder



Dimensions en millimètres

Dimensions in millimetres

Figure 4a - Brûleurs
Burners

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Annex A
(informative)

Details of proposed burner

A burner (catalogue number 10L11-55) and venturi mixer (catalogue number 14-18) complying with the requirements of clause 2.4 can be obtained from:

American Gas Furnace
P.O. Box 496
140 Spring Street
Elizabeth, New Jersey 07207
USA

TEL: +1 201 352 2120

TELEFAX: +1 201 352 5174

Annex B
(informative)

Method of measurement of oxygen index for non-metallic components in electric cables

B.1 Scope

This method describes a procedure which examines the relative flammability of non-metallic components taken from or used in electric cables by measuring the minimum concentration of oxygen in a mixture of oxygen and nitrogen that will just support flaming combustion. This method is presently limited to the use of physically self-supporting test specimens.

B.2 Definition

Oxygen index: The minimum concentration of oxygen, expressed as volume per cent, in a mixture of oxygen and nitrogen that will just support combustion of a material under the conditions of this method.

B.3 Principle of method

The minimum concentration of oxygen in a mixture of oxygen and nitrogen that will just support combustion is measured under equilibrium conditions of "candle-like" burning. The balance between the heat from the combustion of the specimen and the heat lost to the surroundings establishes the equilibrium.

B.4 Apparatus

B.4.1 The test column shall consist of a heat-resistant glass tube of one of the types listed below. The bottom of the column or the base to which the tube is attached shall contain non-combustible material to mix and distribute evenly the gas mixture entering at this base. A wire screen shall be placed above the non-combustible material to catch falling fragments and aid in keeping the base of the column clean.

Means shall be provided for checking or ensuring that the temperature of the gas mixture entering the chimney is 23 °C ± 2 °C. If the means involve an internal probe, its position and profile shall be designed to minimize turbulence within the chimney.

	Minimum inside diameter mm	Height		Restricted upper opening diameter	
		minimum mm	maximum mm	minimum mm	maximum mm
Column A	75	450	–	75	–
Column B	95	210	310	40	50

B.4.2 A suitable timer capable of indicating at least 10 min and accurate to 1 s.

B.4.3 *Specimen holder*

Any small holding device that will support the specimen at its base and hold it vertically in the centre of the column is acceptable.

B.4.4 *Gas supplies*

The gas mixture required for the test may be prepared using oxygen and/or nitrogen of commercial grades or better (>98 % purity) and/or clean air as appropriate (air contains 20,9 % oxygen).

The moisture content of the gas mixture entering the test chimney shall be less than 0,1 % by mass.

NOTE - It cannot be assumed that supplies of bottled oxygen or nitrogen will always contain less than 0,1 % by mass of water, although moisture contents of 0,003 % to 0,01 % by mass are typical. In particular, if the bottle has been charged under adverse conditions, a supply drawn from the last 10 % of the bottle may contain between 0,1 % and 0,5 % by mass of water as the gas pressure diminishes with respect to water vapour pressure at ambient temperatures. Hence the gas supply system should incorporate a drying device or provision should be made for measuring the moisture content.

B.4.5 *Concentration of oxygen measurement*

The concentration of oxygen shall be measured by one of the following methods. In cases of dispute method i) shall be used:

i) The concentration of oxygen in the mixed gases shall be determined by measuring the paramagnetism of the oxygen.

ii) Gas measurement and control devices. Measuring and control devices shall be used which will measure and control the composition of the gas mixture in the test chimney so that the concentration of oxygen in the gas mixture is known to an accuracy of ±0,5 % by volume of the mixture.

B.4.6 *Ignition source*

The igniter should be a butane gas torch with attachments as shown in figure B.1. The flame length should be approximately 30 mm measured in air from the top of the shield.

NOTE - A suitable ignition source is a "Ronson Butane Blowtorch" with a "Stanton Redcroft" attachment (spares reference No. 9234).

