Fire Performance Tests Applied to Fire Resistant Cable Groups

PART II

Could cables be one of the factors that can cause loss of life and property during fire in every part of our lives? Why are fire resistant cables important for our lives? What is the impact of standards and tests on these cables? On this technical article, we will share the answers for these questions with you and evaluate the structure of fire resistant cables.

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1. Vertical Flame Spread Resistance Test for Insulated Single Conductor or Cable (EN 60332-1-2)

The 600 mm long table sample is fixed vertically in an open front metal cell. The propane burner is placed at an angle of 45 ° with the sample cable axis. The test time depends on the cable diameter.

The test is considered successful when the piece of sample does not burn up to 50 mm from the hanger at the end of the test period and the flame extinguishes spontaneously, and the glow expands down to a point less than 540 mm from the lower edge of the upper support, and additionally the distance from the top of the coal to the beginning of the lower coal is 425 mm.

Table-3: Cable Outer Diameter and Flame Application Time

Cable Outer Diameter mm	Flame Application Time sec.
D ≤ 25	60 ± 2
25 < D ≤ 75	120 ± 2
50 < D ≤ 75	240 ± 2
75 < D	480 ± 2

2. Vertical Flame Spread Test on Vertically Mounted, Bundled Wires or Cables (EN IEC 60332-3-21/-22/-23/-24/-25)

Test samples are attached to a steel ladder. The number of samples should be determined to so as to provide the total nominal volume of non-metallic material in the volume specified in the table per meter of test sample. The steel ladder is placed at the back of the test chamber, 1 meter wide, 2 meters deep and 4 meters high. The test room is ventilated through the ventilation hole. The test flame is applied on the cable samples for the duration specified in the table.

Table-4: EN IEC 60332-3 Series and Flame Application Time

EN IEC 60332-3...Series	Category	Non-Metallic Material Volume (lt/m)	Flame Application Time
21	A F/R	7	40
22	A	7	40
23	B	3,5	20
24	C	1,5	20
25	D	0,5	20

At the end, the test is succesful if the carbonized part does not exceed 2.5 meters. This setup tests the effects of the cable bundles in the installation on the flame spread during fire. It is a rigorous test that examines the flame propagation of bundled cables.

3. Measurement of Smoke Density of Cables Burning Under Specified Conditions (EN 61034-2)

In a chamber of 27 (3x3x3) m^3, samples of 1 meter determined depending on the diameter are burned on a tray with alcohol mixture. With a light source and photocell placed opposite each other at a height of 2.1 meters, the light intensity passing through the smoke is measured. At the end of the test (max. 40 minutes) light transmittance should be at least 60%. In other words, for every 100 units of light sent to the room, at least 60 units should pass across the room.

Table-5: Cable Outer Diameter and Light Transmission

Cable Outer Diameter mm	Sample Ranking	Light Transmission %	
40 < D	1	>60%	
20 < D ≤ 40	2	>60%	
10 < D ≤ 20	3	>60%	
5 < D ≤ 10	N_1	>60%	$N_1 = 45/D$
1 < D ≤ 5	N_2	>60%	$N_2 = 45/3D$

4. Experiment for the Gases Released During Combustion of Cables; Determination of Halogen Acid Gas Amount, Measurement of pH and Conductivity (EN 60754-1/-2)

This test allows the measurement of the corrosive gas emission of the insulating or outer sheath polymer. In an oven of 500-600 mm length, at least 1 g of insulation or outer sheath polymer is heated up to 935 °C. The air flow ensures that the released gases are filtered by passing through the bottle filled with pure and pH 7 water.

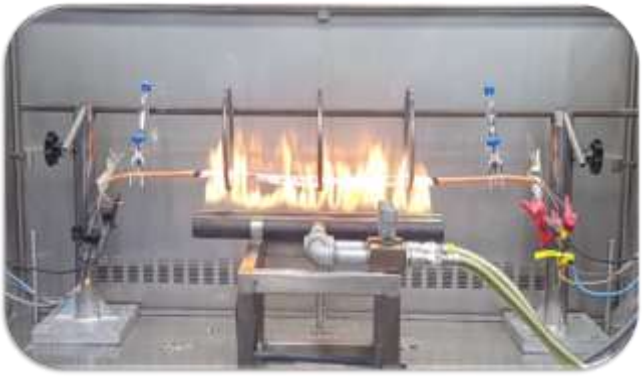
EN 60754-1 is the test method defined as low halogen, and the amount of halogen acid gas is required to be maximum 5 mg / g (0.5%).

