IEC 60331-4

Edition 1.0 2024-12

INTERNATIONAL STANDARD

colour inside

GROUP SAFETY PUBLICATION

Tests for electric cables under fire conditions – Circuit integrity – Part 4: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1kV up to and including 30 kV

IEC 60331-4:2024-12(en)

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FOREWORD

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IEC 60331-4 has been prepared by IEC technical committee 20: Electric cables. It is an International Standard.

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

Draft	Report on voting
20/2194/FDIS	20/2215/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

A list of all parts in the IEC 60331 series, published under the general title *Tests for electric cables under fire conditions – Circuit integrity*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn, or
- revised.

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

INTRODUCTION

The IEC 60331 series consists of the following parts:

IEC 60331-1, *Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*

IEC 60331-2, *Tests for electric cables under fire conditions – Circuit integrity – Part 2: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm*

IEC 60331-3, *Tests for electric cables under fire conditions – Circuit integrity – Part 3: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV tested in a metal enclosure*

IEC 60331-4, *Tests for electric cables under fire conditions – Circuit integrity – Part 4: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1 kV up to and including 30 kV*

IEC 60331-11, *Tests for electric cables under fire conditions – Circuit integrity – Part 11: Apparatus – Fire alone at a flame temperature of at least 750 °C*

IEC 60331-21, *Tests for electric cables under fire conditions – Circuit integrity – Part 21: Procedures and requirements – Cables of rated voltage up to and including 0,6/1,0 kV*

IEC 60331-23, *Tests for electric cables under fire conditions – Circuit integrity – Part 23: Procedures and requirements – Electric data cables*

IEC 60331-25, *Tests for electric cables under fire conditions – Circuit integrity – Part 25: Procedures and requirements – Optical fibre cables*

NOTE 1 IEC 60331-21, IEC 60331-23 and IEC 60331-25 relate to fire-only conditions at a flame temperature of at least 750 °C.

NOTE 2 IEC 60331-11, IEC 60331-21, IEC 60331-23 and IEC 60331-25 are no longer subject to maintenance. The relevant test procedures are given in IEC 60331-1 and IEC 60331-2.

Since its first edition (1970), the IEC 60331 series has been extended and has introduced a range of test apparatus in order that a test can be carried out on large and small power, control, data and optical fibre cables.

Successful tests carried out in accordance with this document will enable an identification to be marked on the product.

TESTS FOR ELECTRIC CABLES UNDER FIRE CONDITIONS – CIRCUIT INTEGRITY –

Part 4 – Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1 kV up to and including 30 kV

1 Scope

This part of the IEC 60331 series specifies the test apparatus and procedure, and gives the performance requirements, including recommended flame application times and flame temperatures, for power cables of rated voltage higher than 0,6/1,0 kV up to and including 18/30 kV for maintaining circuit integrity when subject to fire and mechanical shock under specified conditions.

The test method in this document is restricted to conductor sizes up to and including 120 mm^2. The test results for 120 mm^2 size conductors constructions qualify larger cross-sections of the same cable construction.

In the case of preassembled three-core cables, then the complete cable is considered as tested when a complete single-core of the cable has been tested.

This document includes details for the specific point of failure, continuity checking arrangement, test sample, test procedure and test report relevant to electric power cables with a rated voltage higher than 0,6/1,0 kV up to and including 18/30 kV.

Annex A provides the method of verification of the burner and control system used for the test. Annex B provides a choice of the recommended test apparatus.

Annex C provides, as an option, guidance for using either water spray or water jet protocols.

Annex D provides, as an option, the flame temperature of 1 000 °C, which is applicable for special applications.

Requirements are stated for an identification that can optionally be marked on the cable to signify compliance with this document.

This group safety publication focusing on the test method for circuit integrity safety for power cables of rated voltage higher than 1 kV up to and including 30 kV under fire conditions, is primarily intended to be used as a product safety standard for the products mentioned in the scope, but is also intended to be used by TCs in the preparation of publications for products similar to those mentioned in the scope of this group safety publication, in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a TC is, wherever applicable, to make use of either BSPs or GSPs, or both, in the preparation of its publications.

WARNING – The test given in this document can involve the use of dangerous voltages and temperatures. Suitable precautions should be taken against the risk of shock, burning, fire and explosion that can arise, and against any noxious fumes that can be produced.

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 60584-1, *Thermocouples – Part 1: EMF specifications and tolerances*

3 Terms and definitions

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

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

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

3.1
circuit integrity
ability of an electric cable to continue to operate in a designated manner whilst subjected to a specified flame source for a specified period of time under specified conditions

3.2
draught-free environment
space in which the results of tests are not significantly affected by the local air speed

4 Test conditions

The test shall be carried out in a draught-free environment within a suitable chamber, of minimum volume 20 m^3, with facilities for disposing of any noxious gases resulting from the burning. Sufficient ventilation shall be available to sustain the flame for the duration of the test. Air inlets and the exhaust chimney should be located in such a way that the burner flame remains stable during the verification procedure and test. If necessary, the burner shall be shielded from any draughts by the use of draught shields. Windows may be installed in the walls of the chamber in order to observe the behaviour of the cable during the test. Fume exhaust should be achieved by means of natural draught through a chimney located at least 1 m from the burner. A damper may be used for adjustment of ventilation conditions.

NOTE Experience has shown a chamber similar to the "3 m cube" specified in IEC 61034-1 to be suitable, although other chambers of suitable volume can be used.

The chamber and test apparatus shall be at a temperature of between 10 °C and 40 °C at the start of each test.

The same ventilation and shielding conditions shall be used in the chamber during both the verification and cable test procedures.

