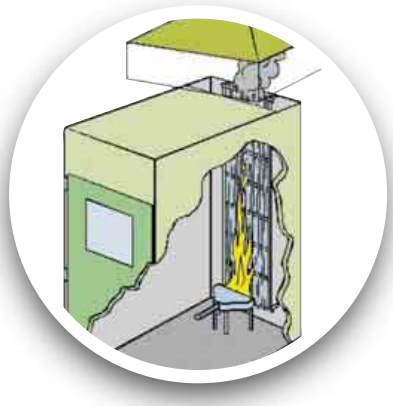
New European Cable Testing and Classification



THE BENCHMARK IN FIRE TESTING

New European Cable Testing and Classification

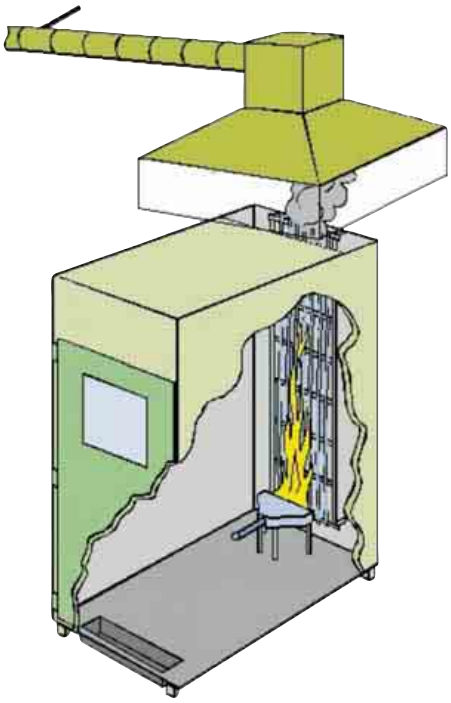
Cables will be tested using 5 test methods, and classified by extending the provisions in the existing CPD classification standard EN 13501 "Fire classification of construction products and building elements — Part 1" to include electric cable requirements. The establishment of these standards has been mandated to CEN and CENELEC by the EU and CENELEC have drafted the modifications to EN 13501 in line with the requirements of the European commission decision and this is currently being progressed within CEN.

Of these standard tests the new standard EN 50399 is the major test procedure for reaction to fire of cables, this test specification derives from work done in an EU funded project called FIPEC, Fire Performance of Electric Cables. This work was performed by a research group consisting of SP, Interscience, ISSEP and CESI. The FIPEC project included a study of cable installations and relevant reference scenarios as well as a comprehensive test program of different kinds of cables. This, together with subsequent Industry test data, was used in the development of the proposal for the European testing and classification system.

Two round robin exercises have been carried out on EN50399. The first was performed by the developers of the system, the FIPEC laboratories. The second round robin was performed through CENELEC and included many test sites. The results were good and comparable to the results of the SBI test used for linings in Europe. Thus the test procedure used is quite robust and well developed. The test results are validated for real fires by using reference scenarios in the FIPEC project and through further analysis and comparisons to other building products under the CPD.

The fire performance of electric cables is now to be uniformly regulated within the European Union. Traditionally these products have not been addressed in national building regulations and classifications had been voluntary or required by larger purchasing agencies. The inclusion of Electric cables within the European Unions Construction Products Directive (CPD) changes this situation. Once implemented all electric cables used in European Union countries will be tested using the same test methods and classified using the same classification system.

The reaction-to-fire classification system used in the CPD was developed in co-operation with European regulators and the cable industry in Europe and presented in 2003. The European Commission decided on a testing and classification system on cables during 2006. The system is built in the same way as that used for linings and pipe insulation. However, it also included the possibility to declare optional acidity of the smoke gases, the sub-classes a1, a2 and a3.



EN50399 Burning behaviour of bunched cable

Both EN 50399 and the modifications to EN 13501 were developed in CENELEC TC 20, WG10 The latter is now working on the proposals for Extended Applications for assessment of cable family fire performance that will enable representative cables to be used to qualify cable groups.

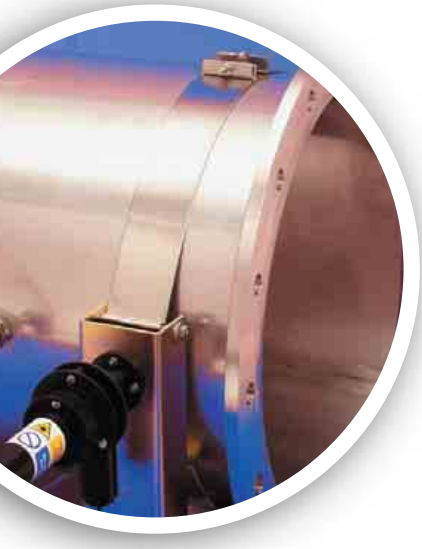
The Extended Application rules were developed in the CEMAC project which was financed by the European Cable Industry in close co-operation with a group of research laboratories, consisting of SP, Interscience, ISSEP, LSF and VDE. The project was lead by Europacable and the RTD contributions were led by SP-Fire Technology. During both the FIPEC and CEMAC projects FTT fire scientists were seconded to Interscience to oversee calibration, test, data acquisition and analysis. We also worked with Interscience in CENELEC on the standard.

