
Skupne preskusne metode za ognjevdržnost kablov - Meritve oddajanja toplote in nastajanja dima na kablilih 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

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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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29.060.20	Kabli	Cables

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amendments and corrigenda (if any)

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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Wärmefreisetzung und Raucherzeugung während der
Prüfung der Flammenausbreitung - Prüfeinrichtung,
Prüfverfahren und Prüfergebnis

This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2020-06-05.

It has been drawn up by CLC/TC 20.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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167 **European foreword**

168 This document (prEN 50399:2020) has been prepared by CLC/TC 20, "Electric cables".

169 This document is currently submitted to the Enquiry.

170 The following dates are proposed:

- latest date by which the existence of this document has to be announced at national level (doa) dor + 6 months
- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) dor + 12 months
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) dor + 36 months (to be confirmed or modified when voting)

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

172 prEN 50399:2020 includes the following significant technical changes with respect to EN 50399:2011:

- 173 — inclusion of the test apparatus in this document, not only by reference to EN 60332-3-10 (see 4.1);
- 174 — improvements of the test apparatus (see 4.2 to 4.7), including the obligatory use of mass flow
175 controllers for the feeding of gases to the burner;
- 176 — several improvements of the qualification of the test equipment, including a check of the flame shape
177 (5.6) and repeatability and reproducibility of the equipment (5.7);
- 178 — additions for testing of flat cables incl. mounting (6.4, 6.5);
- 179 — inclusion of normative Annex K (Check of the flame shape for nominal heat input of 20,5 kW) and
180 Annex L (Repeatability and reproducibility of test results).

181 Introduction

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

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

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

- 193 a) flame spread;
- 194 b) heat release rate;
- 195 c) total heat release;
- 196 d) smoke production rate;
- 197 e) total smoke production;
- 198 f) fire growth rate index;
- 199 g) occurrence of flaming droplets/particles.

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200 The apparatus is derived from that of EN 60332-3-10 [3] but with modifications and with additional
201 instrumentation to measure heat release and smoke production during the test. It has been demonstrated
202 [4] that the utilization of these additional measurement techniques, proven for other standard tests, e.g. for
203 other building products, are appropriate for assessing the reaction to fire performance of electric cables.
204 These techniques include heat release and smoke production measurements. Compared with the test
205 methods described in the EN 60332-3 series, they enable a more comprehensive assessment system,
206 which is both more precise and sensitive, and enables a wider range of fire performance levels.

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

- 211 h) the volume of combustible material exposed to the fire and to any flaming or heat which could be
212 produced by the combustion of the cables;
- 213 i) the geometrical configuration of the cables and their relationship to an enclosure;
- 214 j) the temperature at which it is possible to ignite the gases emitted from the cables;
- 215 k) the quantity of combustible gas released from the cables for a given temperature rise;
- 216 l) the volume of air passing through the cable installation;
- 217 m) the construction of the cable, e.g. armoured or unarmoured, multi or single core.

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

219 The conditions of cable mounting, including volume of material exposed and geometrical configuration of
220 the cables on the test ladder, and volume of airflow through the chamber have been chosen to be in
221 accordance with that required by the Commission Decision 2006/751/EC [5]. CENELEC has not been

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222 involved in the definition of these parameters. These standardized conditions provide the basis for
223 classification, as detailed in EN 13501-6 [6] and EN 50575 [2], but do not necessarily correspond to
224 conditions found in a particular cable installation.

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

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227 1 Scope

228 EN 50399 specifies the apparatus and methods of test for the assessment of vertical flame spread, heat
229 release, smoke production and occurrence of flaming droplets/particles of vertically-mounted electric cables
230 under defined conditions.

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

233 EN 50399 details the apparatus for the fire propagation testing and the arrangement and calibration of the
234 instrumentation to be installed in order to measure the heat release and the smoke production during the
235 test. The combustion gases are collected in a hood above the test chamber and conveyed through an
236 exhaust system, which allows the measurement of heat release rate and smoke production. Test
237 procedures to be used for type approval testing for classification of cables in classes [2, 6] B1_{ca}, B2_{ca}, C_{ca}
238 and D_{ca} are given. Cable installation on the test ladder and the volume of air passing through the chamber
239 are in accordance with the Commission Decision 2006/751/EC [5], which is reflected in the requirements
240 of this standard.

241 2 Normative references

242 The following documents are referred to in the text in such a way that some or all of their content constitutes
243 requirements of this document. For dated references, only the edition cited applies. For undated references,
244 the latest edition of the referenced document (including any amendments) applies.