5 Test apparatus

5.1 Test equipment

The test equipment shall consist of the following:

a) a test ladder, onto which the test specimen is mounted, comprising a steel framework fastened to a rigid support as described in 5.2;

b) a source of heat comprising a horizontally mounted ribbon burner as described in 5.3;

c) a shock-producing device as described in 5.4;

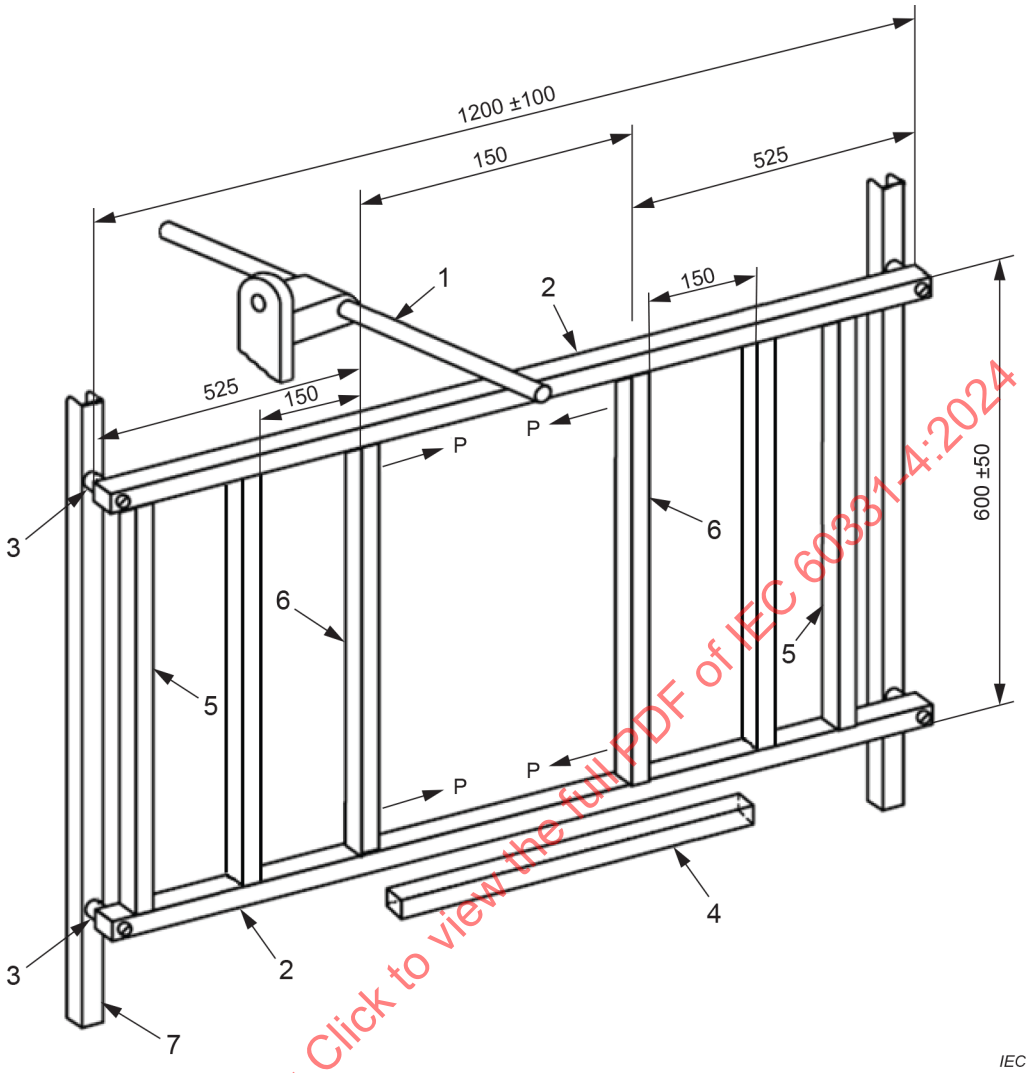
d) a test wall equipped with thermocouples for verification of the source of heat as described in Annex A;

e) a voltage supply arrangement as described in 5.6;

f) and optionally: a water spray or water jet as described in Annex C.

A general arrangement of the test equipment is shown in Figure 1, Figure 2 and Figure 3.

Dimensions in millimetres (dimensions without tolerances are approximate)

