IEC 60332-3-22

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 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A

IEC 60332-3-22:2018-07 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TESTS ON ELECTRIC AND OPTICAL FIBRE CABLES UNDER FIRE CONDITIONS –

Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A

FOREWORD

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International Standard IEC 60332-3-22 has been prepared by IEC technical committee 20: Electric cables.

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INTRODUCTION

IEC 60332-3-22 is part of a series of publications dealing with tests on electric and optical fibre cables under fire conditions.

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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 the 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 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A

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~~ covers category A for methods of test for the assessment of vertical flame spread of vertically mounted bunched wires or cables, electrical or optical, under defined conditions.

This document relates to cables installed on the test ladder to achieve a nominal total volume of non-metallic material of 7 l/m of test sample. The flame application time is 40 min. The method of mounting uses the front of the ladder, a standard or wide ladder being used for cables having a conductor cross-section greater than 35 mm^2 according to the number of test pieces required, and a standard ladder for conductor cross-sections 35 mm^2 and smaller. The category is intended for general use where high volumes of non-metallic material are required to be evaluated.

The test is intended for type approval testing. The requirements for the selection of cables for testing are given in Annex A. The flame spread is measured as the extent of damage of the cable sample. This procedure ~~may~~ can be used to demonstrate the cable's ability to limit flame spread.

A recommended performance requirement is given in Annex B.

NOTE For the purposes 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60332-3-10, *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 60695-4, *Fire hazard testing – Part 4: Terminology concerning fire tests*~~

~~IEC 60811-1-3, *Insulating and sheathing materials of electric cables – Common test methods Part 1: General application – Section 3: Methods for determining the density – Water absorption tests – Shrinkage test*~~

IEC 60811-606, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 606: Physical tests – Methods for determining the density*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. ~~The definitions are 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]

3.2
char
carbonaceous residue resulting from pyrolysis or incomplete combustion

[SOURCE: ISO 13943:2017, 3.47]

3.3
flame spread
propagation of a flame front

[SOURCE: ISO 13943:2017, 3.168]

4 Test apparatus

4.1 General

The apparatus specified in IEC 60332-3-10 shall be used.

4.2 Ignition source

The ignition source shall be one or two ribbon-type propane gas burners as specified in IEC 60332-3-10.

A single burner shall be used with the standard ladder and two burners with the wide ladder.

5 Test procedure

5.1 Test sample

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

The total number of test pieces in the test sample shall be that number required to provide a nominal total volume of non-metallic material of 7 l/m of test sample.

The test sample for type approval shall be ~~chosen within the limitations given~~ in accordance with Annex A.

The test pieces forming the test sample shall be conditioned at a temperature of (20 ± 10) °C for at least 16 h before commencing the test. The test pieces shall be dry.

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

The density of each non-metallic component (including cellular material) shall be measured in an appropriate way, for example ~~clause 8 of IEC 60811-1-3~~ according to IEC 60811-606, in order to obtain values expressed to the second decimal place.

Each non-metallic material C_i shall be removed from the test piece and weighed. Any non-metallic material making up less than 5 % of the total non-metallic mass of the test piece shall be assumed to have a density of 1,0 kg/dm^3.

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

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 density of the component C_i (kg/dm^3);

l is the length of the test piece of cable (m).

The total volume, V, of the non-metallic materials contained in 1 m of cable is equal to the sum of the individual volumes V_1, V_2, etc.

The number of test pieces to be mounted is obtained by taking the closest integer (0,5 and above corresponding to 1) of ~~the number of test pieces to be mounted is obtained by dividing~~ the ratio of the volume per metre specified in 5.1 and the total volume, V, of non-metallic material per metre of cable, subject to a minimum number of two test pieces.

5.3 Mounting of the test sample

5.3.1 Cables having at least one conductor above 35 mm^2

For cables having at least one conductor with a cross-section exceeding 35 mm^2, each test piece shall be attached individually to each rung of the ladder by means of metal wire (steel or copper). For cables up to and including 50 mm diameter, use wire between 0,5 mm and 1,0 mm in diameter. For cables above 50 mm diameter, use wire between 1,0 mm and ~~1,5~~ 2,5 mm in diameter.

