SLOVENSKI STANDARD
SIST EN 50399:2022

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Nadomešča:
SIST EN 50399:2011
SIST EN 50399:2011/A1:2016

Skupne preskusne metode za ognjevzdržnost kablov - Meritve oddajanja toplote in nastajanja dima na kablih med preskusom z razpršenim plamenom - Preskusna naprava, postopki, rezultati

Common test methods for cables under fire conditions - Heat release and smoke production measurement on cables during flame spread test - Test apparatus, procedures, results

Allgemeine Prüfverfahren für das Verhalten von Kabeln und isolierten Leitungen im Brandfall - Messung der Wärmefreisetzung und Raucherzeugung während der Prüfung der Flammenausbreitung - Prüfeinrichtung, Prüfverfahren und Prüfergebnis

Méthodes d'essai communes aux câbles soumis au feu - Mesure de la chaleur et de la fumée dégagées par les câbles au cours de l'essai de propagation de la flamme - Appareillage d'essai, procédure et résultats

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ICS:

13.220.40	Sposobnost vžiga in obnašanje materialov in proizvodov pri gorenju	Ignitability and burning behaviour of materials and products
29.060.20	Kabli	Cables

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EUROPEAN STANDARD

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EN 50399

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ICS 13.220.40; 29.060.20

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English Version

Common test methods for cables under fire conditions - Heat release and smoke production measurement on cables during flame spread test - Test apparatus, procedures, results

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European foreword

This document (EN 50399:2022) has been prepared by CLC/TC 20, “Electric cables”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2023-08-08
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2025-08-08

This document supersedes EN 50399:2011 and all of its amendments and corrigenda (if any).

EN 50399:2022 includes the following significant technical changes with respect to EN 50399:2011:

— inclusion of the detailed description of the test apparatus in this document, rather than by reference to EN 60332-3-10 (see 4.1).

— improvements in the test apparatus (see 4.2 to 4.7), including the mandatory use of mass flow controllers for the supply of gases to the burner.

— several improvements of the qualification of the test equipment, including guidance for a check of the flame shape (5.6) and a performance check of the test equipment (5.7).

— additions for testing of flat cables including mounting (see 6.4 and 6.5).

— new informative Annex K (Check of the flame shape for nominal heat output of 20,5 kW).

— new informative Annex L (Guidance on conducting performance checks of the test equipment).

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Any feedback and questions on this document should be directed to the users’ national committee. A complete listing of these bodies can be found on the CENELEC website.

Introduction

EN 50399 specifies the test apparatus and test procedures for the assessment of the reaction to fire performance of cables to enable classification under the Construction Products Regulation [1, 2] to be achieved.

EN 50399 describes an intermediate scale fire test of multiple cables mounted on a vertical cable ladder and is carried out with a specified ignition source to evaluate the burning behaviour of such cables and enable a direct declaration of performance. The test provides data for the early stages of a cable fire from ignition of cables. It addresses the hazard of propagation of flames along the cable, the potential, by the measurement of the heat release rate, for the fire to affect areas adjacent to the compartment of origin, and the hazard, by the measurement of production of light obstructing smoke, of reduced visibility in the room of origin and surrounding enclosures.

The following parameters may be determined under defined conditions during the test:

a) flame spread.

b) heat release rate.

c) total heat release.

d) smoke production rate.

e) total smoke production.

f) fire growth rate index.

g) occurrence of flaming droplets/particles.

The apparatus is derived from that of EN 60332-3-10 [3, 4] but with modifications and with additional instrumentation to measure heat release and smoke production during the test. It has been demonstrated [5] that the utilization of these additional measurement techniques, proven for other standard tests e.g. for other building products, are appropriate for assessing the reaction to fire performance of electric cables. These techniques include heat release and smoke production measurements. Compared with the test methods described in the EN 60332-3 series, they enable a more comprehensive assessment system, which is both more precise and sensitive, and enables a wider range of fire performance levels.

Care should be exercised in relating the parameters measured to different safety levels in actual cable installations as the actual installed configuration of the cables could be a major determinant in the level of flame spread, heat release and smoke production occurring in an actual fire. These parameters depend upon several features, such as:

a) the volume of combustible material exposed to the fire and to any flaming or heat which could 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, multi- or single core.

All the foregoing assumes that the cables can be ignited when involved in an external fire.