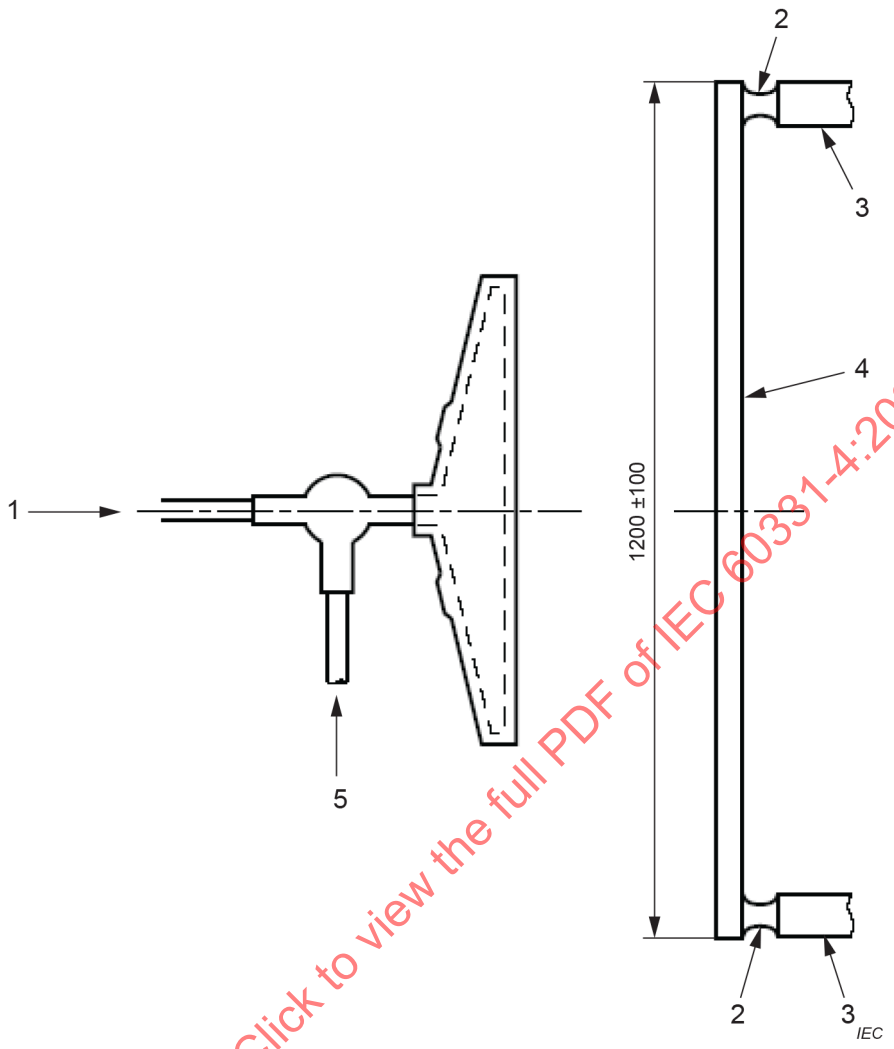


Key

1	shock producing device	5	fixed vertical elements of test ladder
2	steel test ladder	6	adjustable vertical elements of test ladder
3	rubber bush	7	rigid support framework
4	ribbon gas burner	P	plane of adjustment

Figure 1 – Schematic diagram of test configuration (not to scale)

Dimensions in millimetres

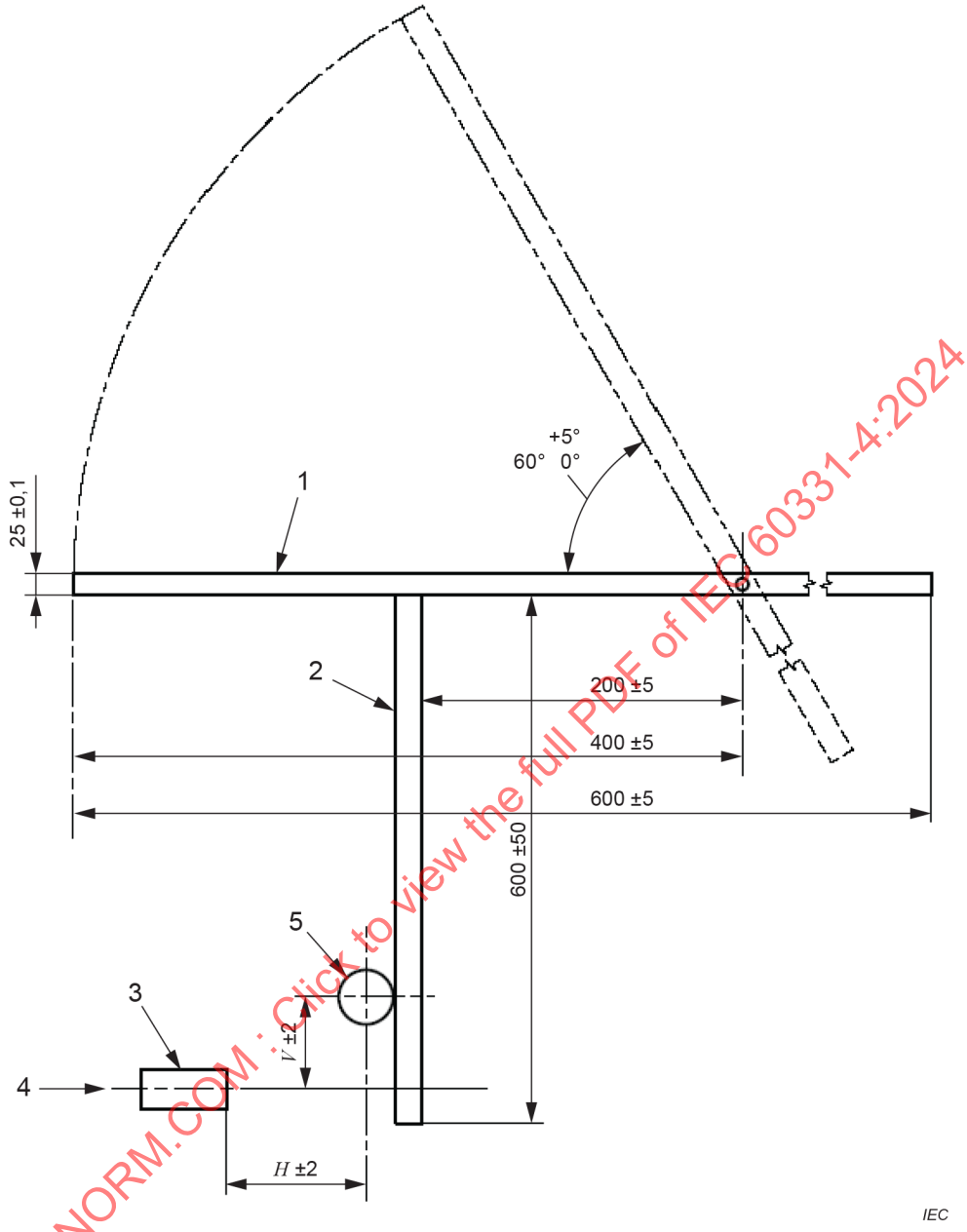


Key

1	entry for air	4	horizontal steel test ladder
2	rubber bush	5	entry for propane gas
3	support framework		

