

**Cable fire protection**  
Flammability tests  
on ship and offshore cables

**The Quality Connection**

**LEONI**

## Marine technologies – product range

The right cable for any application.

Flammability tests	Page
Flammability and fire propagation	4
Smoke density	12
Toxicity of the combustion gases	13
Corrosiveness of the combustion gases	14

Issue: July 2012 © LEONI Elocab GmbH  
Subject to change and error.

### Abbreviations of standards

<b>IEC</b>	International Electrotechnical Commission
<b>EN</b>	European Norm
<b>UIC</b>	Union Internationale des Chemins de Fer (International Union of Railways)
<b>VG</b>	Verteidigungsgerätenorm (German Defence Equipment Standard)
<b>MIL</b>	Military Standard (USA)
<b>BS</b>	British Standard (UK)
<b>Def. St.</b>	Defence Standard (UK)
<b>NES</b>	Naval Engineering Standard (UK)
<b>UL</b>	Underwriters Laboratories Inc. (USA)
<b>NF</b>	Norme Française (National Standard France) (F)
<b>DIN VDE</b>	Deutscher Industrienerverband der Elektroingenieure (German Industrial Standard, Association of Electricians)

All dimensions given in mm.

### Commercial shipbuilding

- Communication and LAN cable
- Bus cable
- CCTV camera cable
- Fire resistant cable
- Coaxial cable
- Special solutions

### Naval technology

- Laterally watertight cable
- Laterally and longitudinally watertight cable for outboard applications
- Inboard cable
- Self-extinguishing submarine cable
- Spiral cable
- Special solutions

### Oceanography

- Towing cable with either steel or aramide cores for rated loads of several tons
- Neutrally buoyant and floating cable for marine research
- Cable for fixed installation

### Offshore

- Communication and LAN cable
- Bus cable
- CCTV camera cable
- Fire resistant cable
- Coaxial cable
- Special solutions

### Cable harnesses



[www.leoni-industrial-solutions.com](http://www.leoni-industrial-solutions.com)

## Flammability tests on ship and offshore

Cables up to 0.6/1 kV.



Cables for ship and marine technology are exposed to varying, in some cases extreme, conditions. While in theory the cables will last a lifetime, in day-to-day operation they may be destroyed by malfunction or outside influences.

Destruction by exposure to fire is an especially critical situation. In addition to losing the cable's functions, burning of all the nonmetallic materials, such as insulation, jacket and foils, can create toxic and/or corrosive substances. Toxic substances directly affect people close to the fire, whereas corrosive by-products of fire and their effects cannot be detected immediately.

It frequently takes weeks or even months before such by-products of fire, dissolved into extinguishing water or atmospheric moisture, corrode metal materials. Fire damage can occur even at locations a long way from the actual source of the fire.

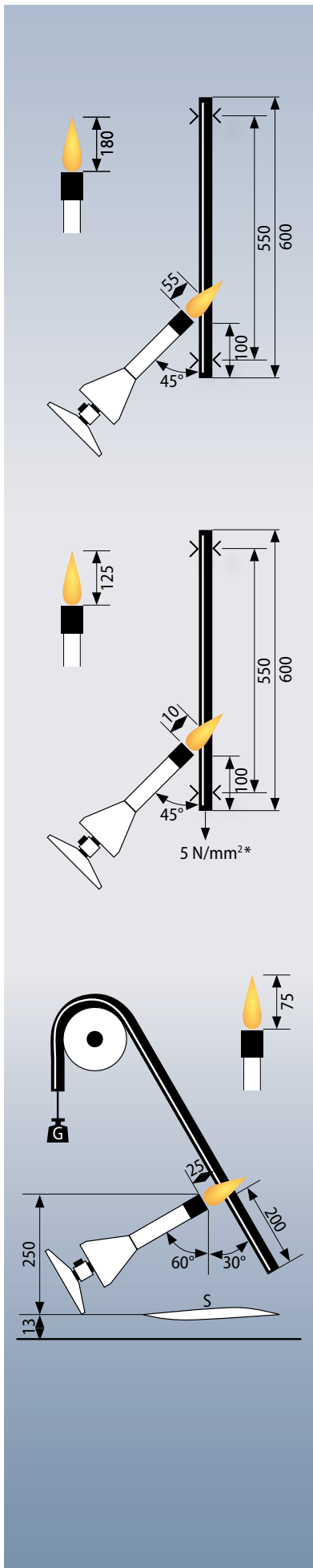
Flammability tests and determination of combustion products are therefore vital to cable technology. They provide information on how fire spreads along the cable as well as on the potential threats to people and materials in the event of a cable fire.

The corresponding tests study:

- the flammability of non-metallic cable components
- the toxicity of fire by-products, especially the gases
- spread of the fire along the cable
- flue gas density in the event of fire
- the corrosiveness of the combustion gases.

The essential flammability tests on ship and offshore cables are described in this brochure. It should be noted that these tests are conducted under standardized conditions and do not reflect the individual behaviour of installed cables and cable bundles in an actual fire.

## Flammability and fire propagation



### 1.1 IEC 60332-1-2 / EN 60332-1-2 / VG 95218-2 Method 1 / BS 4066 Part 1 / VDE 0482-332-1-2

**Test set-up** The single cable under test is secured vertically and flamed with a burner at an angle of 45° to the vertical. Test apparatus acc. to IEC / EN 60332-1-1.

**Flame temperature** Determined by the stipulated setting of the burner flame.

<b>Test duration</b>	Cable with a diameter of $D \leq 25$ mm:	$60 \pm 2$ sec
	Cable with a diameter of $25 < D \leq 50$ mm:	$120 \pm 2$ sec
	$50 < D < 75$ mm:	$240 \pm 2$ sec
	$D > 75$ mm:	$480 \pm 2$ sec

**Compliance criterion** The fire damage must end at least 50 mm below the upper fixing clamp.  
The cable must be self-extinguishing.