Test pieces shall be attached to the front of the ladder in a single layer with a space between each test piece of 0,5 times the cable diameter but not exceeding 20 mm. The ladder may be either standard or wide depending on whichever is necessary to ensure that there shall be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights. Where it is not possible to ensure that there shall be a minimum distance of 50 mm

between the edge of the test sample and the inside of the standard ladder, the wide ladder shall be used.

The maximum width of the test sample for the standard ladder shall be 300 mm and for the wide ladder 600 mm (see Figures 1 and 2). When the wide ladder is used, there shall not be more cable than the number necessary to form a single layer of 600 mm width, allowing for a space between each cable of either half the cable diameter or 20 mm, whichever is the smaller.

When mounting the test pieces, the first test piece shall be positioned approximately in the centre of the ladder and further test pieces added on either side so that the whole array of test pieces is approximately centred on the ladder.

Mount all test pieces on the ladder with the bending (due to bending of the cable on the reel), if any, in the same direction, towards the back side of the test chamber as much as possible.

To achieve straight test pieces between the steel rungs below and above the burner position, it is permitted to fix the test pieces to an additional horizontal support 200 mm to 300 mm lower than the steel rung below the burner position.

NOTE The objective is to improve the repeatability and reproducibility of the test.

5.3.2 Cables having conductors 35 mm^2 and below and optical cables

For cables having all conductors with cross-sections of 35 mm^2 or smaller and optical cables, each test piece shall be attached, either individually or as part of an array, to each rung of the ladder by means of metal wire (steel or copper) between 0,5 mm and 1,0 mm in diameter.

Test pieces shall be attached to the front of the standard ladder in touching formation in one or more layers up to a maximum total width of 300 mm. There shall be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

When mounting the test pieces, the first test piece or array of test pieces shall be positioned approximately in the centre of the ladder and further test pieces or arrays added on either side so that the test sample is approximately centred on the ladder.

Mount all test pieces on the ladder with the bending (due to bending of the cable on the reel), if any, in the same direction, towards the back side of the test chamber as much as possible.

To achieve straight test pieces between the steel rungs below and above the burner position, it is permitted to fix the test pieces to an additional horizontal support 200 mm to 300 mm lower than the steel rung below the burner position.

In order to ensure that the test pieces are straight on the ladder, the test pieces shall be maintained under tension manually while attaching the test pieces to the rung of the ladder by means of a metal wire.

NOTE The objective is to improve the repeatability and reproducibility of the test.

If a second (or more) layer of test pieces is required after the full width of the ladder has been utilized for the first (or following) layer, then the first test piece or array of test pieces in the second (or following) layer shall be positioned approximately in the centre of the ladder and further test pieces or arrays added on either side so that the second (or following) layer is approximately centred on the ladder.

If a large number of test pieces is required to make up a test sample, the test pieces may be attached to each rung of the ladder in flat arrays of cables of a maximum width of five test pieces using the specified metal wire. For consistency, it is recommended that adjacent

arrays of cables are secured together at every rung to ensure that they are in touching formation (see Figure 3).

5.4 Flame application time

The test flame shall be applied for 40 min, after which it shall be extinguished. The air flow rate through the test chamber shall be maintained until cable burning or glowing has ceased, or until a maximum duration of 1 h, after which any remaining cable burning or glowing shall be extinguished.

6 Evaluation of test results

After all cable burning or glowing has ceased or been extinguished, the test sample shall be wiped clean.

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 flame spread shall be measured as the extent of the damage. It shall be measured in metres to two decimal places from the bottom edge of the burner to the onset of char. The onset of char is determined as follows:

– press against the cable surface with a sharp object, for example a knife blade. Where the surface changes from a resilient to a brittle (crumbling) surface, this indicates the onset of char.

7 Performance requirements

The performance requirements for a particular type or class of wire or cable should preferably be given in the individual cable standard. In the absence of any given requirement, the recommended performance requirements given in Annex B should be used.