Figure 2 – Plan view of fire test equipment

Dimensions in millimetres



Key

1	shock producing device	*H*	horizontal distance from burner face to the centre line of test specimen
2	steel test ladder	*V*	vertical distance from centre line of burner to the centre line of test specimen
3	gas burner		
4	centre line of burner face		
5	test sample		

Figure 3 – End elevation of fire test equipment (not to scale)

5.2 Test ladder and mounting

The test ladder shall consist of a steel framework as shown in Figure 1. The four central vertical elements of the ladder shall be centrally installed ensuring a distance of (150 ± 10) mm between each of them. The test ladder shall be (1 200 ± 100) mm long and (600 ± 50) mm high, and the total mass of the test ladder shall be (24 ± 1) kg. Ballast, if required, shall be placed on the steel supports.

NOTE 1 Angle iron approximately 45 mm wide and 6 mm thick, with suitable slots cut to enable the fixing of the bolts or saddles, has been found to be a suitable material for construction of the ladder.

Each horizontal element shall have a mounting hole not more than 200 mm from each end, the exact position and diameter being determined by the particular supporting bush and supporting framework used. The test ladder shall be fastened to a rigid support by four bonded rubber bushes of hardness 50 to 60 Shore A fitted between the horizontal steel elements of the ladder and the support framework, as shown in Figure 1 and Figure 2 so as to allow movement under impact.

NOTE 2 A typical rubber bush, which has been found to be suitable, is shown in Figure 4.

Dimensions in millimetres
(dimensions without tolerances are approximate)

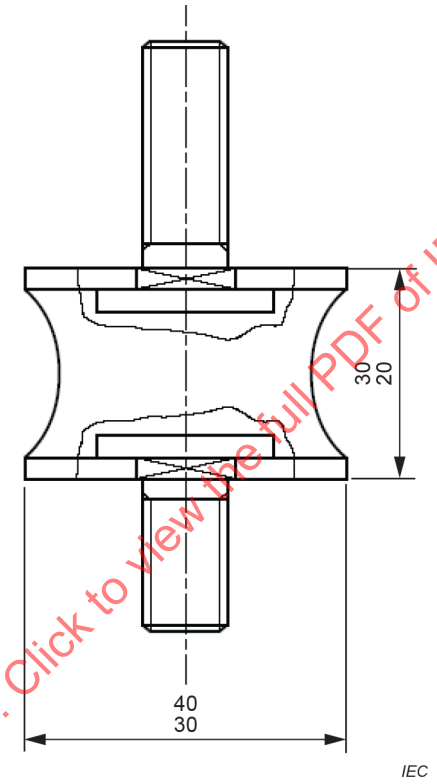


Figure 4 – Typical rubber bush for supporting the test ladder

5.3 Source of heat

5.3.1 Burner

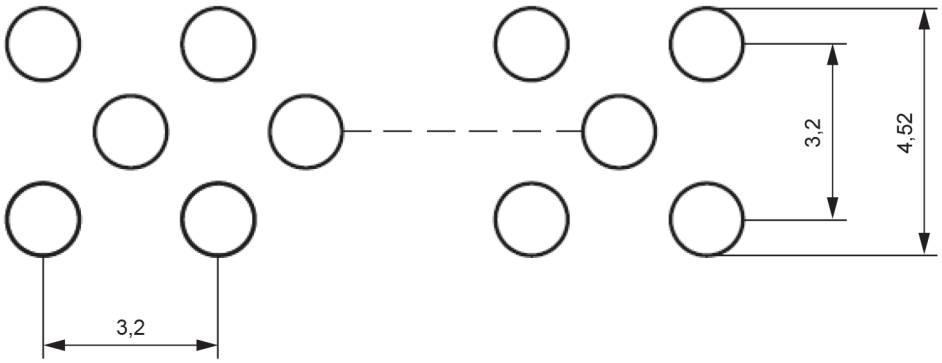
The source of heat shall be a ribbon type propane gas burner with a nominal burner face length of 500 mm with a Venturi mixer. The nominal burner face width shall be 10 mm. The face of the burner shall have three staggered rows of drilled holes, nominally 1,32 mm in diameter and drilled at centres 3,2 mm from one another, as shown in Figure 5.

A centre-feed burner is recommended.

A row of small holes milled on each side of the burner plate, to serve as pilot holes for keeping the flame burning, is permitted.

Guidance on the choice of a recommended burner system is given in Annex B.

Dimensions in millimetres



NOTE Round holes are 1,32 mm in diameter, on centres 3,2 mm from one another, staggered in three rows and centred on the face of the burner. The nominal burner face length is 500 mm.

Figure 5 – Burner face

5.3.2 Flow meters and flow rates

Mass flow meters or mass flow controllers shall be used as the means of controlling accurately the input flow rates of fuel and air to the burner.

For the purposes of this test, the air shall have a dew point not higher than 0 °C. The purity of the propane is at minimum 95 %.