The conditions of cable mounting, including volume of material exposed and geometrical configuration of the cables on the test ladder, and volume of airflow through the chamber have been chosen to be in accordance with that required by the Commission Decision 2006/751/EC [6]. CENELEC has not been involved in the definition of these parameters. These standardized conditions provide the basis for classification, as detailed in EN 13501-6 [7] and EN 50575 [2], but do not necessarily correspond to conditions found in a particular cable installation.

EN 50399 gives the detailed description of the test apparatus and details of the test procedures, which are used.

1 Scope

This document specifies the apparatus and methods of test for the assessment of vertical flame spread, heat release, smoke production and occurrence of flaming droplets/particles of vertically mounted electric cables under defined conditions.

NOTE For the purpose of this document, the term “electric cable” covers all power, control and communication cables, including optical fibre cables and hybrid cables used for the conveyance of energy and/or signals.

This document details the apparatus for the fire propagation testing and the arrangement and calibration of the instrumentation to be installed to measure the heat release and the smoke production during the test. The combustion gases are collected in a hood above the test chamber and conveyed through an exhaust system, which allows the measurement of heat release rate and smoke production. Test procedures to be used for type approval testing for classification of cables in classes [2, 7] $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca} are given. Cable installation on the test ladder and the volume of air passing through the chamber are in accordance with the Commission Decision 2006/751/EC [6], which is reflected in the requirements of this document.

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.

EN 60584-1, *Thermocouples - Part 1: EMF specifications and tolerances (IEC 60584-1)*

EN 60811-203, *Electric and optical fibre cables - Test methods for non-metallic materials - Part 203: General tests - Measurement of overall dimensions (IEC 60811-203)*

EN ISO 13943, *Fire safety - Vocabulary (ISO 13943)*

3 Terms and definitions

For this document, the terms and definitions given in EN ISO 13943 and the following apply.

ISO and IEC maintain terminological 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
heat release rate
HRR
thermal energy released per unit time by an item during combustion under specified conditions

3.2
total heat release
THR
integrated value of the heat release rate over a defined period

3.3
smoke production rate
SPR
smoke production per unit time

3.4
total smoke production
TSP
integrated value of the smoke production rate over a defined period

3.5
flame spread
FS
propagation of a flame front

Note 1 to entry: In this document the extent of flame spread is determined as the extent of damage measured by the onset of char.

3.6
fire growth rate index
FIGRA
highest value of the quotient between *HRR* and time

Note 1 to entry: In this document *FIGRA* is expressed in W/s.

Note 2 to entry: Details of the calculation of *FIGRA* are given in Annex G.

3.7
flaming droplet
flaming particle
material separating from the specimen during the test and continuing to flame for a minimum period as described in this test method

3.8
***E′*-value**
heat release per unit volume of oxygen consumed

3.9
electric cable
all power, control and communication cables, including optical fibre cables and hybrid cables which are a combination of two or more of these cable types

3.10
non-circular cable
cables are considered non-circular if the measured difference between any two values of the overall diameter of the cable at the same cross-section exceeds 15 % of the largest overall diameter

Note 1 to entry: So-called figure of 8 cables, consisting of two exactly identical circular cables connected together with a very small, extruded interconnecting link are considered to be non-circular cables.

4 Test apparatus

4.1 General

The test apparatus, as represented in Figure 1, is derived from the equipment defined in IEC 60332-3-10 [3]. It shall be installed inside a building fully protected from the possible influences of the elements (such as wind, temperature and rain). The test shall not be carried out if the ambient temperature in the test chamber and in the building where the test chamber is located is below 5 °C or above 40 °C. The ambient temperature is measured (0,30 ± 0,05) m from an outer sidewall of the test chamber at a location (0,5 ± 0,1) m below the top of the chamber. In addition, prior to the start of a test the back wall temperature inside the test chamber, measured at a point on the back wall (1,50 ± 0,05) m from the floor and (0,50 ± 0,05) m from a sidewall (so centred on the backwall), shall be below 40 °C.

The size of the room where the test apparatus is located shall be large enough to sustain an ambient temperature between 5 °C and 40 °C and a stable flow of the air through the test equipment during the entire duration of the test.

Other equipment having an influence on the oxygen and carbon dioxide concentration levels and/or the airflow in the test room shall not be operated simultaneously with the EN 50399 equipment as that could affect the test.

The test apparatus shall consist of the test chamber, ladder, ignition source (burner), air supply equipment, hood, exhaust duct, extracting ventilator, smoke measuring equipment and combustion gas equipment to determine heat release; these parts are specified in the following paragraphs. A fire extinguishing system may also be present in the test apparatus.