### 1.2 IEC 60332-2-2 / EN 60332-2-2 / VG 95218-2 Method 2 / BS 4066 Part 2 / VDE 0482-332-2-2

**Test set-up** The single cable under test is secured vertically and flamed with a burner at an angle of 45° to the vertical. Test apparatus acc. to IEC / EN 60332-2-1.

**Flame temperature** Determined by the stipulated setting of the burner flame.

**Test duration**  $20 \pm 1$  sec

**Compliance criterion** The fire damage must end at least 50 mm below the upper fixing clamp.  
The cable must be self-extinguishing.

\* for cables with metallic conductors

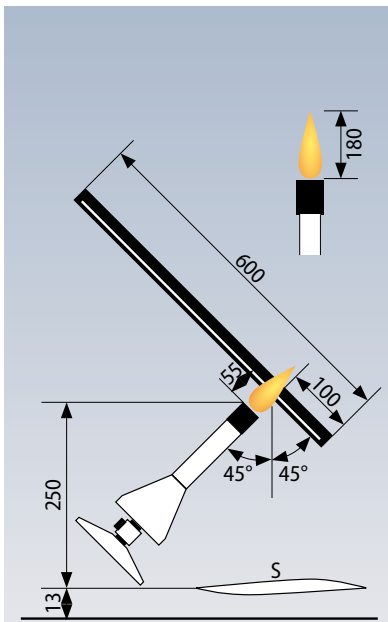
### 1.3 MIL-W-22758 / MIL-W-8104 / VG 95218-2 Method 4

**Test set-up** The single cable under test is weighted over a pulley at an angle of 30° to the vertical, in order to keep the sample stretched out during the test. The burner flame is directed at the cable from below under an angle of 60° to the vertical. 250 mm below the point of heat application on the sample, a tissue paper (S) is spread horizontally at least 13 mm above the chamber floor. The burner flame is adjusted to a height of 75 mm with an inner flame cone of 25 mm. The flame is applied to the sample 200 mm above the clamping point at a right angle.

**Flame temperature** At least 950 °C

**Test duration** 30 sec

**Compliance criterion** It is only permitted for the sample to continue burning for at most 30 seconds after the flame has been removed. Overall the fire damage to the cable must not exceed 76 mm. The tissue paper (S) spread out underneath must not be ignited by dripping material.



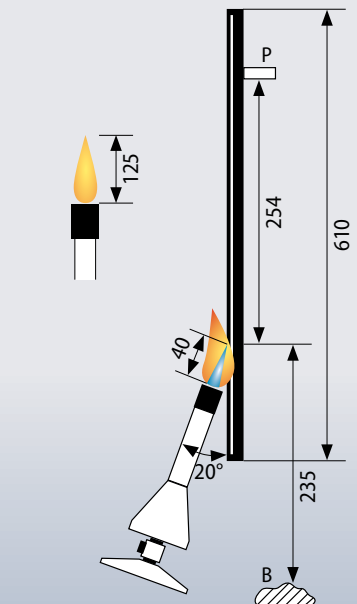
#### 1.4 VG 95218-2 Method 3

**Test set-up** The single cable under test is weighted over a pulley and secured at an angle of 45° to the vertical. The burner flame is directed at the cable from below under an angle of 45° to the vertical. 25 mm below the point of heat application on the sample, tissue paper (S) is spread out horizontally underneath the sample, at least 13 mm above the chamber floor.

**Flame temperature** Determined by the stipulated setting of the burner flame.

**Test duration** Cable with a diameter of  $\leq 25$  mm: 60 sec  
Cable with a diameter of  $25 < D < 50$  mm: 120 sec

**Compliance criterion** It is only permitted for the sample to continue burning for at most 30 seconds after the flame has been removed. Overall the fire damage to the cable must not exceed 76 mm. The tissue paper (S) spread out underneath must not be ignited by dripping material.



#### 1.5 UL 2556 Section 9.3 (FT1) / Section 9.4 (VW-1) / UL 1581 Sec.1061 (cable flame)

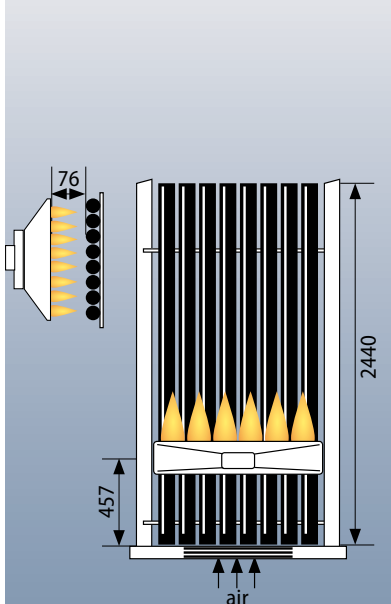
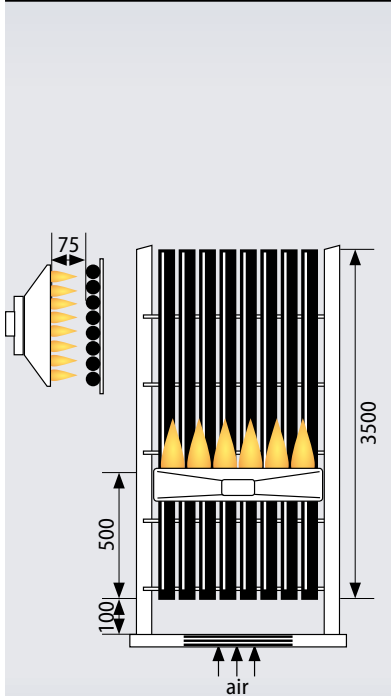
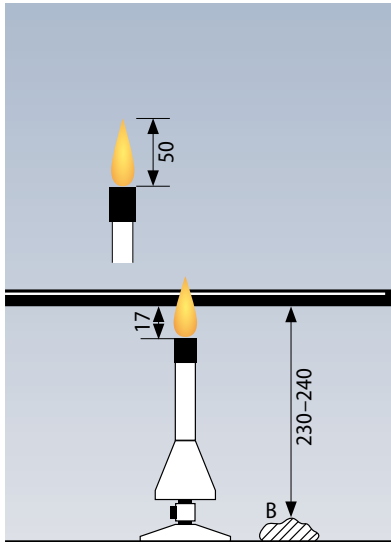
**Test set-up** The cable is secured vertically and provided with a paper indicator flag (P, 10 x 20 mm). A burner is used to apply the flame and it is secured at an angle of 20° to the vertical.