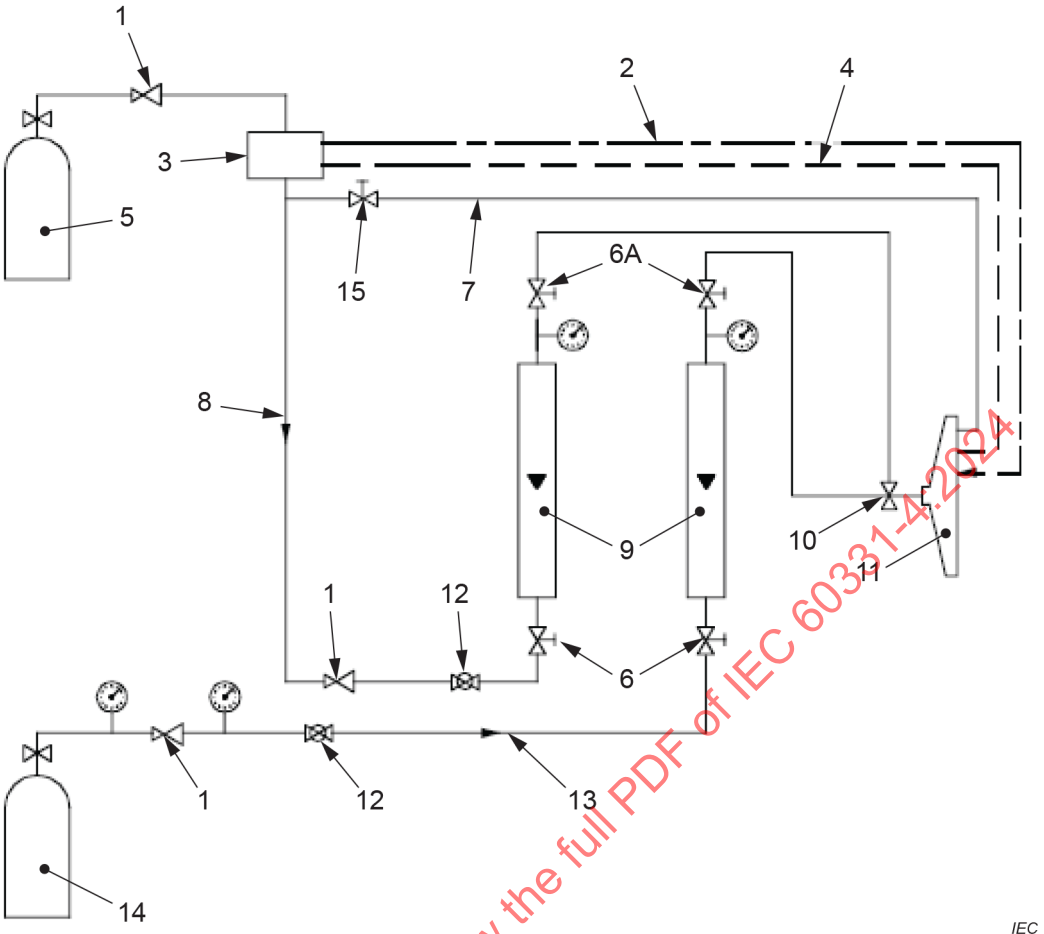
For a flame temperature of 830^{+40}_{0} °C, the mass flow rates used for the test shall be as follows:

propane: (335 ± 13) mg/s;

air: (3 200 ± 160) mg/s.

NOTE Equivalent flow rate in l/min can be estimated provided there is a density of 2,01 g/l for propane and 1,29 g/l for air in standard conditions (101,3 kPa, 0 °C).

A schematic diagram of an example of a burner control system is given in Figure 6.



Key

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

Figure 6 – Schematic diagram of an example of a burner control system

5.3.3 Verification

The burner and control system shall be subject to verification following the procedure given in Annex A.

5.4 Shock producing device

The shock producing device shall consist of a mild steel round bar (25,0 ± 0,1) mm in diameter and (600 ± 5) mm long. The bar shall be freely pivoted about an axis parallel to the test ladder, which shall be in the same horizontal plane as, and (200 ± 5) mm away from, the upper edge of the ladder. The axis shall divide the bar into two unequal lengths, the longer length being (400 ± 5) mm which shall impact the ladder. The bar shall drop under its own weight from an angle of (60^{+5}_{0}) to the horizontal to strike the upper edge of the ladder at its midpoint as shown in Figure 1 and Figure 3.

5.5 Positioning of source of heat

The burner face shall be positioned in the test chamber so that it is at least 200 mm above the floor of the chamber, or any solid mounting block, and at least 500 mm from any chamber wall.

By reference to the centre point of the test specimen (cable) to be tested, the burner shall be positioned centrally at a horizontal distance of (H ± 2) mm from the burner face to the centre of the test specimen and at a vertical distance of (V ± 2) mm from the burner horizontal central plane to the centre of the test specimen, as shown in Figure 3.

The exact burner location to be used during cable testing shall be determined using the verification procedure given in Annex A, where the values of H and V to be used shall be determined.

The burner should be rigidly fixed to the framework during testing so as to prevent movement relative to the test specimen.

5.6 Voltage supply arrangement

The voltage supply shall be provided by a three-phase star connected or single-phase transformer(s) of sufficient capacity to maintain the test voltage up to the maximum leakage current allowable.

A circuit-breaker shall be used to detect any breakdowns by controlling the earth leakage current with a 30 mA threshold.

6 Test specimen

6.1 Test specimen preparation

A cable sample at least 6 m long shall be available from the cable length for test. Each individual test specimen to be tested shall consist of a piece of cable, taken from the cable sample, not less than 2 000 mm long with approximately 300 mm of sheath or outer covering removed at each end.

Before testing, all cable samples shall be conditioned at (23 ± 5) °C for not less than 16 h at a relative humidity of (50 ± 20) %.