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

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

248 EN ISO 13943, *Fire safety — Vocabulary (ISO 13943)*
<https://standards.iteh.ai/catalog/standards/sist/f993c843-0ee3-44ec-9de8-1c07070545dc/osist-pren-50399-2020>

249 3 Terms and definitions

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

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

- 252 • IEC Electropedia: available at <http://www.electropedia.org/>
- 253 • ISO Online browsing platform: available at <http://www.iso.org/obp>

254 3.1

255 **heat release rate**

256 *HRR*

257 thermal energy released per unit time by an item during combustion under specified conditions

258 3.2

259 **total heat release**

260 *THR*

261 integrated value of the heat release rate over a defined period

262 3.3

263 **smoke production rate**

264 *SPR*

265 smoke production per unit time

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266 **3.4**267 **total smoke production**268 *TSP*

269 integrated value of the smoke production rate over a defined period

270 **3.5**271 **flame spread**272 *FS*

273 propagation of a flame front

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

276 **3.6**277 **fire growth rate index**278 *FIGRA*279 highest value of the quotient between *HRR* and time

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

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

282 **3.7**283 **flaming droplets/particles**

284 material separating from the specimen during the test and continuing to flame for a minimum period as
285 described in this test method

286 **3.8**287 **E-value**

288 heat release per unit volume of oxygen consumed

289 **3.9**290 **electric cable**

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

293 **4 Test apparatus**294 **4.1 General**

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

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

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

309 The test apparatus shall consist of the test chamber, ladder, ignition source (burner), air supply equipment,
310 hood, exhaust duct, extracting ventilator, smoke measuring equipment and combustion gas equipment to
311 determine heat release; these parts are specified in the following paragraphs.

312 **WARNING:** Care should be taken in monitoring and extinguishing cable fires once the test specimen has
313 started to propagate fire. Some specimens could have a very high capacity to generate high heat release
314 levels that could damage the test equipment and instrumentation. It is important that testing staff are
315 sufficiently trained in dealing with such fires and have adequate firefighting facilities at their disposal during
316 testing.

317 It is recommended that indicative temperature measurements are taken through the use of thermocouples
318 installed along the cable bunch being tested at 1,5 m and 2,5 m above the burner and at the top of the
319 chamber or in the duct. Such measurements can give an early indication of any excessive temperature or
320 burning condition that could require the test to be aborted in order to prevent damage to the test equipment.

321 4.2 Test chamber

322 The test chamber (see Figure 2) shall have a width of $(1\ 000 \pm 100)$ mm, a depth of $(2\ 000 \pm 100)$ mm and
323 a height of $(4\ 000 \pm 100)$ mm; the floor of the chamber shall be raised above ground level. The test chamber
324 shall be airtight along its sides, air being admitted at the base of the test chamber through an aperture of
325 (800 ± 20) mm \times (400 ± 10) mm situated (150 ± 10) mm from the front wall of the test chamber and centred
326 relative to the width (1000 ± 100) mm of the chamber.

327 An outlet (300 ± 30) mm \times $(1\ 000 \pm 100)$ mm shall be made at the rear edge of the top of the test chamber.
328 The back, sides and door of the test chamber shall be thermally insulated to give a coefficient of heat
329 transfer of approximately $0,7\ \text{W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$. For example, a steel plate 1,5 mm to 2,0 mm thick covered with
330 65 mm of mineral wool with a suitable external cladding is satisfactory (see also Figure 4). The distance
331 between the ladder and the rear wall of the chamber is (150 ± 10) mm, and between the bottom rung of the
332 ladder and the floor (400 ± 5) mm (see Figure 5).

333 All other openings in the test chamber through the chamber walls, for example openings needed to feed
334 the gas supply tube(s) to the burner and connection of thermocouples, shall be carefully sealed. Any other
335 leakage such as insufficient sealing of the chamber door shall be avoided. The door of the test chamber
336 shall be closed throughout the test.

337 **NOTE** The tightness of the door sealing can easily be checked during operation by using a "candle" flame (on the
338 outside of the chamber) as a sensor for an air flow into or out of the chamber through the door sealing. A flame which
339 bends towards or away from the door gap indicates insufficient sealing. The candle flame check is performed with the
340 exhaust air flow set at $1 \pm 0,05\ \text{m}^3/\text{s}$, the inlet air flow into the chamber set to $8000 \pm 400\ \text{l/min}$ and the burner set at
341 $20,5\ \text{kW}$.

342 Additional installations in the chamber, other than those required by this standard, are not allowed since
343 they can influence the distribution of the air flow. Therefore for instance covers on top of the burner - (to
344 avoid material falling down on the burner during the test)- should be avoided and the flow around the ladder
345 shall not be substantially affected by brackets, rails or bars for positioning ladders or reinforcement of the
346 chamber. The size of the support of the burner shall also be kept small to minimize the influence on the
347 distribution of the air flow.

348 4.3 Ignition source

349 4.3.1 Type

350 The ignition source shall be a ribbon-type propane gas burner complete with a venturi mixer, and a set of
351 mass flow controllers. The distance between venturi mixer and burner shall be between 0,15 m and 5,0 m.
352 Bends between venturi mixer and burner shall be minimized. When the venturi is mounted inside the
353 chamber the inner diameter of the tubing (piping or braided flexible hose) between the venturi mixer and
354 burner shall be at least equal to 20 mm. When the venturi is mounted outside of the chamber, the inner
355 diameter of all the tubing (piping or braided flexible hose) supplying gases to the burner inside the chamber
356 shall be at least equal to 20 mm. The propane gas shall have a purity of at least 95 % purity of propane.
357 The flame-producing surface of the burner shall consist of a flat metal plate through which 242 holes of
358 1,32 mm in diameter are drilled on 3,2 mm centres in three staggered rows of 81, 80 and 81 holes each to
359 form an array having the nominal dimensions 257 mm \times 4,5 mm. As the burner plate may be drilled without
360 the use of a drilling jig, the spacing of the holes could vary slightly. Additionally, rows of small holes on each
361 side of the burner plate serve as pilot holes with the function of keeping the flame burning. In order to

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362 prevent clogging of pilot holes as much as possible the burner shall be run for 5 min with low air flow, after
363 or separate from a test.