**Flame temperature** Determined by the stipulated setting of the Tirril burner flame.

**Test duration** Section 9.3: 5 cycles of flame application for 15 sec with a break of 15 sec  
Section 9.4: 5 cycles of flame application for 15 sec with a break of 15 sec and a maximum break of 60 sec  
Section 1061: 3 cycles of flame application for 60 sec with a break of 30 sec

**Compliance criterion** It is only permitted for the sample to continue burning for at most 60 seconds after the flame has been removed and for at most 25 % of the paper indicator flag (P) to be burned. The cotton wadding (B) must not be ignited by dripping material.

(Does not apply to the FT1 test)



**1.6 UL 1581 Section 1090 (H) / UL 2556 Section 9.1 (FT2)**

**Test set-up** The cable is secured horizontally and vertically and flamed with a burner (the burner is tilted at an angle of 20° for the FT2 test). Cotton wadding (B) is placed next to the burner.

**Flame temperature** Determined by the stipulated setting of the burner flame.

**Test duration** 30 sec

**Compliance criterion** The flame propagation speed must not exceed 25 mm/min.

The cotton wadding (B) must not be ignited by dripping material.

Section 1090: The rate of dispersion of the cable may not exceed 25 mm/min

Section 9.1: The length of the carbonized part may not exceed 100 mm

**1.7 IEC 60332-3 / EN 60322-3 / VDE 0482-332-3**

**Test set-up** The cables are secured to a ladder, close together or spaced apart depending on the type of fire. The cables can be secured in several layers. Test apparatus acc. to IEC / EN 60332-3-10.

**Flame temperature** Determined by the stipulated quantity of propane gas and air.

**Test duration** IEC Part 21/EN Part 21: Category A F/R for special applications only

IEC Part 22/EN Part 22: Category A (7 l flammable material/m): 40 min

IEC Part 23/EN Part 23: Category B (3.5 l flammable material/m): 40 min

IEC Part 24/EN Part 24: Category C (1.5 l flammable material/m): 20 min

IEC Part 25/EN Part 25: Category D (0.5 l flammable material/m): 20 min

**Compliance criterion** The visible area of fire damage to the cables must not exceed 2.5 m in height from the bottom edge of the burner.

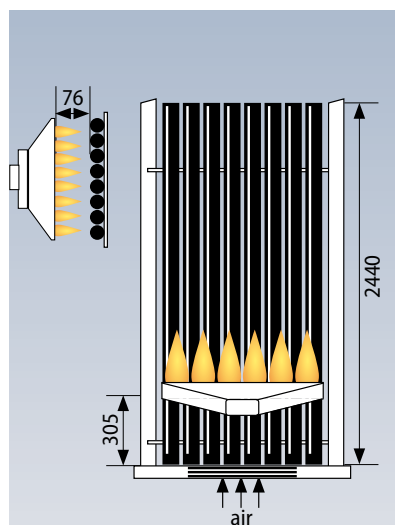
**1.8 UL 1685 Vertical Tray / UL 2556 Section 9.6 Method 1 (UL method)**

**Test set-up** The cables are secured to a ladder in a single layer (quantity depends on the diameter of the cable). The length of each sample is 2.44 m.

**Flame temperature** Determined by the stipulated quantity of propane gas and air. The power equals 20.5 kW (70,000 Btu/hr).

**Test duration** 20 minutes (2 tests to be performed)

**Compliance criterion** The area of fire damage to the cables must be less than 2.44 m (measured from the bottom of the ladder).



### 1.9 UL 1685 FT4 / IEEE 1202 / UL 2556 Section 9.6 Method 2 (CSA method)

**Test set-up** The cables are secured to a ladder in a single layer (quantity depends on the diameter of the cable). The length of each sample is 2.44 m. Cables with a diameter of <math><13\text{ mm}</math> are secured to the ladder in bundles. The burner is tilted at an angle of

**Flame temperature** Determined by the stipulated quantity of propane gas and air.  
The power equals 20.5 kW (70,000 Btu/hr).

**Test duration** 20 minutes (2 tests to be performed)

**Compliance criterion** The area of fire damage to the cables must be less than 1.5 m (measured from the bottom edge of the burner nozzle).

### 1.10 UL 1666 Riser

**Test set-up** The cables are secured to a ladder in a single layer (quantity depends on the diameter of the cable). The length of each sample is 5.33 m. The flame is applied using a burner diffuser plate.

**Flame temperature** Determined by the stipulated quantity of propane gas and air.  
The power equals 154.5 kW (527,500 Btu/hr).