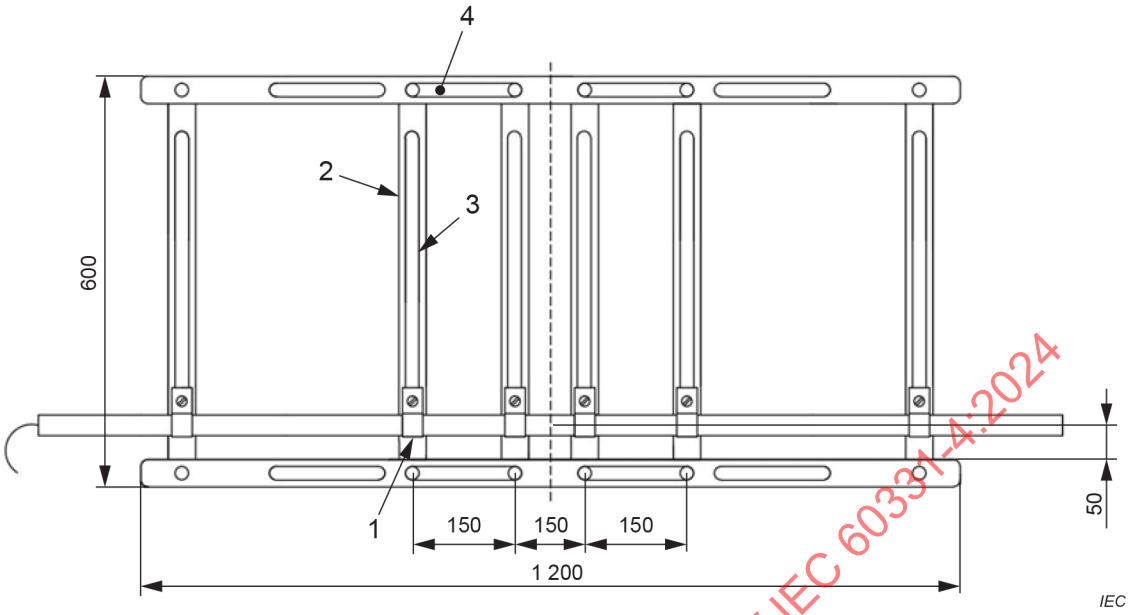
At each end of the test specimen each conductor shall be suitably prepared for electrical connections, and, if there is more than one conductor, the exposed conductors shall be spread apart to avoid contact with each other.

All metal layers and all semi-conductive layers over the insulation shall be stripped on a length long enough to avoid an electrical arc. For connections see 7.2.

6.2 Test specimen mounting

The test specimen shall be mounted straight centrally on the test ladder using the two fixed vertical elements and the four adjustable vertical elements, as shown in Figure 7, using metal clips to fix the cable to these vertical elements. The clips shall be earthed P-clips made of metal strip (20 ± 2) mm wide for cables up to 50 mm in diameter, and (30 ± 3) mm wide for larger cables and shall be used on the four central vertical elements. The P-clips shall be formed so as to have approximately the same diameter as the test specimen under test.

Dimensions in millimetres
(dimensions are approximate)



Key

1	P-clip	3	slot for P-clip fixing
2	adjustable vertical elements	4	slot for movement of adjustable vertical elements

Figure 7 – Method of mounting test specimen

7 Test procedure

7.1 Test equipment and arrangement

The test procedure shall be carried out using the apparatus detailed in Clause 5.

Mount the test specimen on the test ladder and adjust the burner to the correct position relative to the test specimen in accordance with 5.5.

7.2 Electrical connections and electrification

The insulation surface shall be smooth and clean.

At least one end of the protective conductors, metal screens, or metallic layer shall be connected to the earth of the voltage supply.

Connect the transformer(s) to the conductors. For single- or three-phase cables connect each phase conductor to a separate phase of the transformer(s) output with a circuit-breaker.

Alternatively, three-phase conductors with individual metal screens can be connected to a single phase transformer so that the usage of a three-phase transformer is unnecessary.

The other ends of conductor and screens can be left unconnected depending on the type of electrical supply and short-circuit detection system.

7.3 Flame, shock application and voltage supply

Ignite the burner and adjust the propane and air flow rates to those obtained during the verification procedure depending on the required temperature (see Annex A). The fire shall impinge the cable during the test. Immediately after, start the test duration timer and switch on the electricity supply adjusting the voltage to the rated voltage of the cable (subject to a maximum voltage of 30 kV AC), i.e. the test voltage between conductors shall equal the rated voltage between conductors, and the test voltage from conductor to earth shall equal the rated voltage from conductor to earth.

NOTE IEC 60060-1 gives information regarding electrical test equipment.

Activate the shock-producing device. The shock-producing device shall impact the ladder after 5 min ± 10 s from activation and subsequently at 5 min ± 10 s intervals. After each impact, the impacting bar shall be raised from the test ladder no more than 20 s after the impact.

7.4 Optional water spray or water jet

In case a water spray or water jet is required by the customer, the specific device shall be activated for a specific period of time. Annex C describes the two possible alternatives.

8 Performance requirements

8.1 Flame application time

The flame application time shall be as specified in the relevant cable standard. In the absence of such a standard, a flame application time of a minimum of 30 min, 60 min, 90 min or 120 min shall be chosen.

8.2 Acceptance criteria

With reference to the test procedure given in Clause 7, the cable possesses the characteristics for providing circuit integrity so long as during the course of the test

– the voltage is maintained at least for the specified duration without breakdown;

– a conductor does not rupture, i.e. after the test using a multimeter the continuity between each extremities of the conductors is validated.

Failure by either one of the criteria listed shall be sufficient to show a failure for that cable.

9 Retest procedure

In the event of a failure, as judged by the requirements of the relevant standard, two further test specimens, taken from the same cable sample, shall be tested. If both comply, the test shall be deemed successful.