WARNING — Care should be taken in monitoring and extinguishing cable fires once the test specimen has started to propagate fire. Some specimens could generate high heat release rates that could damage the test equipment and instrumentation. It is important that testing staff are sufficiently trained in dealing with such fires and have adequate firefighting facilities at their disposal during testing.

4.2 Test chamber

The test chamber (see Figures 2 and 4) shall have an internal width of (1 000 ± 100) mm, an internal depth of (2 000 ± 100) mm and an internal height of (4 000 ± 100) mm; the floor of the chamber shall be raised above ground level. The test chamber shall be airtight along its sides, air being admitted at the base of the test chamber through an aperture of (800 ± 20) mm × (400 ± 10) mm situated (150 ± 10) mm from the internal face of the front wall of the test chamber and centred relative to the width of the chamber.

An outlet (300 ± 30) mm × (1 000 ± 100) mm shall be made at the rear edge of the top of the test chamber. The rear edge of this outlet can extend up to 60 mm forward of the rear wall of the chamber.

The back, sides and door of the test chamber shall be thermally insulated to give a coefficient of heat transfer of approximately 0,7 $W \cdot m^{-2} \cdot K^{-1}$. For example, a steel plate 1,5 mm to 2,0 mm thick covered with 65 mm of mineral wool with a suitable external cladding is satisfactory (see Figure 4 showing only the back- and sidewalls, but doors shall be properly insulated as well). The distance between the ladder and the internal face of the rear wall of the chamber is (150 ± 10) mm, and between the bottom rung of the ladder and the floor is (400 ± 5) mm (see Figure 5).

A heat-resisting glass window(s) covering a minimum surface area of 0,09 m^2 to observe flaming droplets and the fire propagation shall be mounted in the door. The door of the test chamber shall be closed throughout the test.

All openings in the test chamber through the chamber walls, for example openings needed to feed the gas supply tube(s) to the burner, shall be carefully sealed. Any leakage such as insufficient sealing of the chamber door shall be avoided.

NOTE The tightness of the door sealing can easily be checked during operation by using a “candle” flame (on the outside of the chamber) as a sensor for an air flow into or out of the chamber through the door sealing. A flame which bends towards or away from the door gap indicates insufficient sealing. The candle flame check is performed with the exhaust air flow set at (1 ± 0,05) m^3/s, the inlet air flow into the chamber set to (8 000 ± 400) l/min and the burner set at 20,5 kW.

Additional installations in the chamber, other than those required by this document, are not allowed since they can influence especially the distribution of the air flow. Therefore, for instance protective layers for the backwall and covers on top of the burner (to avoid material falling down on the burner during the test) shall be avoided. The flow around the ladder shall not be substantially affected by brackets, rails or bars used for positioning ladders or reinforcement of the chamber. The size of the support of the burner and an optional fire extinguishing system shall be kept small to minimize the influence on the distribution of the air flow.

4.3 Ignition source

4.3.1 Type

The ignition source shall be a ribbon-type propane gas burner complete with a venturi mixer, and a set of mass flow controllers. The distance between venturi mixer and burner shall be between 0,15 m and 5,0 m. Bends between venturi mixer and burner shall be minimized. When the venturi is mounted inside the chamber the inner diameter of the tubing (piping or braided flexible hose) between the venturi mixer and burner shall be at least equal to 20 mm. When the venturi is mounted outside of the chamber, the inner diameter of all the tubing (piping or braided flexible hose) supplying gases to the burner inside the chamber shall be at least equal to 20 mm. The propane gas shall have a purity of at least 95 %. The flame-producing surface of the burner shall consist of a flat metal plate through which 242 holes of 1,32 mm in diameter are drilled on 3,2 mm centres in three staggered rows of 81, 80 and 81 holes each to form an array having the nominal dimensions 257 mm × 4,5 mm.

NOTE Burners with 243 holes (arranged in 3 rows of 81 holes) are also found in the market and give equal results.

As the burner plate may be drilled without the use of a drilling jig, the spacing of the holes could vary slightly. Additionally, a row of small holes is drilled on each side of the burner plate to serve as pilot holes with the function of keeping the flame burning.

In order to minimize clogging of the pilot holes the burner may be run for 5 minutes with a propane flow of approximately 442 mg/s and an air flow of approximately 4200 mg/s (or as high as possible if this cannot be achieved), after or separate from a test.

The diameter of the main burner holes has an influence on the burner flame. Thus the main burner holes need to be measured and inspected on a regular basis and they shall be kept free from any obstructions. Cleaning with a brass brush or a 1,2 mm drill bit held in a pin vice is recommended; care should be taken that the holes do not change shape or size. The diameter of the burner holes shall be between 1,30 mm and 1,40 mm. In case the diameter of the holes in the burner are measured to be outside this range the burner needs to be replaced.