B.4.7 *Extractor fan*

To ensure the removal of smoke, soot and toxic fumes, the apparatus shall be sited in an area having efficient exhaust facilities that do not interfere with the test results.

B.5 Test specimen

B.5.1 The test specimens are flat rectangular sheets having the following dimensions:

length	70 mm to 150 mm
width	6,5 mm ± 0,5 mm
thickness	3,0 mm ± 0,5 mm

B.5.2 The specimens may be obtained by moulding, cutting or machining from the cable constituents to be tested. Where this is not possible with a cable containing vulcanized material, a moulded, vulcanized slab prepared from material sampled during manufacture of the same production batch shall be used.

B.5.3 The edges of the test pieces shall be smooth and free from fuzz or burrs of material from machining or peripheral flash from moulding.

B.6 Procedure

B.6.1 Each specimen shall be marked with two lines 8 mm and 58 mm from the top. For ease of viewing each line should be marked on at least two adjacent faces. For white or coloured specimens an ordinary ball-point pen may be used. For black specimens a contrasting ink should be used. The ink shall be allowed to dry before the test.

Clamp the specimen in the holder vertically in the approximate centre of the column with the top of the specimen at least 100 mm below the top of the open column.

If a restricted opening column is used as specified in B.4.1, the top of the specimen shall be as least 40 mm below the opening.

B.6.2 The test shall be carried out at (23 ± 2) °C and the samples shall be pre-conditioned at (23 ± 2) °C and at a relative humidity of 50 % ± 5 % for 24 h.

B.6.3 Set the desired initial concentration of oxygen flowing through the column. The gas flow rate in the column shall be 40 mm/s ± 10 mm/s as calculated at laboratory conditions from the total flow of gas in cubic millimetres per second divided by the area of the column in square millimetres.

B.6.4 Allow the gas to flow for at least 30 s to purge the system.

B.6.5 Apply the ignition source so that 6 mm (approximately) of the flame shall impinge on the top of the specimen. As the specimen burns, the ignition source shall be lowered to maintain the flame impingement of approximately 6 mm. The oxygen concentration shall not be adjusted after lighting the test piece.

The ignition flame shall be applied until the specimen has burnt down to the 8 mm line. It shall then be removed and timing commenced.

B.6.6

i) If the specimen burns for 3 min or longer, or for a length of 50 mm or longer, the specimen shall be extinguished and the concentration shall be recorded at or after 3 min or at or after 50 mm.

ii) If the specimen stops burning before 3 min and for less than 50 mm the concentration of oxygen shall be taken as being low. The extinguishing time shall be recorded.

B.6.7 Insert a new specimen. (A specimen may be re-used if cooled and the burned end cut off, provided it complies with B.5.2 and B.6.2.)

Adjust the oxygen concentration on the results of B.6.6. Repeat the test procedures of B.6.4 to B.6.6.

B.6.8 Continue the test according to B.6.7 with one test only at each oxygen concentration until two concentrations are obtained which satisfy the conditions given in items a), b) and c) below:

a) the first oxygen concentration gives the result that the specimen burns for at least 3 min or along a length of at least 50 mm;

b) the second oxygen concentration gives the result that the specimen extinguishes itself within less than 3 min and burns along a length of less than 50 mm;

c) the numerical difference between the percent oxygen concentration found in items a) and b) shall not exceed 0,25.

The oxygen concentration corresponding to item a) above is taken as the approximate oxygen index value at this stage.

B.6.9 Confirmatory tests shall now be carried out using the following criteria:

At each oxygen concentration tried, the majority result of three determinations shall be recorded as the result for that concentration. (Results from the original series, obtained in B.6.8 shall be included.)

The first concentration tried should be the approximate oxygen index value obtained in B.6.8. Tests shall then be continued in steps not exceeding ±0,25 % oxygen concentration either up or down depending on the majority result at this approximate oxygen index value.