**Test duration** 30 minutes (2 tests to be performed)

**Compliance criterion** The area of fire damage to the cables must be less than 3.66 m (measured from the bottom of the ladder) and the temperature of any of the thermocouples (at a height of 3.66 m) must not exceed

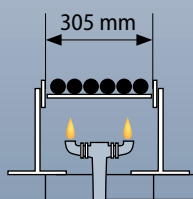
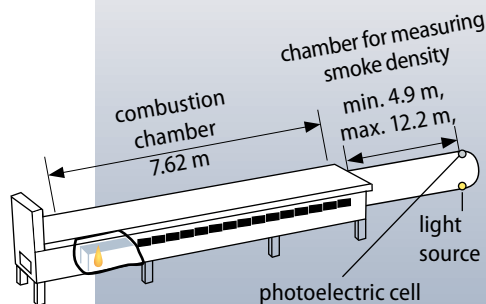
### 1.11 NFPA 262 / FT6 Steiner-Tunnel (UL 910 withdrawn)

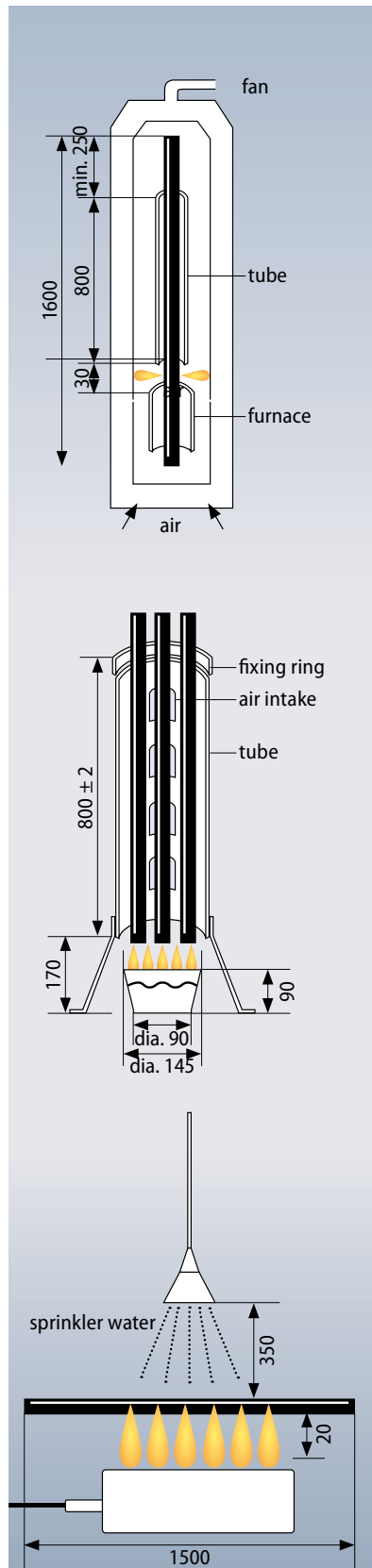
**Test set-up** The cables are secured to a horizontal ladder in a single layer (quantity depends on the diameter of the cable). The length of each sample is 7.32 m. A device for measuring the smoke density is placed behind the combustion chamber.

**Flame temperature** Determined by the stipulated quantity of propane gas and air.  
The power equals 86 kW (294,000 Btu/hr).

**Test duration** 20 minutes (2 tests to be performed)

**Compliance criterion** The area of fire damage to the cables must not exceed 1.52 m.  
The mean optical density of the smoke produced must not exceed a value of 0.15. The maximum optical smoke density should not exceed 0.5 (light transmission of 32 %).





### 1.12 NF C32-070 Test 2 / UIC 895 VE Appendix 7

**Test set-up** The cable is secured vertically in a furnace with a subsequent tube (125 mm in diameter).

**Flame temperature**  $830 \text{ }^\circ\text{C} \pm 50 \text{ }^\circ\text{C}$

**Test duration** 30 min

**Compliance criterion** The end of the cable protruding from the top of the tube must not be damaged.

### 1.13 Def.-St. 02-641 (formerly NES 641)

**Test set-up** Three cables are secured vertically in a tube ("Swedish chimney").  
A flame is applied by burning liquid, which is in a dish underneath the tube.

**Flame temperature** Is determined by the flammable liquid.

**Test duration** Until all the liquid has burned off.

**Compliance criterion** The visible area of fire damage to the cables must not exceed 250 m down from the top edge of the cable.

### 1.14 BS 6387 Category W

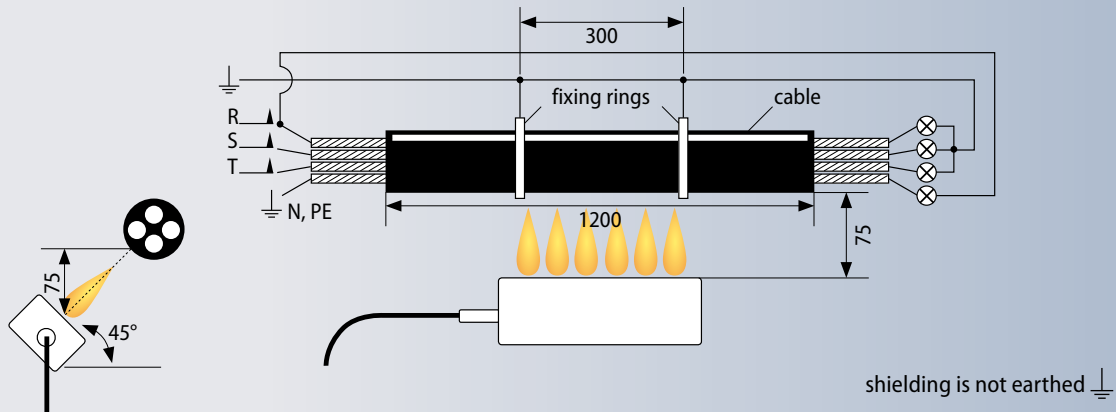
**Test set-up** The cable is laid horizontally. The buffered fibers and shielding must be connected to a power supply with a voltage of  $U_0/U$ . The flame is applied across a width of 1500 mm. After 15 minutes a sprinkler is turned on.