8 Retest procedure

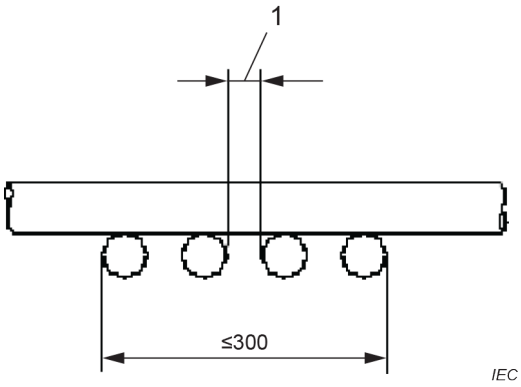
In case of a disputed failure, two further tests shall be undertaken as detailed in Clause 5. The test shall be deemed as satisfactory if both tests meet the stated requirement.

9 Test report

The test report shall include the following information:

a) full description of the cable tested;
b) manufacturer of the cable tested;
c) the part of the standard against which the test was carried out;
d) the number of test pieces;
e) the total volume of non-metallic material, per metre of test sample, of the test pieces;
f) the method of mounting (i.e. spaced or touching);
g) the number of layers and number of test pieces in each layer;
h) flame application time (i.e. 40 min);
i) the number of burners (i.e. one or two);
j) the extent of damage;
k) the time to extinction of all burning or glowing.

Dimensions in millimetres

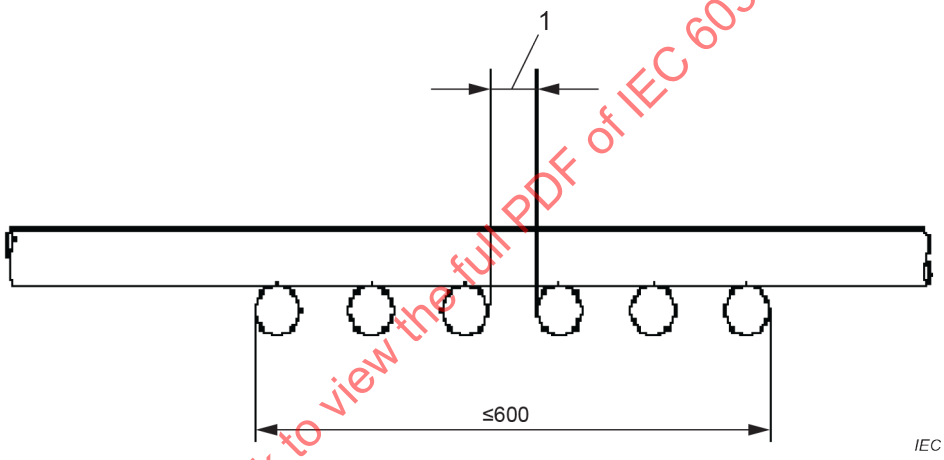


Key

1 spacing distance

Figure 1 – Spaced cables mounted on the front side of the standard ladder

Dimensions in millimetres

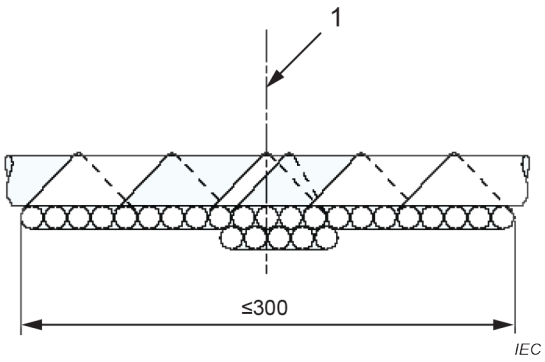


Key

1 spacing distance

Figure 2 – Spaced cables mounted on the front side of the wide ladder

Dimensions in millimetres



Key

1 centre line of ladder

Figure 3 – Touching cables mounted on front side of the standard ladder (arrays of cables in contact)

Annex A
(normative)

Guidance on cable selection for type approval testing

The choice of cable type and conductor cross-section for type approval testing shall be as given in the cable specification, or as agreed between purchaser and manufacturer.

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~~ specified method of mounting. Therefore, the selection of cables for this document shall comply with the following:

- only the front face of the ladder shall be used;
- for cables having a conductor cross-section greater than 35 mm^2, there shall not be 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;
- for cables having a conductor cross-section of 35 mm^2 or smaller and optical cables, there is no restriction on cable selection;
- the minimum number of test pieces shall be two.