When majority results are obtained which satisfy items a), b) and c) of B.6.8, testing shall be discontinued.

The majority result corresponding to item a) of B.6.8 is taken as the absolute oxygen index value of the material under test.

B.7 Report

The report shall include the following:

i) the absolute oxygen index value;

ii) a description of any unusual behaviour observed during the test.

B.8 Confirmation of minimum oxygen index

The procedure which has been described is for determining the absolute value of the oxygen index. Where it is required to check that the oxygen index is above a minimum specified value, the procedure outlined in B.6.3, B.6.4 and B.6.5 shall be adopted and the requirement is satisfied if item ii) of B.6.6 is applicable.

NOTES

1 *Test column*

It has been found that if the glass test column becomes unduly hot, lower oxygen index values may be obtained. It is therefore suggested that two test columns should be available for use.

2 *Calibration*

Suitable methods of calibration and degree of accuracy of equipment are to be incorporated in due course.

3 *Flowmeters*

If flowmeters are used which are calibrated for air, corrections should be made for the densities of the gases.

Publications de la CEI préparées par le Comité d'Etudes n° 20 *(suite)*

245:– Conducteurs et câbles isolés au caoutchouc, de tension nominale au plus égale à 450/750 V.

245-1 (1985)	Première partie: Prescriptions générales.
245-2 (1980)	Deuxième partie: Méthodes d'essais. Modification n° 1 (1985).
245-3 (1980)	Troisième partie: Conducteurs isolés au silicone, résistant à la chaleur. Modification n° 1 (1985).
245-4 (1980)	Quatrième partie: Câbles souples. Modification n° 2 (1988).
245-5 (1980)	Cinquième partie: Câbles pour ascenseurs. Modification n° 1 (1985).
245-6 (1980)	Sixième partie: Câbles souples pour électrodes de soudage à l'arc. Modification n° 1 (1985).
287 (1982)	Calcul du courant admissible dans les câbles en régime permanent (facteur de charge 100%). Modification n° 1 (1988). Amendement n° 2 (1991). Amendement 3 (1993).
331 (1970)	Caractéristiques des câbles électriques résistant au feu.

332:– Essais des câbles électriques soumis au feu.

332-1 (1993)	Première partie: Essais sur un fil ou câble vertical isolé.
332-2 (1989)	Deuxième partie: Essai sur un petit conducteur ou câble isolé à âme en cuivre, en position verticale.
332-3 (1992)	Troisième partie: Essais sur des fils ou câbles en nappes.
502 (1983)	Câbles de transport d'énergie isolés par diélectriques massifs extrudés pour des tensions assignées de 1 kV à 30 kV. Amendement n° 4 (1990). Amendement 5 (1993).
541 (1976)	Comparaison des câbles souples de la CEI et des câbles souples de l'Amérique du Nord.

702:– Câbles à isolant minéral et leurs terminaisons de tension nominale ne dépassant pas 750 V.

702-1 (1988)	Première partie: Câbles. Amendement n° 1 (1992)
702-2 (1986)	Deuxième partie: Terminaisons.
719 (1992)	Calcul des valeurs minimales et maximales des dimensions extérieures moyennes des conducteurs et câbles à âmes circulaires en cuivre et de tension nominale au plus égale à 450/750 V.
724 (1984)	Guide aux limites de température de court-circuit des câbles électriques de tension assignée au plus égale à 0,6/1,0 kV. Amendement 1 (1993).

754:– Essai des gaz émis lors de la combustion des câbles électriques.

754-1 (1982)	Première partie: Détermination de la quantité de gaz acide halogéné émis lors de la combustion d'un matériau polymérisé prélevé sur un câble.
754-2 (1991)	Deuxième partie: Détermination de l'acidité des gaz émis lors de la combustion d'un matériau prélevé sur un câble par mesurage du pH et de la conductivité.