**Flame temperature**  $650 \pm 40 \text{ }^\circ\text{C}$

**Test duration** 30 min (2 tests to be performed)

**Compliance criterion** When the flame is applied, it must still be possible to transmit power or signals via all conductors. There must be no short circuit between the conductors or to the shielding.





**1.15 DIN VDE 0472-814 / BS 6387 Category C**

**Test set-up** The cable is laid horizontally, with the cores and shield connected to a power supply at the following voltages:

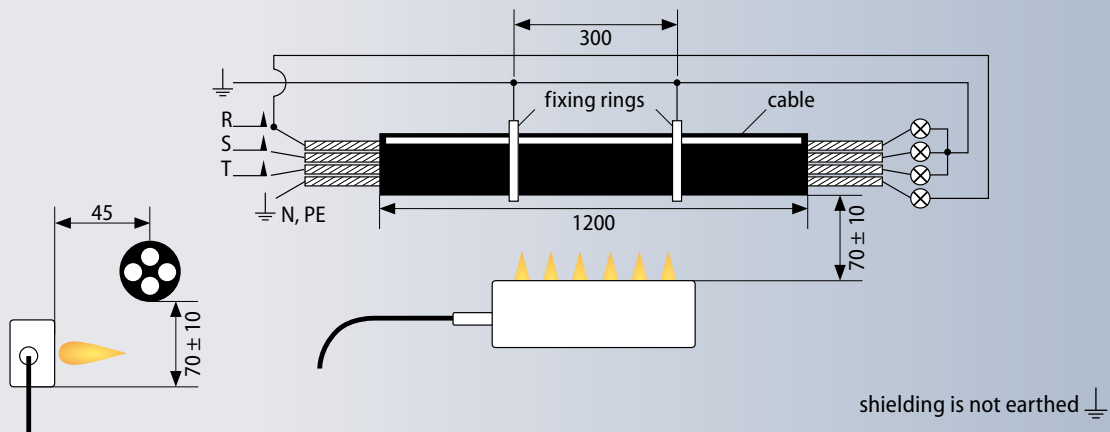
- Data cables: 110 V
- High voltage cables 0.6/1 kV: 230/400 V
- BS: all cables  $U_0/U$

The flame is applied from below across a width of 1200 mm. The flame is directed at the cable.

**Flame temperature** min. 750 °C BS: 950 °C ± 40 °C

**Test duration** 180 min

**Compliance criterion** When the flame is applied and during a cooling period of an additional 12 hours, it must still be possible to transmit power or signals via all conductors. There must be no short circuit between the conductors or to the shielding and no break in the conductors.



**1.16 IEC 60331-21 / IEC 60331-22 (draft) / IEC 60331-23**

**Test set-up** The cable is laid horizontally, with the core and shield connected to a power supply at the following voltages:

- High voltage cables 0.6/1 kV:  $U_0/U$  min. 100 V
- Data cables: 110 V

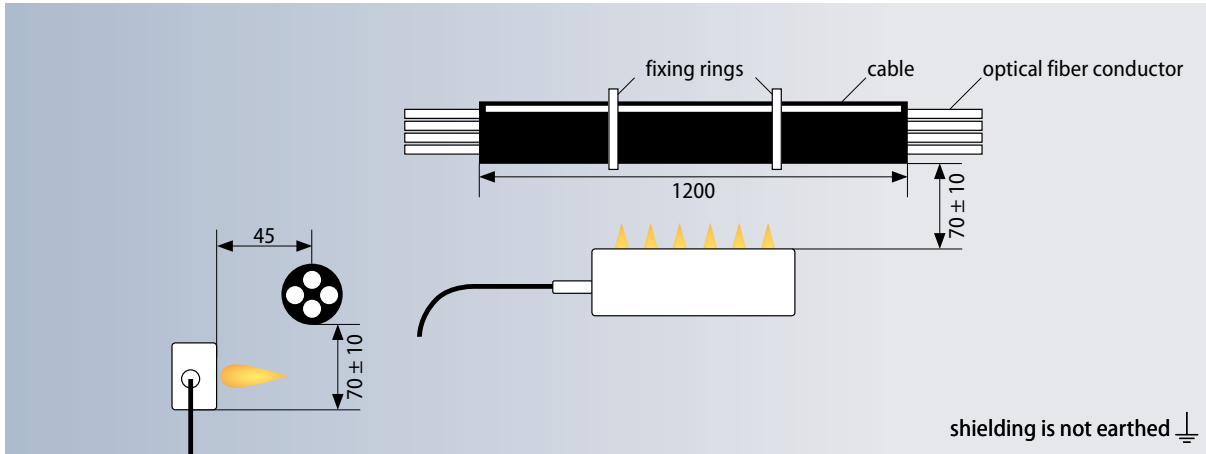
The flame is applied under the cable from a horizontally offset position across a width of 1200 mm.

- Part 21: power and control cables ≤ 1 kV
- Part 22 (draft): power cables > 1 kV
- Part 23: copper data cables

**Flame temperature** At least 750 °C (equipment IEC 60331-11)

**Test duration** Recommended: 90 min

**Compliance criterion** When the flame is applied and during a cooling period of an additional 15 minutes, it must still be possible to transmit power or signals via all conductors. There must be no short circuit between the conductors or to the shielding and no open phase.