10 Test report

The test report shall include the following information:

a) the number of this document;
b) a full description of the cable tested;
c) the manufacturer of the cable tested;
d) the test voltage;
e) any options used in the test procedure (i.e. failure detection method);
f) the type and disposition of clips supporting the cable sample;
g) the method used for temperature monitoring during the verification procedure;
h) the point of failure mechanism (i.e. voltage not maintained or conductor rupture);
i) the actual performance requirement applied (by reference to Clause 8);
j) the flame application time;
k) the chamber volume and temperature at the start of the test.

11 Cable marking

If a cable is required to be marked to signify compliance with this document, it shall be marked with the number of this document and the duration of flame application, as follows: "IEC 60331-4 (XX)" where XX shall be the duration in minutes. The marking shall be in addition to any requirement of the cable standard.

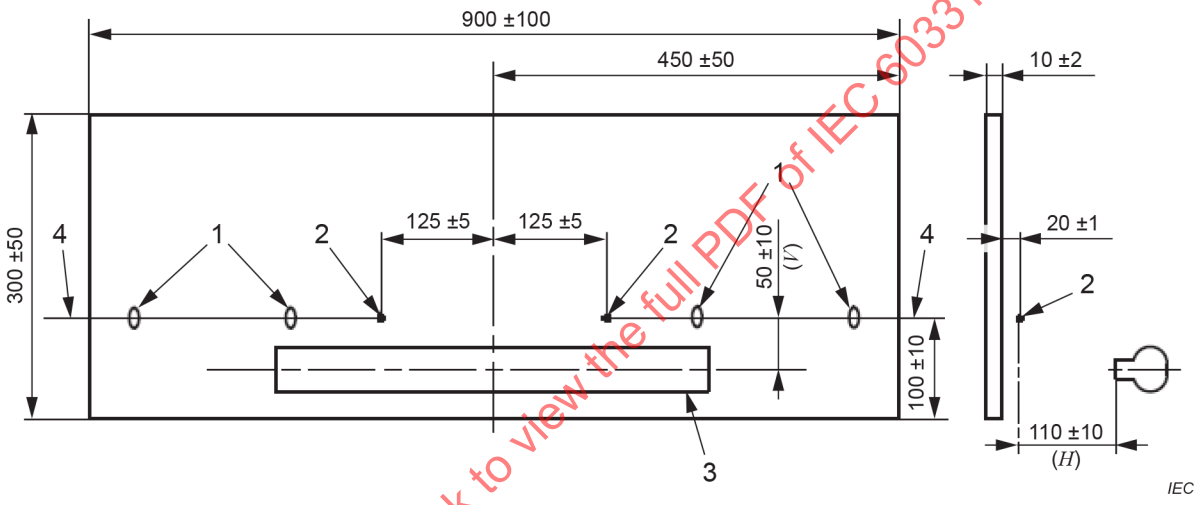
Annex A
(normative)

Verification procedure for the source of heat

A.1 Measuring equipment

The flame temperature shall be measured using two 1,5 mm mineral insulated, stainless steel sheathed thermocouples type K in accordance with IEC 60584-1, mounted on the test wall as shown in Figure A.1. The thermocouple tips shall be (20,0 ± 1,0) mm in front of the test wall. The horizontal line of the thermocouples shall be (100 ± 10) mm above the bottom of the wall. The wall shall consist of a board of heat-resistant, non-combustible and non-metallic material (900 ± 100) mm long, (300 ± 50) mm high and (10 ± 2) mm thick.

Dimensions in millimetres



Key

1 thermocouple supports
2 thermocouple tip
3 burner
4 1,5 mm type K sheathed thermocouples
H horizontal distance of thermocouple tip from burner face
V vertical distance of thermocouple tip from centre line of burner

Figure A.1 – Temperature measuring arrangement

A.2 Procedure

Position the burner 100 mm to 120 mm horizontally from the thermocouple (H) and 40 mm to 60 mm vertically below the centre line of the thermocouples (V) as shown in Figure A.1.

Ignite the burner and adjust the gas and air supplies to those given in 5.3 depending on the required temperature.

Monitor the temperature as recorded by the thermocouples over a period of 10 min to ensure conditions are stable.

A.3 Evaluation

The verification procedure shall be considered satisfactory if:

a) the arithmetic mean of the averaged readings for each of the two thermocouples over the 10 min falls within the requirement of 830^{+40}_{0} °C;

b) the difference of the averaged readings for each of the two thermocouples over the 10 min period does not exceed 40 °C.

At least one measurement shall be made every 30 s in order to obtain the average.

The actual method of obtaining the average thermocouple reading over the period is not specified, but it is recommended that a recorder with averaging facilities is used in order to damp the variability caused by point measurement.

If the verification is not successful, the flow rates shall be altered within the tolerances given in 5.3 and a further verification carried out.

A.4 Further verification

If the verification of Clause A.3 is not successful, the distances (H and V) between the burner and thermocouples shall be altered (within the tolerance given in Clause A.1) and a further verification carried out.

If no successful verification can be achieved within the tolerances given, then the burner system shall be considered as incapable of providing the source of heat required by this document.

A.5 Verification report

The position established for successful verification (H and V) and flow rates used shall be recorded.

Annex B
(informative)

Guidance on the choice of recommended test apparatus

A commercially available burner face meeting the recommendations of this document is the AGF burner insert 11-55, and a suitable 500 mm burner, including the specified burner face, is the AGF, reference 1857B[1]. A recommended Venturi mixer is the AGF 14-18.

[1] AGF burner insert 11-55, AGF 1857B and AGF 14-18 are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the products named. Equivalent products may be used if they can be shown to lead to the same results.