A summary of all conditions for type approval testing to this document is given in Table A.1.

Table A.1 – Summary of test conditions

Category and designation	A	
Range of conductor cross-sections (mm^2)	> 35[a]	≤ 35[b]
Non-metallic volume per metre of test sample (l)	7	7
Use of standard ladder, maximum width of test sample: 300 mm		
– number of layers:	1	≥ 1
– number of burners:	1	1
Use of wide ladder, maximum width of test sample: 600 mm		N/A[c]
– number of layers:	1	–
– number of burners:	2	–
Positioning of test pieces	Spaced	Touching
Flame application time (min)	40	40

[a] At least one conductor greater than 35 mm^2.

[b] No conductor cross-section exceeding 35 mm^2 or optical cable.

[c] N/A = not applicable.

Annex B
(informative)

Recommended performance requirements

The maximum extent of the charred portion measured on the sample shall not have reached a height exceeding 2,5 m above the bottom edge of the burner.

This recommended performance requirement confirms, on the basis of experience gained, the value previously given in IEC TR 60332-3:1992, 2.8.1.

Bibliography

IEC TR 60332-3:1992[1], *Tests on electric cables under fire conditions – Part 3: Tests on bunched wires or cables*

ISO 13943:2017, *Fire safety – Vocabulary*

[1] Withdrawn.

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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 the 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 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A

1 Scope

This part of IEC 60332 covers category A for methods of test for the assessment of vertical flame spread of vertically mounted bunched wires or cables, electrical or optical, under defined conditions.

This document relates to cables installed on the test ladder to achieve a nominal total volume of non-metallic material of 7 l/m of test sample. The flame application time is 40 min. The method of mounting uses the front of the ladder, a standard or wide ladder being used for cables having a conductor cross-section greater than 35 mm^2 according to the number of test pieces required, and a standard ladder for conductor cross-sections 35 mm^2 and smaller. The category is intended for general use where high volumes of non-metallic material are required to be evaluated.

The test is intended for type approval testing. The requirements for the selection of cables for testing are given in Annex A. The flame spread is measured as the extent of damage of the cable sample. This procedure can be used to demonstrate the cable's ability to limit flame spread.

A recommended performance requirement is given in Annex B.

NOTE For the purposes 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60332-3-10, *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 60811-606, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 606: Physical tests – Methods for determining the density*

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]

3.2
char
carbonaceous residue resulting from pyrolysis or incomplete combustion

[SOURCE: ISO 13943:2017, 3.47]

3.3
flame spread
propagation of a flame front

[SOURCE: ISO 13943:2017, 3.168]

4 Test apparatus

4.1 General

The apparatus specified in IEC 60332-3-10 shall be used.

4.2 Ignition source

The ignition source shall be one or two ribbon-type propane gas burners as specified in IEC 60332-3-10.

A single burner shall be used with the standard ladder and two burners with the wide ladder.

5 Test procedure

5.1 Test sample

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

The total number of test pieces in the test sample shall be that number required to provide a nominal total volume of non-metallic material of 7 l/m of test sample.

The test sample for type approval shall be in accordance with Annex A.

The test pieces forming the test sample shall be conditioned at a temperature of (20 ± 10) °C for at least 16 h before commencing the test. The test pieces shall be dry.

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

The density of each non-metallic component (including cellular material) shall be measured in an appropriate way, for example according to IEC 60811-606, in order to obtain values expressed to the second decimal place.

Each non-metallic material C_i shall be removed from the test piece and weighed. Any non-metallic material making up less than 5 % of the total non-metallic mass of the test piece shall be assumed to have a density of 1,0 kg/dm^3.

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

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 density of the component C_i (kg/dm^3);

l is the length of the test piece of cable (m).

The total volume, V, of the non-metallic materials contained in 1 m of cable is equal to the sum of the individual volumes V_1, V_2, etc.

The number of test pieces to be mounted is obtained by taking the closest integer (0,5 and above corresponding to 1) of the ratio of the volume per metre specified in 5.1 and the total volume, V, of non-metallic material per metre of cable, subject to a minimum number of two test pieces.