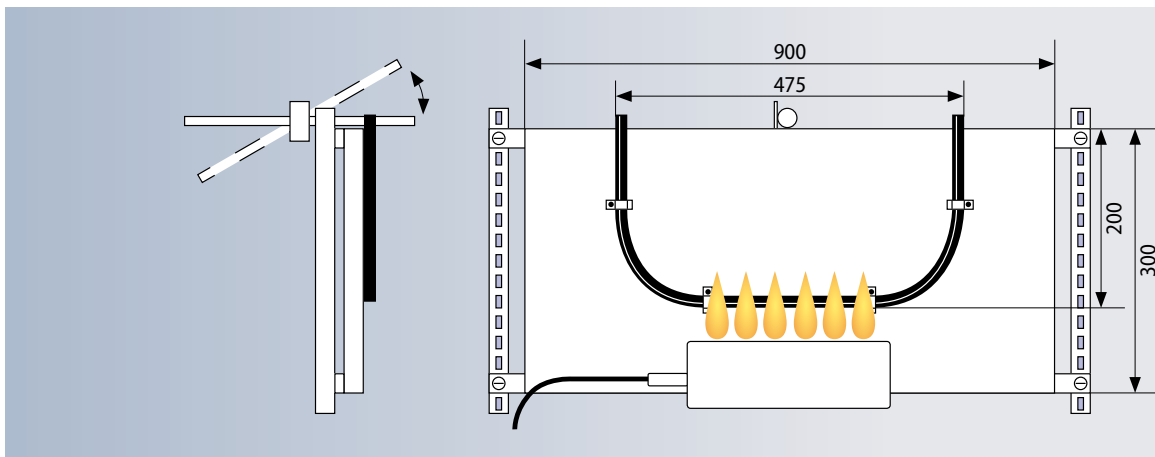
**1.17 IEC 60331-25**

**Test set-up** The fiber optic cable is laid horizontally and the optical fibers must be connected. The flame is applied under the cable from a horizontally offset position across a width of 1200 mm.

**Flame temperature** At least 750 °C (equipment IEC 60331-11)

**Test duration** 90 min

**Compliance criterion** When the flame is applied and during a cooling period of an additional 15 minutes, it must still be possible to transmit signals via the optical fibers.



**1.18 IEC 60331-1 / IEC 60331-2**

**Test set-up** The cable is secured onto a positioning board and a flame is applied from the front. The positioning board is subjected to shocks every 15 minutes during the combustion period.

Part 1: cables with a diameter > 20 mm

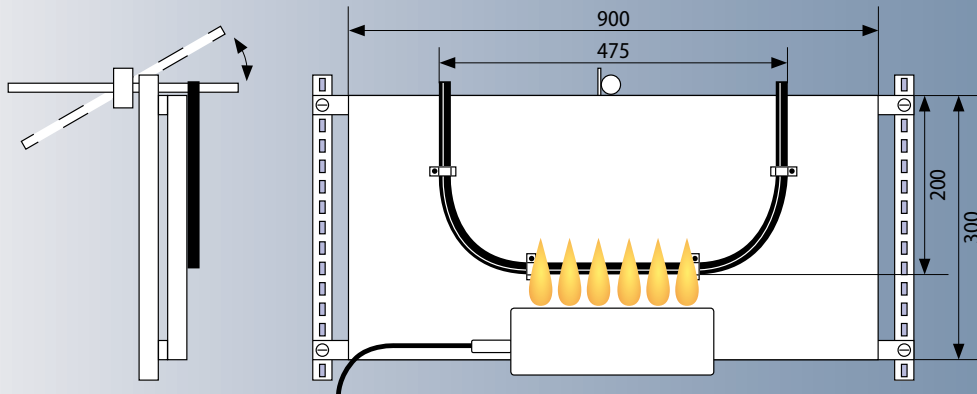
Part 2: cables with a diameter ≤ 20 mm

Test apparatus acc. to IEC 60331-11.

**Flame temperature** Min. 830 °C (equipment IEC 60331-1)

**Test duration** Recommended: 120 min

**Compliance criterion** When the flame is applied, it must still be possible to transmit power or signals via all conductors. There must be no short circuit between the conductors or to the shielding.



**1.19 EN 50200**

**Test set-up** The cable (max. 20 mm in diameter) is secured onto a positioning board and a flame is applied from the front. The positioning board is subjected to shocks every 15 minutes during the combustion period.

**Flame temperature** 842 °C

**Test duration** 120 min

**Compliance criterion** ■ **For cables and cords with a rated voltage of up to 600/1000 V:**

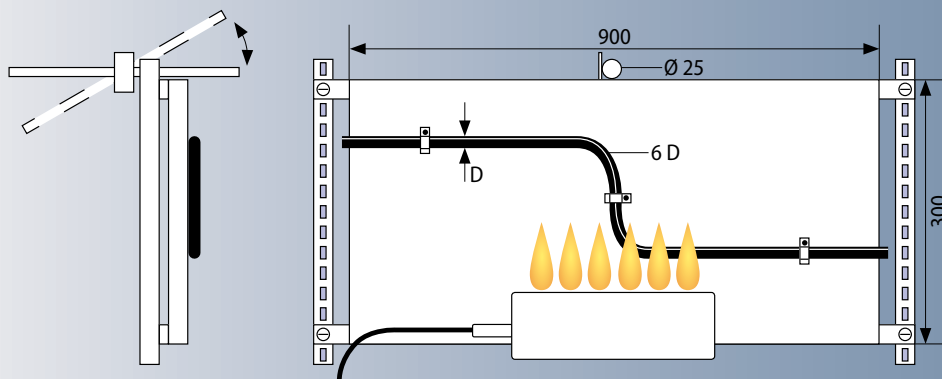
There must be no short circuit between the conductors and no break in the conductors.

■ **For data and communication cables without a rated voltage:**

There must be no short circuit between the conductors and no break in the conductors.

■ **For fiber optic cables:**

The increase in attenuation must not exceed the values defined in the relevant design standards.



**1.20 BS 6387 Category Z**

**Test set-up** The cable is secured onto a positioning board and a flame is applied from below. The positioning board is subjected to two shocks every minute during the combustion period.