(suite)

IEC publications prepared by Technical Committee No. 20 *(continued)*

245:– Rubber insulated cables of rated voltages up to and including 450/750 V.

245-1 (1985)	Part 1: General requirements.
245-2 (1980)	Part 2: Test methods. Amendment No. 1 (1985).
245-3 (1980)	Part 3: Heat resistant silicone insulated cables. Amendment No. 1 (1985).
245-4 (1980)	Part 4: Cords and flexible cables. Amendment No. 2 (1988).
245-5 (1980)	Part 5: Lift cables. Amendment No. 1 (1985).
245-6 (1980)	Part 6: Arc welding electrode cables. Amendment No. 1 (1985).
287 (1982)	Calculation of the continuous current rating of cables (100% load factor). Amendment No. 1 (1988). Amendment No. 2 (1991). Amendment 3 (1993).
331 (1970)	Fire-resisting characteristics of electric cables.

332:– Tests on electric cables under fire conditions.

332-1 (1993)	Part 1: Test on a single vertical insulated wire or cable.
332-2 (1989)	Part 2: Test on a single small vertical insulated copper wire or cable.
332-3 (1992)	Part 3: Tests on bunched wires or cables
502 (1983)	Extruded solid dielectric insulated power cables for rated voltages from 1 kV to 30 kV. Amendment No. 4 (1990). Amendment 5 (1993).
541 (1976)	Comparative information on IEC and North American flexible cord types.

702:– Mineral insulated cables and their terminations with a [illegible] voltage not exceeding 750 V.

702-1 (1988)	Part 1: Cables. Amendment No. 1 (1992)
702-2 (1986)	Part 2: Terminations.
719 (1992)	Calculation of the lower and upper limits for the average outer dimensions of cables with circular copper conductors and of rated voltages up to and including 450/750 V.
724 (1984)	Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0,6/1,0 kV. Amendment 1 (1993).

754:– Test on gases evolved during combustion of electric cables.

754-1 (1982)	Part 1: Determination of the amount of halogen acid gas evolved during the combustion of polymeric materials taken from cables.
754-2 (1991)	Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 20

55:– Câbles isolés au papier imprégné sous gaine métallique pour des tensions assignées inférieures ou égales à 18/30 kV (avec âmes conductrices en cuivre ou aluminium et à l'exclusion des câbles à pression de gaz et à huile fluide).

55-1 (1978) Première partie: Essais.
Modification n° 1 (1989).

55-2 (1981) Deuxième partie: Généralités et exigences de construction.
Modification n° 1 (1989).

141:– Essais de câbles à huile fluide, à pression de gaz et de leurs dispositifs accessoires.

141-1 (1976) Première partie: Câbles au papier à huile fluide et à gaine métallique et accessoires pour des tensions alternatives inférieures ou égales à 400 kV.
Modification n° 1 (1990).
Amendement n° 2 (1990).

141-2 (1963) Deuxième partie: Câbles à pression de gaz interne et accessoires pour des tensions alternatives inférieures ou égales à 275 kV.
Modification n° 1 (1967).

141-3 (1963) Troisième partie: Câbles à pression de gaz externe (à compression de gaz) et accessoires pour des tensions alternatives inférieures ou égales à 275 kV.
Modification n° 1 (1967).

141-4 (1980) Quatrième partie: Câbles à huile fluide en tuyau à isolation de papier imprégné sous forte pression d'huile et accessoires pour des tensions alternatives inférieures ou égales à 400 kV.
Amendement n° 1 (1990).

173 (1964) Couleurs pour les conducteurs des câbles souples.

183 (1984) Guide pour le choix des câbles à haute tension.
Amendement n° 1 (1990).

227:– Conducteurs et câbles isolés au polychlorure de vinyle, de tension nominale au plus égale à 450/750 V.

227-1 (1993) Partie 1: Prescriptions générales.