5.3 Mounting of the test sample

5.3.1 Cables having at least one conductor above 35 mm^2

For cables having at least one conductor with a cross-section exceeding 35 mm^2, each test piece shall be attached individually to each rung of the ladder by means of metal wire (steel or copper). For cables up to and including 50 mm diameter, use wire between 0,5 mm and 1,0 mm in diameter. For cables above 50 mm diameter, use wire between 1,0 mm and 2,5 mm in diameter.

Test pieces shall be attached to the front of the ladder in a single layer with a space between each test piece of 0,5 times the cable diameter but not exceeding 20 mm. The ladder may be either standard or wide depending on whichever is necessary to ensure that there shall be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights. Where it is not possible to ensure that there shall be a minimum distance of 50 mm between the edge of the test sample and the inside of the standard ladder, the wide ladder shall be used.

The maximum width of the test sample for the standard ladder shall be 300 mm and for the wide ladder 600 mm (see Figures 1 and 2). When the wide ladder is used, there shall not be more cable than the number necessary to form a single layer of 600 mm width, allowing for a space between each cable of either half the cable diameter or 20 mm, whichever is the smaller.

When mounting the test pieces, the first test piece shall be positioned approximately in the centre of the ladder and further test pieces added on either side so that the whole array of test pieces is approximately centred on the ladder.

Mount all test pieces on the ladder with the bending (due to bending of the cable on the reel), if any, in the same direction, towards the back side of the test chamber as much as possible.

To achieve straight test pieces between the steel rungs below and above the burner position, it is permitted to fix the test pieces to an additional horizontal support 200 mm to 300 mm lower than the steel rung below the burner position.

NOTE The objective is to improve the repeatability and reproducibility of the test.

5.3.2 Cables having conductors 35 mm^2 and below and optical cables

For cables having all conductors with cross-sections of 35 mm^2 or smaller and optical cables, each test piece shall be attached, either individually or as part of an array, to each rung of the ladder by means of metal wire (steel or copper) between 0,5 mm and 1,0 mm in diameter.

Test pieces shall be attached to the front of the standard ladder in touching formation in one or more layers up to a maximum total width of 300 mm. There shall be a minimum distance of 50 mm between the edge of the test sample and the inside of the ladder uprights.

When mounting the test pieces, the first test piece or array of test pieces shall be positioned approximately in the centre of the ladder and further test pieces or arrays added on either side so that the test sample is approximately centred on the ladder.

Mount all test pieces on the ladder with the bending (due to bending of the cable on the reel), if any, in the same direction, towards the back side of the test chamber as much as possible.

To achieve straight test pieces between the steel rungs below and above the burner position, it is permitted to fix the test pieces to an additional horizontal support 200 mm to 300 mm lower than the steel rung below the burner position.

In order to ensure that the test pieces are straight on the ladder, the test pieces shall be maintained under tension manually while attaching the test pieces to the rung of the ladder by means of a metal wire.

NOTE The objective is to improve the repeatability and reproducibility of the test.

If a second (or more) layer of test pieces is required after the full width of the ladder has been utilized for the first (or following) layer, then the first test piece or array of test pieces in the second (or following) layer shall be positioned approximately in the centre of the ladder and further test pieces or arrays added on either side so that the second (or following) layer is approximately centred on the ladder.

If a large number of test pieces is required to make up a test sample, the test pieces may be attached to each rung of the ladder in flat arrays of cables of a maximum width of five test pieces using the specified metal wire. For consistency, it is recommended that adjacent arrays of cables are secured together at every rung to ensure that they are in touching formation (see Figure 3).

5.4 Flame application time

The test flame shall be applied for 40 min, after which it shall be extinguished. The air flow rate through the test chamber shall be maintained until cable burning or glowing has ceased, or until a maximum duration of 1 h, after which any remaining cable burning or glowing shall be extinguished.

6 Evaluation of test results

After all cable burning or glowing has ceased or been extinguished, the test sample shall be wiped clean.

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 flame spread shall be measured as the extent of the damage. It shall be measured in metres to two decimal places from the bottom edge of the burner to the onset of char. The onset of char is determined as follows:

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

7 Performance requirements

The performance requirements for a particular type or class of wire or cable should preferably be given in the individual cable standard. In the absence of any given requirement, the recommended performance requirements given in Annex B should be used.