364 The diameter of the main burner holes has an influence on the burner flame. Thus the main burner holes
365 need to be measured and inspected on a regular basis and they shall be kept free from any obstructions.
366 Cleaning with a brass brush or a 1,2 mm drill bit held in a pin vice is recommended; care should be taken
367 that the holes do not change shape or size. The diameter of the burner holes shall be between 1,30 and
368 1,40 mm. In case the holes in the burner are measured to be larger than 1,40 mm the burner needs to be
369 replaced.

370 The burner is shown in Figure 6, and the placement of the holes in Figure 7.

371 To ensure reproducibility between results from different testing equipment, a burner, which is readily
372 available, shall be used; for details, see Annex H. If a burner is used different from the one prescribed in
373 this standard, the laboratory shall demonstrate full equivalence. Correctness of the burner can be checked
374 by applying the procedures described in Annexes K and L.

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

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

381 Figure 8 shows an example of a burner control system.

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

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

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

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

393 For the purposes of this test, the air shall have a dew-point not higher than 0 °C.

394 The flow rates for the test shall be as given in Clause 6.7 of this document.

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

- 396 — the gas supply system should be equipped with flashback arresters;
- 397 — a flame failure protection device should be used;
- 398 — safe sequencing of the propane and air supply should be employed during ignition and extinguishing.

399 4.3.2 Positioning

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

404 An auxiliary template may be used for the correct positioning of the burner versus the front surface of the
405 cable sample.

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

407 4.4 Ladder

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

409 4.5 Inlet air supply

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

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

423 The airflow shall be set prior to a test at $(8\ 000 \pm 400)$ l / min at a temperature between 5 and 40 °C. The
424 airflow rate shall be measured in a circular duct prior to the rectangular cross section duct. It shall be
425 measured by a gas flow measuring device located at a straight section of the circular duct. The minimum
426 length of straight circular section before and after the measuring device shall be selected according to the
427 technical specification of the measuring device. It is recommended to use a fluid flow measuring system
428 according to either EN ISO 5167-2 (orifice plate) or EN ISO 5167-4 (venturi tube), but another measuring
429 device with similar or better accuracy can be used (such as a gas mass flowmeter or an ultrasound system).
430 A pitot tube may be used when the readings are calibrated by taking multiple samples across the inlet duct
431 in accordance with Annex D.

432 The airflow shall be checked throughout the test and shall not vary by more than 10 % of the set value. A
433 suitable automatic air supply control to ensure a constant flow may be used.

434 The airflow distribution in the test chamber shall not be disturbed (for instance by objects not specified in
435 this standard), since a disturbed airflow distribution can significantly affect the flame spread. A disturbed
436 airflow could, for instance, result in an asymmetrical combustion pattern on the test specimen; the
437 combustion pattern can be monitored in conjunction with the "Check of the flame shape" (see 5.6 and
438 Annex K).

439 In order to remove noxious gases, it is recommended to maintain the air flow for some minutes after the
440 end of the test, before entering the test chamber.

441 4.6 Hood

442 A hood, see Figure 10, having a truncated shape, and where the base has a minimum length of 1,50 m and
443 a minimum width of 1,00 m, shall be centred above the outlet of the test chamber. The maximum size of
444 the hood shall be 2,5 m by 2,5 m. The base of the hood shall be raised above the top of the test chamber,
445 with the largest side of the hood (if any) parallel to the largest side of the outlet of the chamber. A gap
446 between the top of the test chamber and the base of the hood shall be between 200 mm to 400 mm, the
447 recommended gap should be as close to 300mm as possible. There shall be a chamber above the hood to
448 allow a connection to the exhaust duct. The exhaust duct should leave the chamber horizontally (as shown
449 in Figure 1 and 9). Plates/baffles shall be installed in the hood to improve mixing of the air and effluents.
450 The system shall be designed to collect all the combustion products leaving the test chamber through the
451 outlet during the test. There shall be no leakage of flames or smoke.

452 Objects not specified in this standard (for instance ladder hoisting devices) shall not be present in the hood.
453 The exhaust capacity shall be at least 1 m³/s at normal pressure and a temperature of 25 °C. The exhaust
454 system design shall not be based on natural convection. In order to extract all gases and vapours, especially
455 in the case of heavily burning cables, or cables which require to be specially extinguished and produce high
456 volumes of gases and vapours, an exhaust system with a capacity of 1,5 m³/s is recommended.