227-2 (1979) Deuxième partie: Méthodes d'essais.
Modification n° 1 (1985).

227-3 (1993) Partie 3: Conducteurs pour installations fixes.

227-4 (1992) Partie 4: Câbles sous gaine pour installations fixes.

227-5 (1979) Cinquième partie: Câbles souples.
Modification n° 1 (1987).

227-6 (1985) Sixième partie: Câbles pour ascenseurs et câbles pour connexions souples.

228 (1978) Ames des câbles isolés. Guide pour les limites dimensionnelles des âmes circulaires.
Amendement 1 (1993).

228A (1982) Premier complément.

229 (1982) Essais sur les gaines extérieures des câbles, qui ont une fonction spéciale de protection et sont appliquées par extrusion.

230 (1966) Essais de choc des câbles et de leurs accessoires.

(suite)

IEC publications prepared by Technical Committee No. 20

55:– Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas-pressure and oil-filled cables).

55-1 (1978) Part 1: Tests.
Amendment No. 1 (1989).

55-2 (1981) Part 2: General and construction requirements.
Amendment No. 1 (1989).

141:– Tests on oil-filled and gas-pressure cables and their accessories.

141-1 (1976) Part 1: Oil-filled, paper-insulated, metal-sheathed cables and accessories for alternating voltages up to and including 400 kV.
Amendment No. 1 (1990).
Amendment No. 2 (1990).

141-2 (1963) Part 2: Internal gas-pressure cables and accessories for alternating voltages up to 275 kV.
Amendment No. 1 (1967).

141-3 (1963) Part 3: External gas-pressure (gas compression) cables and accessories for alternating voltages up to 275 kV.
Amendment No. 1 (1967).

141-4 (1980) Part 4: Oil-impregnated paper-insulated high-pressure oil-filled pipe-type cables and accessories for alternating voltages up to and including 400 kV.
Amendment No. 1 (1990).

173 (1964) Colours of the cores of flexible cables and cords.

183 (1984) Guide to the selection of high-voltage cables.
Amendment No. 1 (1990).

227:– Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V.

227-1 (1993) Part 1: General requirements.

227-2 (1979) Part 2: Test methods.
Amendment No. 1 (1985).

227-3 (1993) Part 3: Non-sheathed cables for fixed wiring.

227-4 (1992) Part 4: Sheathed cables for fixed wiring.

227-5 (1979) Part 5: Flexible cables (cords).
Amendment No. 1 (1987).

227-6 (1985) Part 6: Lift cables and cables for flexible connections.

228 (1978) Conductors of insulated cables. Guide to the dimensional limits of circular conductors.
Amendment 1 (1993).

228A (1982) First supplement.

229 (1982) Tests on cable oversheaths which have a special protective function and are applied by extrusion.

230 (1966) Impulse tests on cables and their accessories.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 20 *(suite)*

853:– Calcul des capacités de transport des câbles pour les régimes de charge cycliques et de surcharge de secours.

853-1 (1985) Première partie: Facteurs de capacité de transport cyclique pour des câbles de tensions inférieures ou égales à 18/30 (36) kV.

853-2 (1989) Deuxième partie: Régime cyclique pour des câbles de tensions supérieures à 18/30 (36) kV et régimes de secours pour des câbles de toutes tensions.

885:– Méthodes d'essais électriques pour les câbles électriques.

885-1 (1987) Première partie: Essais électriques pour les câbles, les conducteurs et les fils, pour une tension inférieure ou égale à 450/750 V.

885-2 (1987) Deuxième partie: Essais de décharges partielles.

885-3 (1988) Troisième partie: Méthode d'essais pour mesures de décharges partielles sur longueurs de câbles de puissance extrudés.

949 (1988) Calcul des courants de court-circuit admissibles au plan thermique, tenant compte des effets d'un échauffement non adiabatique.

986 (1989) Guide aux limites de température de court-circuit des câbles électriques de tension assignée de 1,8/3 (3,6) kV à 18/30 (36) kV.
Amendement 1 (1993).