8 Retest procedure

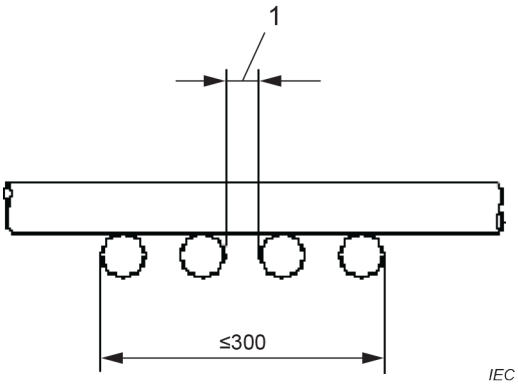
In case of a disputed failure, two further tests shall be undertaken as detailed in Clause 5. The test shall be deemed as satisfactory if both tests meet the stated requirement.

9 Test report

The test report shall include the following information:

a) full description of the cable tested;
b) manufacturer of the cable tested;
c) the part of the standard against which the test was carried out;
d) the number of test pieces;
e) the total volume of non-metallic material, per metre of test sample, of the test pieces;
f) the method of mounting (i.e. spaced or touching);
g) the number of layers and number of test pieces in each layer;
h) flame application time (i.e. 40 min);
i) the number of burners (i.e. one or two);
j) the extent of damage;
k) the time to extinction of all burning or glowing.

Dimensions in millimetres

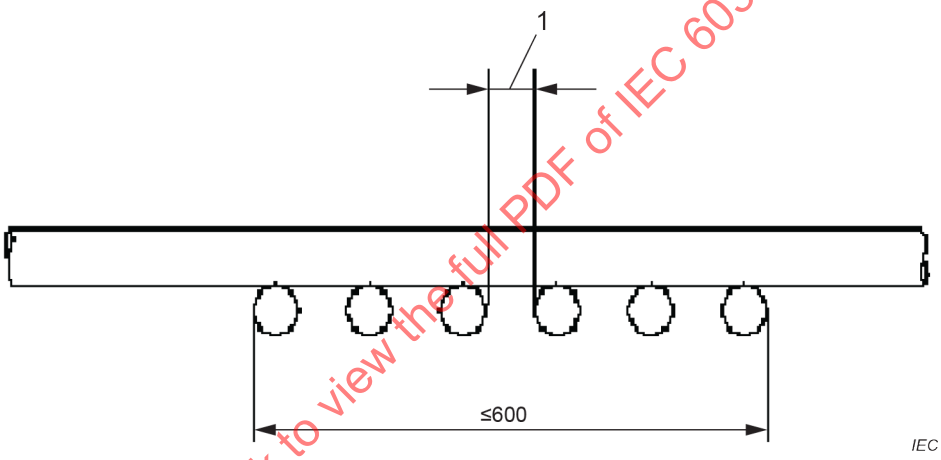


Key

1 spacing distance

Figure 1 – Spaced cables mounted on the front side of the standard ladder

Dimensions in millimetres

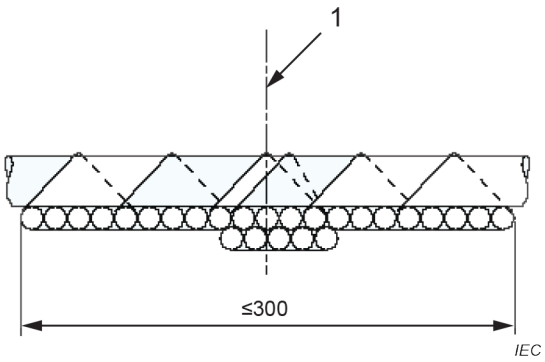


Key

1 spacing distance

Figure 2 – Spaced cables mounted on the front side of the wide ladder

Dimensions in millimetres



Key

1 centre line of ladder

Figure 3 – Touching cables mounted on front side of the standard ladder (arrays of cables in contact)

Annex A
(normative)

Guidance on cable selection for type approval testing

The choice of cable type and conductor cross-section for type approval testing shall be as given in the cable specification, or as agreed between purchaser and manufacturer.