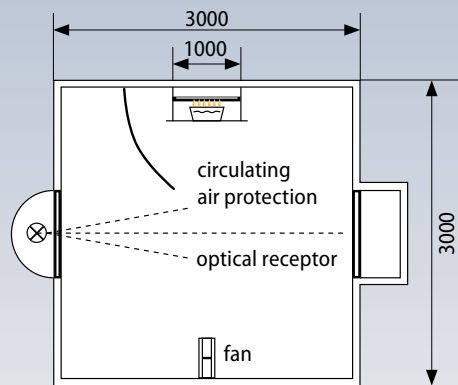
**Flame temperature** 950 ± 40 °C

**Test duration** 15 min

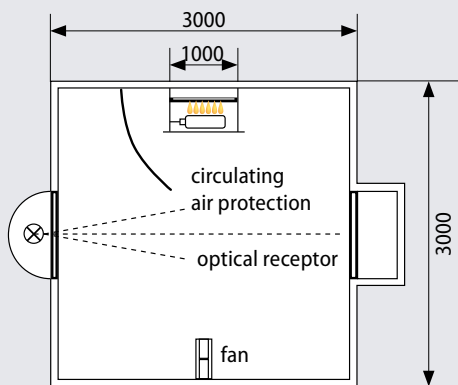
**Compliance criterion** When the flame is applied, it must still be possible to transmit power or signals via all conductors.

There must be no short circuit between the conductors or to the shielding.

## Smoke density



high: 2000



high: 3000

### 2.1 IEC 61034-2 / EN 61034-2 / VDE 0482-1034-2 / NF C32-073-2

**Test set-up** A cable specimen is burnt in a closed chamber using a flammable liquid. The light transmittance of the resulting smoke is measured optically. Test apparatus acc. to IEC/EN 61034-1

**Flame temperature** Determined by the quantity and composition of the fuel.

**Test duration** 40 min

**Compliance criterion** The smoke must transmit the light at the end of the test's duration, as stated in individual specifications. The recommendation of light transmission is 60 % minimum.

### 2.2 Def.-St. 02-711 (formerly NES 711)

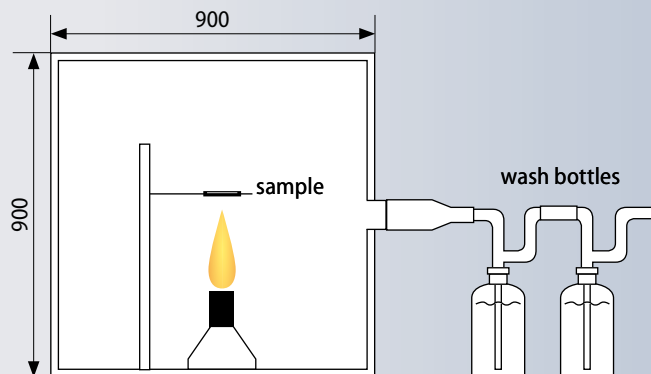
**Test set-up** The devices under test are burnt in a test chamber using gas burners. The light transmittance is measured optically.

**Flame temperature** Not specified (devices under test must be fully burnt).

**Test duration** 20 min

**Compliance criterion** At the end of the test the light transmittance of the smoke must be at least 70%/40%/10%, depending on the product category, unless stated otherwise in the individual specifications.

## Toxicity of the combustion gases



### 3.1 IEC 60695-7 / EN 60695-7

**Test set-up** This standard covers the general aspects of toxicity of smoke and combustion gases as well as the potential hazard (general guidelines).

Part 1: general

Part 2: summary and relevance of test methods

Part 3: use and interpretation of test results

### 3.2 Def.-St. 02-713 (formerly NES 713) / VG 95218-2 Method

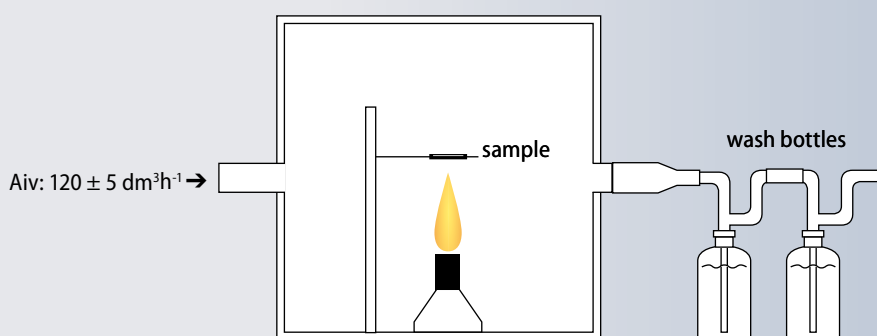
**Test set-up** The individual non-metallic materials of the cables are burnt in a test chamber.

The toxicity of the combustion gas is determined analytically for 14 substances .

**Flame temperature**  $1150 \pm 50 \text{ }^\circ\text{C}$

**Test duration** 5 min

**Compliance criterion** The toxicity values for the individual non-metallic materials of the cable are added together according to their proportion of the total volume. The toxicity index for the overall cable must not exceed a value of 5.