In accordance with the EN 60754-2 standard, the pH value of the product is required to be higher than 4.3 and the conductivity measurement value is generally lower than 10 µS / mm in order to be halogen-free.

5. Circuit Integrity Test Under Fire Conditions (IEC 60331-21/-23/-25)

It covers the test process and performance features, including the recommended flame application time for the cables, which are laid horizontally and are required to maintain the integrity of the circuit under a flame at 750 °C. Flame application time should be as specified in the relevant cable standard. It is generally requested as 180 minutes.

Maintaining the voltage, e.g. no fuse blows or circuit breaker cut; It is considered to have the characteristics of ensuring circuit integrity provided that the conductor does not break, e.g. the lamp does not go out. If both are eligible, the experiment must be considered successful.

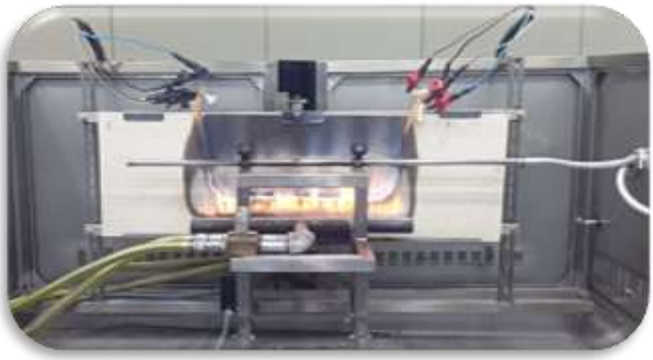


6. Fire Resistance Test of Unprotected Small Size Cables Used in Emergency Safety Circuits (Mechanical Shock Circuit Integrity) (EN 50200)

In this test applied to cables with a diameter smaller than 20 mm, a single cable is mounted on a special fiber glass wall with minimum bending radius, and heated with a propane burner at min. 830 °C (the target is 842 °C). During the test, a rated voltage is applied to the cable and a mechanical shock is applied to the wall every 5 minutes. where the cable is attached with a force of 25 kg. It is considered to have the characteristics of ensuring circuit integrity provided that the voltage is maintained within the time specified in the standard of the cable, e.g the conductor does not break, no fuse blows or circuit breakers cut, and the lamp does not go out. Usually 120 minutes strength is required.

6.1. EN 50200 - Annex E Test According to Water Spray Protocol

The requirement to rely on a water spray when assessing fire resistance may be a feature of national standards or codes of practice or specific product standards. In cases where water spray is required; The water spray should be started 15 minutes after the start of the EN 50200 test and while flame and shock are still being applied. Water application, 15 minutes; it should continue until the end of the test. The test, in which 15 minutes of water spray is applied, takes 30 minutes in total. It is considered to have the characteristics of ensuring circuit integrity provided that the voltage is maintained, i.e. no fuse blows or circuit breaker cut; the conductor does not break, or the lamp does not go out.



7. Fire Resistance Test of Unprotected Large Size Power and Control Cables Used in Emergency Safety Circuits (Mechanical Shock Circuit Integrity / EN IEC 60331-1 (EN 50362))

The conditions of the test applied to cables with a diameter smaller than 20 mm are exactly valid. In other words, there is no change in the applied temperature and mechanical shock values. Only cables with a diameter greater than 20 mm are mounted to the test device using a suitable system.

8. Fire Resistance of Electrical Cable Systems Required to Maintain Environmental Integrity (Function Continuity / DIN 4102-12)

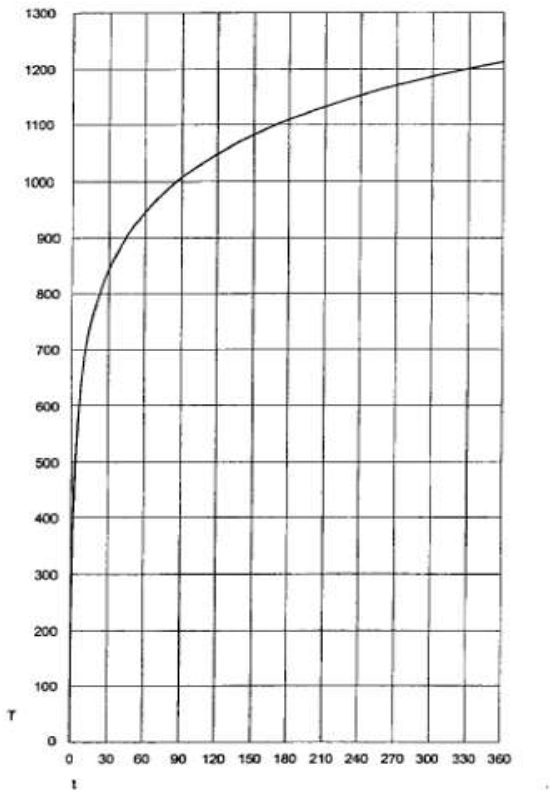
In order to test the fire performance of a complete electrical system, the cables are laid inside the 3-meter-long furnace as inside the building using cable ducts, cable ladders and clips. By attaching certain levels of weights to the cable trays and ladders in order to obtain the closest simulation to reality; the temperature is allowed to increase in the furnace according to the temperature curve in Figure 1. The system is exposed to flames above 1000 °C after 90 minutes.