Annex C
(informative)

Guidance for using optional water spray or water jet protocol

C.1 General

A requirement to withstand a water spray or water jet when assessing resistance to fire can be a feature of national standards or codes of practice or particular product standards.

Where the water spray or water jet requirement is necessary the requirements given in Clause 4 to Clause 10 shall apply with the modifications in Clause C.2.

During this test the cable extremities shall be protected.

C.2 Modifications for optional water spray or jet protocols

C.2.1 Water spay device – Option A

The water spray bar shall consist of a metallic tube (copper or stainless steel) of nominal thickness 1,00 mm and overall diameter (15,5 ± 1,0) mm, closed at one end and open at the other to allow the inflow of water. The inflow of water shall be maintained at an approximately constant water pressure.

The tube shall have one row of 17 holes of nominal 0,85 mm diameter drilled on 30 mm centres as shown in Figure C.1.

The bar shall be positioned centrally with respect to the test sample as shown in Figure C.2.

The output of water from the bar shall be at a flow rate of (0,80 ± 0,05) l/min. This shall be verified by volumetric measurement.

The tube shall be capable of adjustment such that the resulting water spray is centralized around the burned portion of the test sample.

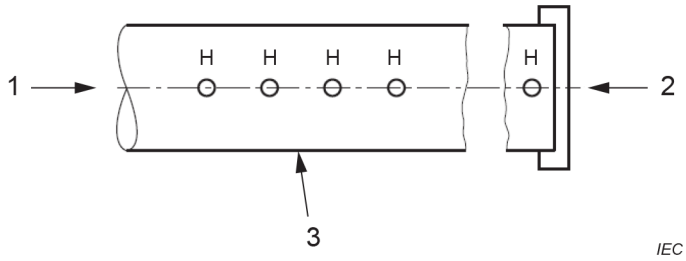
The use of a metal plate device over the burner to avoid ingress of water is permitted. If a plate is used, the verification shall be carried out with the metal plate in place.

NOTE A steel plate of suitable thickness extending horizontally 12 mm from the burner face and fixed 12 mm vertically above the centre line of the burner has been found to be satisfactory.

If the metal plate device is not used, the flame is likely to be extinguished. In such cases the gas supply should be turned off and a new test carried out.

The water spray shall be applied for the last 15 min of the test, for example, for a 120 min test, after 105 min, the water spray shall be applied until the end of the 120 min test.

The duration of survival, measured in minutes, to the point of failure shall be recorded for each cable tested.

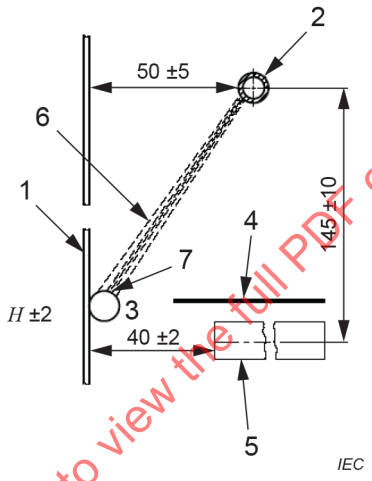


Key

1	inflow of water	3	metallic tube – diameter = (15,5 ± 1,0) mm
2	closed end	H	17 holes at nominal 30 mm centres

Figure C.1 – Water spray tube

Dimensions in millimetres



Key

1	steel test ladder	5	burner
2	water spray tube	6	spray directed at sample
3	test sample	7	centre point of spray
4	metal plate (see note in C.2.1)		

Figure C.2 – Water spray application

C.2.2 Water jet device – Option B

Comprising a 6,3 mm hose nozzle as shown in Figure C.3 (see IEC 60529:1989, Clause 14 and IEC 60529:1989/AMD2:2013, Clause 14), mounted above the test specimen at an angle of (45 ± 5)° to the vertical and at a distance of (500 ± 25) mm and secured such that the water jet strikes the test specimen in the middle as shown in Figure C.4. The nozzle is not directly attached to the metal frame but at a distance of 150 mm as shown in Figure C.5.

Dimensions in millimetres
(dimensions are approximate)

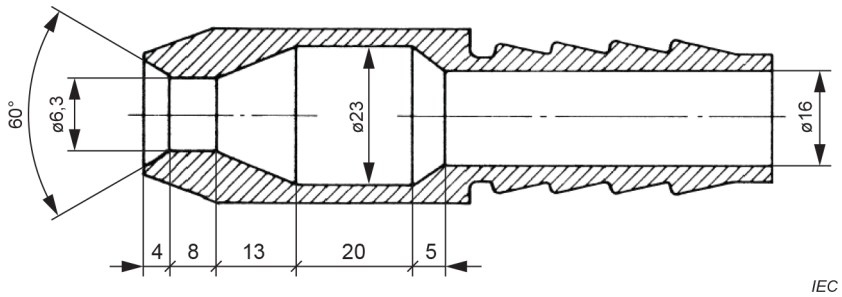


Figure C.3 – Hose nozzle

The nozzle shall be supplied with water at a flow rate of 12,5 l/min via an on/off valve. The flow rate shall be measured by a volumetric method prior to the test and the water supply adjusted if necessary. The water supply pipe shall be fitted with an in-line flow meter so that the water flow rate can be monitored during the test.

Five minutes before the end of the flame application, activate the water jet device and apply a burst of water of 5 s duration. Sixty seconds after the start of this burst of water apply a further burst of water of 5 s duration. Repeat this procedure until a total of 5 bursts of water have been applied. Maintain the test voltage throughout the water drenching phase even if the flame is extinguished by the water.

The nozzle shall not be fixed directly on the rig so as to not impact or to be impacted by the effect of vibration.