### 3.3. EN 50305-9.2 / NF F63-305-9.2

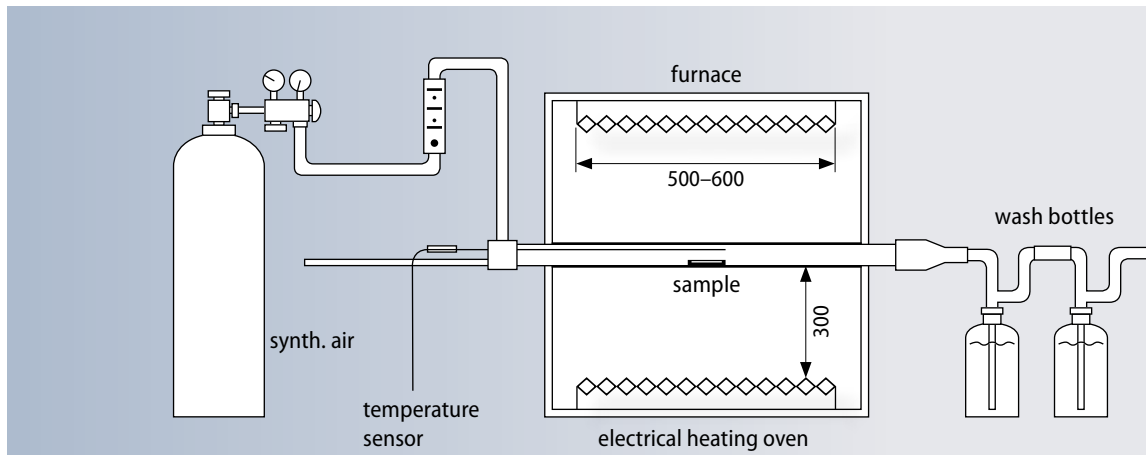
**Test set-up** The individual non-metallic components of the cables are burnt in a test chamber. The toxicity of the fire gas is determined analytically covering 5 substances.

**Flame temperature**  $800 \pm 10 \text{ }^\circ\text{C}$

**Test duration** 20 min

**Compliance criterion** The toxicity index of the non-metallic components of the cable are calculated according to their proportion of the total mass of the burned gases.

## Corrosiveness of the combustion gases (absence of halogen)



### 4.1 IEC 60754 / EN 50267 / VDE 0482-267-1 / NF C32-074

**Test set-up** This standard covers the general aspects of corrosiveness of smoke and combustion gases dissolved in water or atmospheric moisture as well as the potential hazard (general guidelines).

### 4.2 IEC 60754-1 / EN 50267-2-1 / VDE 0482-267-2-1 / NF C32-074-21

**Test set-up** A sample of between 0.5 g and 1.0 g is heated in a tube. The resulting gases are dissolved and tested for their halogen content. Test apparatus acc. to EN 50267-1.

**Flame temperature**  $800 \pm 10 \text{ }^\circ\text{C}$

**Test duration**  $40 \pm 5$  minutes in total, with at least 20 minutes at the maximum temperature

**Compliance criterion** The amount of halogen acid is expressed as mg of hydrochloric acid per gramm mass of sample

**Scope** For compounds or materials described as "zero halogen" and all materials containing less than 5 mg/g halogen acid equivalent, it is recommended to use the method specified in IEC 60754-2/EN 50267-2-2.

### 4.3 IEC 60754-2 / EN 50267-2-2 / VDE 0482-267-2-2 / NF C32-074-22

**Test set-up** A sample of 1 g of all non-metallic cable components is burnt in a furnace. The pH value and the conductivity of the combustion gases dissolved in water are measured. Test apparatus acc. to EN 50267-1.

**Flame temperature** At least  $935 \text{ }^\circ\text{C}$

**Test duration** 30 min

**Compliance criterion** The pH value and the conductivity must be measured. Recommendation: The pH value of the washing water must be at least 4.3, the conductivity of the washing water must be at most  $10 \mu\text{S}/\text{mm}$ . The criteria are valid for one non-metallic component of a cable.

### 4.4 EN 50267-2-3 / VDE 0482-267-2-3

**Test set-up** A sample of 1 g of all non-metallic components of a cable is burnt in a furnace. The pH value and conductivity of the combustion gases released in water are measured.

**Flame temperature** At least  $935 \text{ }^\circ\text{C}$

**Test duration** 30 min

**Compliance criterion** The pH value and the conductivity of all non-metallic components is to calculate according to their proportion of mass in the cable. The criteria are valid for the complete cable.

## Business Unit Industrial Solutions – worldwide

Proximity to the customer is a key element of our corporate philosophy.

This is the reason why you will find LEONI close to you wherever you are.

Please don't hesitate to make use of our strong distribution network.

More information...

... of our sales network under:  
[www.leoni-industrial-solutions.com](http://www.leoni-industrial-solutions.com)

... for marine technology applications under:  
[www.leoni-traffic.com](http://www.leoni-traffic.com)



### LEONI Industrial Solutions – centres of competence

#### Germany

LEONI Elocab GmbH  
LEONI HighTemp Solutions GmbH  
LEONI Kabel GmbH  
LEONI Protec Cable Systems GmbH  
LEONI Special Cables GmbH

#### France

LEONI CIA Cable Systems S.A.S.

#### Great Britain

LEONI Tailor-Made Cable UK Ltd.

#### Spain

LEONI Special Cables Ibérica S.A.

#### Slovakia

LEONI Cable Slovakia spol. s.r.o.

#### Canada

LEONI Elocab Ltd.

#### USA

LEONI Engineering Products & Services Inc.

#### India

LEONI Cable Solutions (India) Private Limited

#### China

LEONI Special Cables (Changzhou) Co. Ltd.

#### Japan

LEONI Wire & Cable Solutions Japan K.K.

#### Singapore

LEONI Special Cables GmbH

You can find the contact details of our international partners on [www.leoni-industrial-solutions.com](http://www.leoni-industrial-solutions.com)

Find out more:

**Business Unit Industrial Solutions**

[www.leoni-industrial-solutions.com](http://www.leoni-industrial-solutions.com)

**LEONI Elocab GmbH**

Obere Lerch 34

91166 Georgensgmünd

Germany

Phone +49 (0)9172-6980-0

Fax +49 (0)9172-2029

E-mail [industrial-solutions@leoni.com](mailto:industrial-solutions@leoni.com)