1034:– Mesure de la densité de fumées dégagées par des câbles électriques brûlant dans des conditions définies.

1034-1 (1990) Partie 1: Appareillage d'essai.

1034-2 (1991) Part 2: Procédure d'essai et prescriptions.

1042 (1991) Méthode de calcul des coefficients de réduction de l'intensité de courant admissible pour des groupes de câbles posés à l'air libre et protégés du rayonnement solaire direct.

1059 (1991) Optimisation économique des sections d'âme de câbles électriques de puissance.

1138 (1992) Câbles d'équipement portable de mise à la terre et de court-circuit.

1238-1 (1993) Connecteurs sertis et à serrage mécanique pour câbles d'énergie à âmes en cuivre ou en aluminium – Partie 1: Méthodes d'essais et prescriptions

IEC publications prepared by Technical Committee No. 20 *(continued)*

853:– Calculation of the cyclic and emergency current rating of cables.

853-1 (1985) Part 1: Cyclic rating factor for cables up to and including 18/30 (36) kV.

853-2 (1989) Part 2: Cyclic rating of cables greater than 18/30 (36) kV and emergency ratings for cables of all voltages.

885:– Electrical test methods for electric cables.

885-1 (1987) Part 1: Electrical test for cables, cords and wires for voltages up to and including 450/750 V.

885-2 (1987) Part 2: Partial discharge tests.

885-3 (1988) Part 3: Test methods for partial discharge measurements on lengths of extruded power cables.

949 (1988) Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects.

986 (1989) Guide to the short-circuit temperature limits of electric cables with a rated voltage from 1,8/3 (3,6) kV to 18/30 (36) kV.
Amendment 1 (1993).

1034:– Measurement of smoke density of electric cables burning under defined conditions.

1034-1 (1990) Part 1: Test apparatus.

1034-2 (1991) Part 2: Test procedure and requirements.

1042 (1991) A method for calculating reduction factors for groups of cables in free air, protected from solar radiation.

1059 (1991) Economic optimization of power cable size.

1138 (1992) Cables for portable earthing and short-circuiting equipment.

1238-1 (1993) Compression and mechanical connectors for power cables with copper or aluminium conductors – Part 1: Test methods and requirements.

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Publications de la CEI préparées par le Comité d'Etudes n° 20 *(suite)*

800 (1992)	Câbles chauffants de tension nominale 300/500 V pour le chauffage des locaux et de la protection contre la formation de glace.
811:–	Méthodes d'essais communes pour les matériaux d'isolation et de gainage des câbles électriques
811-1:–	Première partie: Méthodes d'application générale.
811-1-1 (1985)	Section un: Mesure des épaisseurs et des dimensions extérieures - Détermination des propriétés mécaniques. Modification n° 1 (1988). Modification n° 2 (1989).
811-1-2 (1985)	Section deux: Méthodes de vieillissement thermique. Modification n° 1 (1989).
811-1-3 (1985)	Section trois: Méthodes de détermination de la masse volumique - Essais d'absorption d'eau - Essai de rétraction. Modification n° 1 (1990). Amendement 2 (1993).
811-1-4 (1985)	Section quatre: Essais à basse température. Amendement 1 (1993).
811-2:–	Deuxième partie: Méthodes spécifiques pour les mélanges élastomères.
811-2-1 (1986)	Section un: Essai de résistance à l'ozone - Essai d'allongement à chaud - Essai de résistance à l'huile. Amendement 1 (1992). Amendement 2 (1993).
811-3:–	Troisième partie: Méthodes spécifiques pour les mélanges PVC.
811-3-1 (1985)	Section un: Essai de pression à température élevée - Essais de résistance à la fissuration. Amendement 1 (1993).
811-3-2 (1985)	Section deux: Essai de perte de masse - Essai de stabilité thermique. Amendement 1 (1993).
811-4:–	Quatrième partie: Méthodes spécifiques pour les mélanges polyéthylène et polypropylène.
811-4-1 (1985)	Section un: Résistance aux craquelures sous contraintes dues à l'environnement - Essai d'enrou-lement après vieillissement thermique dans l'air - Mesure de l'indice de fluidité à chaud - Mesure dans le PE du taux de noir de carbone et/ou des charges minérales. Modification n° 1 (1988). Amendement 2 (1993).
811-4-2 (1990)	Section deux: Allongement à la rupture après préconditionnement - Essai d'enroulement après préconditionnement - Essai d'enroulement après vieillissement thermique dans l'air - Mesure de l'augmentation de masse - Essai de stabilité à long terme (annexe A) - Méthode d'essai pour l'oxydation catalytique par le cuivre (annexe B).
811-5-1 (1990)	Cinquième partie: Méthodes spécifiques pour les matières de remplissage - Section un: Point de goutte - Séparation d'huile - Fragilité à basse température - Indice d'acide total - Absence de composés corrosifs - Permittivité à 23 °C - Résistivité en courant continu à 23 °C et 100 °C.
840 (1988)	Essais des câbles de transport d'énergie à isolation extrudée pour des tensions assignées supérieures à 30 kV (U_m = 36 kV) et jusqu'à 150 kV (U_m = 170 kV). Amendement 2 (1993).