How are cables classified?

EN 13501 shows the test methods and performance criteria (see Table 1) that must be met in order for a cable to meet a particular classification (A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.)

The 5 test methods used are:

- Burning behaviour of bunched cables – Scenario 1 (EN 50399) -
  This test evaluates the potential contribution of a cable to the early stages of development of a fire, under direct exposure to a 20,5 kW flame source. The test is relevant for the classes $B2_{ca}$, C_{ca} and D_{ca}.
- Burning behaviour of bunched cables – Scenario 2 (EN 50399) -
  This test evaluates the potential contribution of a cable to the early stages of development of a fire, under direct exposure to a 30 kW flame source. The test is relevant for the class $B1_{ca}$.
- Burning behaviour of single cables (EN 60332-1-2) -
  This test evaluates the flame spread of a cable under exposure to a small flame. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.
- Smoke production of burning cables (EN 50268) -
  This test evaluates the potential contribution of a cable to obscuration of vision when burning under static air flow conditions. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}, in association with the additional classification for smoke.
- Acidity levels produced by burning cables (EN 50267-2-3) -
  This test evaluates the potential contribution of burning cable materials to the hazardous properties of evolved gases. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}, in association with the additional classification for acidity.
- Heat of combustion test (EN ISO 1716) -
  This test determines the potential maximum total heat release of a product when completely burning, regardless of its end use. The test is relevant for the class A_{ca}.

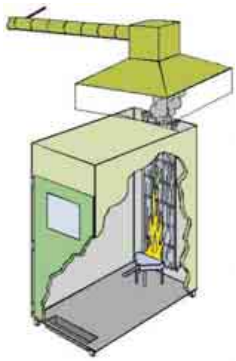


EN 50399 Burning behaviour of bunched cables

The EN 50399 was based on IEC 60332-3 with the addition of heat release measurement and a modified air inlet system. This is accomplished by fitting a small instrumented section of ducting into the exhaust system of the rig and using this with associated FTT gas analysis instrumentation and software. The duct section houses all gas sampling probes, temperature and mass flow probes and has ports for the smoke measuring system.

Duct section placed in EN 50399 exhaust

EN 50399 Cable Test Interior detail



EN 50399 Schematic

The gas analysis instrumentation is housed in a 19" instrument rack containing: -

- Oxygen Analyser (paramagnetic) supplied with temperature and pressure compensation for primary heat release measurement.
- Carbon Dioxide Analyser (infrared) for use in heat release measurement.
- Dual stage soot filter, refrigerant cold trap, drying column, pump and waste regulators for conditioning the sample gases prior to analysis.
- Controls for the smoke measurement system (if purchased).
- Data logger (if purchased).

Clients already owning the FTT Dual Cone Calorimeter, ISO 9705 Room/Corner test or SBI can use their instrumentation to measure heat release rate from their cable test. Conversely the EN 50399 Gas Analysis rack can be used to instrument other calorimeters (e.g. FTT Dual Cone Calorimeter etc.).

FTT offers two smoke measurement systems, laser or white light. The laser system is similar to that used in the cone calorimeter and complies with ISO 5660 incorporating an advanced noise reduction specification. The white light system is similar to that used in the SBI test and constructed to DIN 50055.

EN 60332-1-2 Tests on electric and optical fibre cables under fire conditions.

Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame

This part of EN 60332 specifies the procedure for testing the resistance to vertical flame propagation for a single vertical electrical insulated conductor or cable, or optical fibre cable, under fire conditions. EN 60332-1-2 specifies the use of a 1 kW pre-mixed flame and the test evaluates the flame spread of a cable under exposure to a small flame. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.

EN 50268 Common test methods for cables under fire conditions: Measurement of smoke density of cables burning under defined conditions

The 3 Metre Cube is used for measuring smoke emission when electric cables are burned under defined conditions, for example, a few cables burned horizontally. These units are produced to meet the specification used in many electric cable tests. The unit can be supplied in a self-assembly kit form or can be fully installed by FTT Engineers.

The equipment comprises of:

- 3 Metre Cube assembly
- Photometric system, stands, fans and sample mounting frames
- Extraction fan and ducting
- Chart Recorder or Windows Software.

EN 50267-2-3 Common test methods for cables under fire conditions: Tests on gases evolved during combustion of materials from cables

Part 2-3: Determination of degree of acidity of gases for cables by determination of the weighted average of pH and conductivity

This test was developed to assess the amount of acid gas which is evolved when cable insulating, sheathing and other materials burn as this acid can cause damage to electrical and electronic equipment not involved in the fire itself.. This test method uses pH and electrical conductivity as an indirect assessment of this property and is being used as the assessment method for the additional acid classification with classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}.