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 specified method of mounting. Therefore, the selection of cables for this document shall comply with the following:

- only the front face of the ladder shall be used;
- for cables having a conductor cross-section greater than 35 mm^2, there shall not be 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;
- for cables having a conductor cross-section of 35 mm^2 or smaller and optical cables, there is no restriction on cable selection;
- the minimum number of test pieces shall be two.

A summary of all conditions for type approval testing to this document is given in Table A.1.

Table A.1 – Summary of test conditions

Category and designation	A	
Range of conductor cross-sections (mm^2)	> 35[a]	≤ 35[b]
Non-metallic volume per metre of test sample (l)	7	7
Use of standard ladder, maximum width of test sample: 300 mm		
– number of layers:	1	≥ 1
– number of burners:	1	1
Use of wide ladder, maximum width of test sample: 600 mm		N/A[c]
– number of layers:	1	–
– number of burners:	2	–
Positioning of test pieces	Spaced	Touching
Flame application time (min)	40	40

[a] At least one conductor greater than 35 mm^2.

[b] No conductor cross-section exceeding 35 mm^2 or optical cable.

[c] N/A = not applicable.

Annex B
(informative)

Recommended performance requirements

The maximum extent of the charred portion measured on the sample shall not have reached a height exceeding 2,5 m above the bottom edge of the burner.

This recommended performance requirement confirms, on the basis of experience gained, the value previously given in IEC TR 60332-3:1992, 2.8.1.

Bibliography

IEC TR 60332-3:1992[1], *Tests on electric cables under fire conditions – Part 3: Tests on bunched wires or cables*

ISO 13943:2017, *Fire safety – Vocabulary*

[1] Withdrawn.

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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

Partie 3-22: Essai de propagation verticale de la flamme des fils ou câbles montés en nappes en position verticale – Catégorie A

AVANT-PROPOS

1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
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7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 60332-3-22 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.

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
20/1799/FDIS	20/1816/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 ce document 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 au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

L'IEC 60332-3-22 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 former 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 distinguées 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 dont au moins un conducteur est 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 en 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 ELECTRIQUES ET DES CÂBLES À FIBRES OPTIQUES SOUMIS AU FEU –

Partie 3-22: Essai de propagation verticale de la flamme des fils ou câbles montés en nappes en position verticale – Catégorie A

1 Domaine d'application

La présente partie de l'IEC 60332 couvre la catégorie A 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.

Le présent document concerne les câbles montés sur l'échelle d'essai afin d'obtenir un volume total nominal de matériau non métallique de 7 l/m d'échantillon d'essai. La durée d'application de la flamme est de 40 min. La méthode de montage utilise la face avant de l'échelle, celle-ci étant du type standard ou du type large pour les câbles dont au moins un conducteur est de section supérieure à 35 mm^2 selon le nombre d'éprouvettes exigé, et du type standard pour les câbles dont tous les conducteurs sont de sections inférieures ou égales à 35 mm^2. Cette catégorie est prévue pour une utilisation générale lorsqu'il est requis d'évaluer le comportement de volumes élevés de matériau non métallique.

L'essai est prévu pour les essais d'acceptation de type. Les exigences pour la sélection des câbles pour l'acceptation de type sont données à l'Annexe A. La propagation de la flamme est mesurée comme étant l'étendue de la partie endommagée de l'échantillon de câble. Cette procédure peut être utilisée pour démontrer l'aptitude du câble à limiter la propagation de la flamme.

L'Annexe B donne une recommandation pour l'exigence de performance.

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

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60332-3-10, *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 60811-606, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 606: Essais physiques – Méthodes de détermination de la masse volumique*

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]

3.2
résidu charbonneux
résidu carboné, résultant d'une pyrolyse ou d'une combustion incomplète

[SOURCE: ISO 13943:2017, 3.47]

3.3
propagation de flamme
propagation d'un front de flamme

[SOURCE: ISO 13943:2017, 3.168]

4 Appareillage d'essai

4.1 Généralités

L'appareillage spécifié dans l'IEC 60332-3-10 doit être utilisé.

4.2 Source d'allumage

La source d'allumage doit être constituée par un ou deux brûleurs à propane du type à ruban, tel qu'il est spécifié dans l'IEC 60332-3-10.

Un seul brûleur doit être utilisé avec l'échelle du type standard et deux brûleurs avec l'échelle du type large.