(suite)

IEC publications prepared by Technical Committee No. 20 *(continued)*

800 (1992)	Heating cables with a rated voltage of 300/500 V for comfort heating and prevention of ice formation.
811:–	Common test methods for insulating and sheathing materials of electric cables.
811-1:–	Part 1: Methods for general application.
811-1-1 (1985)	Section One: Measurement of thickness and overall dimensions - Tests for determining the mechanical properties. Amendment No. 1 (1988). Amendment No. 2 (1989).
811-1-2 (1985)	Section Two: Thermal ageing methods. Amendment No. 1 (1989).
811-1-3 (1985)	Section Three: Methods for determining the density - Water absorption tests - Shrinkage test. Amendment No. 1 (1990). Amendment No. 2 (1993).
811-1-4 (1985)	Section Four: Tests at low temperature. Amendment 1 (1993).
811-2:–	Part 2: Methods specific to elastomeric compounds.
811-2-1 (1986)	Section One: Ozone resistance test - Hot set test - Mineral oil immersion test. Amendment 1 (1992). Amendment 2 (1993).
811-3:–	Part 3: Methods specific to PVC compounds.
811-3-1 (1985)	Section One: Pressure test at high temperature - Tests for resistance to cracking. Amendment 1 (1993).
811-3-2 (1985)	Section Two: Loss of mass test - Thermal stability test. Amendment 1 (1993).
811-4:–	Part 4: Methods specific to polyethylene and polypropylene compounds.
811-4-1 (1985)	Section One: Resistance to environmental stress cracking - Wrapping test after thermal ageing in air - Measurement of the melt flow index - Carbon black and/or mineral content measurement in PE. Amendment No. 1 (1988). Amendment 2 (1993).
811-4-2 (1990)	Section Two: Elongation at break after pre-conditioning - Wrapping test after pre-conditioning - Wrapping test after thermal ageing in air - Measurement of mass increase - Long-term stability test (Appendix A) - Test method for copper-catalysed oxidative degradation (Appendix B).
811-5-1 (1990)	Part 5: Methods specific to filling compounds - Section One: Drop point - Separation of oil - Lower temperature brittleness - Total acid number - Absence of corrosive components - Permittivity at 23 °C - D.C. resistivity at 23 °C and 100 °C.
840 (1988)	Tests for power cables with extruded insulation for rated voltages above 30 kV (U_m = 36 kV) up to 150 kV (U_m = 170 kV). Amendment 2 (1993).

(continued)