A schematic drawing of the burner is shown in Figure 6, and the arrangement of the burner holes is shown in Figure 7.

To ensure reproducibility between results from different testing equipment, a burner, which is readily available, shall be used; for details, see Annex H. If a burner is used which is different from the one prescribed in Annex H, the laboratory shall demonstrate full equivalence. The correct performance of the burner can be checked using the procedures described in Annexes K and L.

The burner shall be fitted with suitable accurate mass flow controllers for both propane and air. It is recommended to use digital mass flow controllers with an accuracy (including linearity) of ± 0,5 % of reading plus ± 0,1 % of full scale. Mass flow controllers having a display or data output (so the gas consumption can be seen in real time) are recommended.

The mass flow controllers shall be designed to be used at the operating pressures; their calibration shall be conducted at the operating pressure.

Figure 8 shows an example of a burner control system.

The calibration of the mass flow controllers for the propane and air flows can be checked by weighing the gas consumption over a given time at operating flow rates. For checking the propane flow, weigh the propane using a balance having a scale resolution of 1 g, and a time of at least 20 min. For the check of the air flow, a 10 litre air bottle and a time of no more than 5 min is advised as problems caused by condensation and/or ice formation are then avoided.

The accuracy of the mass flow controllers shall be determined at the initial commissioning stage, after replacement and at least every year by weighing the gas consumption. The data should be recorded.

Rotameter-type flow meters can additionally be installed but are optional and only for visualization of the flow of the gases during a test.

The piping between the mass flow controllers and the burner shall be checked regularly for leakages. Special care shall be taken when checking for leaks from the propane supply line as part of that line can be under negative pressure due to the venturi mixer.

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

The flow rates for the test shall be as given in 6.7.

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

— the gas supply system should be equipped with flashback arresters.

— a flame failure protection device should be used.

— safe sequencing of the propane and air supply should be employed during ignition and extinguishing.

4.3.2 Positioning

For the test, the burner shall be arranged horizontally at a distance of (75 ± 5) mm from the front surface of the cable sample, (600 ± 5) mm above the floor of the test chamber and symmetrical with the vertical axis of the ladder. The point of application of the burner flame shall lie approximately midway between two rungs of the ladder (see Figure 4 and Figure 5).

An auxiliary template may be used to place the burner in the correct position relative to the front surface of the cable sample.

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

4.4 Ladder

A steel ladder of (500 ± 5) mm width shall be used; details of the ladder are given in Figure 9.

4.5 Inlet air supply

A means of supplying a controlled air flow through the chamber shall be used. Air shall be introduced to the test chamber through a plenum box (air inlet box) fitted directly underneath, and of approximately the same dimensions as, the air inlet aperture. The depth of the plenum box shall be (150 ± 10) mm measured from the grid downwards. Air shall be blown into the plenum box from a suitable fan through a rectangular straight section of duct of constant cross section of (300 ± 10) mm width and (80 ± 5) mm height and a minimum length of 800 mm, which shall be parallel to the floor and along the burner centre line as shown in Figure 2 and Figure 3. The ducting between the fan and the rectangular straight section of duct shall enter from the rear of the chamber. The duct shall be arranged to inlet air through the plenum box aperture that is in its longest side and closest to the rear of the chamber. A grid shall be fitted in the air inlet aperture to achieve uniform flow of the air. The grid shall be constructed of steel plate approximately 2 mm thick with holes of approximately 5 mm diameter drilled at approximately 8 mm spacing between centres.

A grille may be placed over the air inlet aperture underneath or on top of the steel plate grid to facilitate accessing the test chamber but shall be removed before the start of a test.

The airflow shall be set prior to a test at (8 000 ± 400) l / min at a temperature between 5 °C and 40 °C. The airflow rate shall be measured in a circular duct prior to the rectangular cross section duct. It shall be measured by a gas flow measuring system located at a straight section of the circular duct. The minimum length of straight circular section before and after the measuring device shall be selected according to the technical specification of the measuring device. It is recommended to use a fluid flow measuring system according to either EN ISO 5167-2 (orifice plate) [12] or EN ISO 5167-4 (venturi tube) [13], but other measuring devices with similar or better accuracy can be used (such as a gas mass flowmeter or an ultrasound system). A pitot tube [14] may be used where the flow rate is determined by taking multiple samples across the inlet duct using the method given in Annex D.