5 Procédure d'essai

5.1 Echantillon d'essai

L'échantillon d'essai doit comprendre un certain nombre de tronçons de câble issus de la même longueur de production, ayant chacun une longueur minimale de 3,5 m.

Le nombre total de tronçons de câble constituant l'échantillon d'essai doit être égal au nombre requis pour fournir un volume total nominal de matériau non métallique de 7 l/m d'échantillon d'essai.

L'échantillon d'essai pour l'acceptation de type doit être conforme à l'Annexe A.

Les tronçons de câble formant l'échantillon d'essai doivent être conditionnés à une température de (20 ± 10) °C pendant au moins 16 h avant de commencer l'essai. Les tronçons de câble doivent être secs.

5.2 Détermination du nombre de tronçons de câble

Pour calculer le nombre approprié de tronçons de câble, il est nécessaire de déterminer le volume par mètre de matériau non métallique d'un tronçon de câble.

Une longueur de câble qui ne doit pas être inférieure à 0,3 m est soigneusement coupée de telle manière que les surfaces coupées soient perpendiculaires à l'axe du câble, permettant ainsi une mesure précise de sa longueur.

La masse volumique de chaque composant non métallique (y compris les matériaux cellulaires) doit être mesurée par une méthode appropriée, par exemple selon l'IEC 60811-606, afin d'obtenir des valeurs exprimées avec deux décimales.

Chaque matériau non métallique C_i doit être retiré de l'échantillon et pesé. Tout matériau non métallique entrant pour moins de 5 % dans la masse totale non métallique du tronçon de câble doit être considéré comme ayant une masse volumique de 1,0 kg/dm^3.

Lorsque les écrans semi-conducteurs ne peuvent pas être séparés des matériaux d'isolation, ils peuvent être considérés comme faisant partie de l'isolant pour la mesure de leur masse et de leur masse volumique.

Le volume V_i (en litres par mètre de câble) de chaque composant non métallique C_i est calculé comme suit:

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

où

M_i est la masse du composant C_i (kg);

ρ_i est la masse volumique du composant C_i (kg/dm^3);

l est la longueur de l'échantillon de câble (m).

Le volume total, V, de matériau non métallique contenu dans 1 m de câble est égal à la somme des volumes individuels V_1, V_2, etc.

Le nombre de tronçons de câble à monter est obtenu en prenant le nombre entier le plus proche (0,5 et au-dessus correspondant à 1) du rapport entre le volume par mètre spécifié en 5.1 et le volume total, V, de matériau non métallique par mètre de câble, soumis à un nombre minimal de deux tronçons de câble.

5.3 Montage de l'échantillon d'essai

5.3.1 Câbles dont au moins un conducteur est de section supérieure à 35 mm^2

Pour les câbles dont au moins un conducteur est de section supérieure à 35 mm^2, chaque tronçon de câble doit être attaché individuellement à chaque barreau de l'échelle au moyen d'un fil métallique (en acier ou en cuivre). Pour les câbles de diamètre inférieur ou égal à 50 mm, utiliser un fil de diamètre compris entre 0,5 mm et 1,0 mm. Pour les câbles de diamètre supérieur à 50 mm, utiliser un fil de diamètre compris entre 1,0 mm et 2,5 mm.

Les tronçons de câble doivent être attachés en une seule couche sur la face avant de l'échelle avec un espacement entre chaque tronçon de câble de 0,5 fois le diamètre du câble, sans toutefois excéder 20 mm. L'échelle peut être soit du type standard soit du type large, selon ce qui est nécessaire pour avoir une distance minimale de 50 mm entre le bord de l'échantillon d'essai et l'intérieur des montants de l'échelle. Lorsqu'il n'est pas possible d'avoir une distance minimale de 50 mm entre le bord de l'échantillon d'essai et l'intérieur de l'échelle standard, l'échelle large doit être utilisée.

La largeur maximale de l'échantillon d'essai doit être de 300 mm pour l'échelle standard et de 600 mm pour l'échelle large (voir Figures 1 et 2). Lorsque l'échelle large est utilisée, il ne doit pas y avoir plus de câble que le nombre nécessaire pour former une seule couche d'une