The equipment comprises of:

- Control unit
- Furnace
- Magnetic stirrer
- pH meter and calibration pH solutions

EN ISO 1716 Reaction to fire tests for building products – Determination of the heat of combustion

The bomb calorimeter is the instrument most widely used to measure the heat of combustion or calorific value of a material. A test specimen of known mass is burned under standardised conditions. The heat of combustion, determined under these conditions, is calculated on the basis of the measured temperature rise while taking account of heat loss.

The combustion process is initiated in an atmosphere of oxygen in a constant volume container, the bomb, which is a vessel built to withstand high pressures. The bomb is immersed in a stirred water bath, and the whole device is the calorimeter vessel. The calorimeter vessel is also immersed in a second outer water bath. The water temperature in the calorimeter vessel and that of the outer bath are both monitored and used in the calculation. The test is used to qualify products for the classes A_{ca}

The FTT Oxygen Bomb calorimeter consists of:

- Bomb calorimeter with embedded computer control, user-friendly interface, LCD graphics display, high accuracy / resolution PRTs, RS232 interface port for printer and programming
- Oxygen bomb and bucket (calorimeter vessel)
- Thermostatically controlled bath, circulator, cooler, pipette (2L)
- EN ISO 1716 sample preparation device, firing wire & cotton, cigarette making device
- Printer (optional)

Why FTT?

FTT has been at the forefront of test instrumentation development in reaction to fire applications for over 20 years and now sets the benchmark in this field of testing. FTT's production and design facility in the UK continues to develop bench-scale instrumentation and large-scale tests for a wide range of regulatory requirements and offers a worldwide sales and technical support service.

Table 1
EN 13501: Classes of reaction-to-fire performance for electric cables

CLASS	TEST METHOD(S)	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION
A_{ca}	EN ISO 1716	PCS ≤ 2,0 MJ/kg [1]	
$B1_{ca}$	EN 50399-2-2 [5] and	FS ≤ 1.75 m and THR_{1200s} ≤ 10 MJ and Peak HRR ≤ 20 kW and FIGRA ≤ 120 W/s	Smoke production [2, 6] and Flaming droplets/particles [3] and Acidity [4, 8]
	EN 60332-1-2	H ≤ 425 mm	
$B2_{ca}$	EN 50399-2-1 [5] and	FS ≤ 1.5 m; and THR_{1200s} ≤ 15 MJ; and Peak HRR ≤ 30 kW; and FIGRA ≤ 150 W/s H ≤ 425 mm	Smoke production [2, 7] and Flaming droplets/particles [3] and Acidity [4, 8]
	EN 60332-1-2	H ≤ 425 mm	
C_{ca}	EN 50399-2-1 [5] and	FS ≤ 2.0 m; and THR_{1200s} ≤ 30 MJ; and Peak HRR ≤ 60 kW; and FIGRA ≤ 300 W/s	Smoke production [2, 7] and Flaming droplets/particles [3] and Acidity [4, 8]
	EN 60332-1-2	H ≤ 425 mm	
D_{ca}	EN 50399-2-1 [5] and	THR_{1200s} ≤ 70 MJ; and Peak HRR ≤ 400 kW; and FIGRA ≤ 1300 W/s	Smoke production [2, 7] and Flaming droplets/particles [3] and Acidity [4, 8]
	EN 60332-1-2	H ≤ 425 mm	
E_{ca}	EN 60332-1-2	H ≤ 425 mm	
F_{ca}	No performance determined		

[1] For the product as a whole, excluding metallic materials, and for any external component (i.e. sheath) of the product.

[2] s1 = TSP_{1200s} ≤ 50 m^2 and Peak SPR ≤ 0.25 m^2/s
s1a = s1 and transmittance in accordance with EN 50268 ≥ 80%
s1b = s1 and transmittance in accordance with EN 50268 ≥ 60% < 80%
s2 = TSP_{1200s} ≤ 400 m^2 and Peak SPR ≤ 1.5 m^2/s
s3 = not s1 or s2

[3] For $FIPEC_{20}$ Scenarios 1 and 2: d0 = No flaming droplets/particles within 1200 s; d1 = No flaming droplets/particles persisting longer than 10 s within 1200 s; d2 = not d0 or d1.

[4] EN 50267-2-3: a1 = conductivity < 2.5 µS/mm and pH > 4.3; a2 = conductivity < 10 µS/mm and pH > 4.3; a3 = not a1 or a2. No declaration = No Performance Determined.

[5] Air flow into chamber shall be set to 8000 ± 400 l/min.
$FIPEC_{20}$ Scenario 1 = EN 50399-2-1 with mounting and fixing as below
$FIPEC_{20}$ Scenario 2 = EN 50399-2-2 with mounting and fixing as below

[6] The smoke class declared for class $B1_{ca}$ cables must originate from the $FIPEC_{20}$ Scen 2 test.

[7] The smoke class declared for class $B2_{ca}$, C_{ca}, D_{ca} cables must originate from the $FIPEC_{20}$ Scen 1 test.

[8] Measuring the hazardous properties of gases developed in the event of fire, which compromise the ability of the persons exposed to them to take effective action to accomplish escape, and not describing the toxicity of these gases.

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