It is aimed to ensure the continuity of the function at the end of the targeted time. Periods of 30, 60 and 90 minutes are defined in the DIN 4102-12 standard.

Table-6: Functional Protection and Duration

Functional Protection Classification	Duration min.
E30	30≥
E60	60≥
E90	90≥

Figure-1: Standard Temperature / Time Curve According to EN 1363-1 (ISO 834)



Duration min.	Oven Temperature °C	Duration min.	Oven Temperature °C
0	20	90	1006
5	576	120	1049
10	678	150	1082
15	738	180	1110
20	781	210	1133
30	842	240	1153
45	902	300	1186
60	945	360	1214

Why should PVC and PE Polymers Not Be Used in Fire Resistant Cables?

Polyvinyl chloride (PVC) is a widely used material in cable insulation and sheath. It is preferred because it is cheap and easily applicable. Although its flame retardancy is improved with additives, it emits dense smoke and corrosive gas during fire. Dense smoke, as can be expected, makes the evacuation of people and the work of firefighting and rescue teams difficult. HCl, CO2 and CO gases, which are produced as a result of burning PVC-based cables and building materials during fire, are the primary cause of death for people. Hydrochloric acid, which is formed by the combination of HCl gas with water, rapidly corrodes metal building elements and electronic devices.

Polyethylene (PE) material does not contain chemically halogen molecules. It does not emit poisonous and corrosive gas when burned. However, it contributes to the growth of the fire since it does not have flame retardant properties and is easily flammable. Smoke density is also higher than HFFR compounds. For these reasons, it is not recommended to use cables made of polyethylene material inside the building.

What are the Points to Consider in Fire Resistant Cable Selection?

Based on the *Features of Fire Resistant Cables*, the flame spread, smoke, toxic gas and heat spreading properties of fire resistant cables should be designed and manufactured at the level required by the standards in such a way that they do not affect human health. In order to guarantee these criteria, project companies should make sure that the product is certified by an internationally accredited certification body when selecting the cable.

On the other hand, in our country, according to the Regulation on the Protection of Buildings from Fire, the minimum working time during a fire is determined as 60 minutes. However, there is no information about the fire resistance test standard by which the performance will be determined. Here again, the project companies should be selected in accordance with the fire resistance standard stipulated in the usage areas or areas of the building/structure.

Structures Using Fire Resistant Cables

In the "General Specifications on Construction, Mechanical and Electrical Installation", it is pointed out where fire resistant cables will be used. According to this specification; all buildings with big crowds and high potential of panic, and high-rise buildings, hospitals, theaters, schools, cinemas, shopping malls, data processing centers, tunnels, mines, factories are required to use non-flammable, fire-resistant Halogen-free cable channels, pipes and fittings that provide the required dielectric property.

The Use of Certified Cables and Importance of Manufacturer Laboratory Infrastructure

Certification is critical because it means that the products and services are evaluated in an independent and impartial manner regarding their compliance with national and international standards. Although the certificate is a very important indicator for project and contracting companies, it must be supported by the laboratory infrastructure of the manufacturers. Sustainable quality is as important as obtaining the certificate. An effective laboratory infrastructure is required to ensure continuous improvement and sustainability of performance.

Cooperation with independent, expert and accredited test organizations is the first assurance for every user and market. Subsequently, it periodically conducts both market and company audits. This ensures its up-to-dateness and continuity.

Thus, the use of cables, which are increasing day by day in our living spaces, is of utmost importance, especially for the fire performance, life and property safety. The use of correct and reliable cables in the right area will minimize fire risks and possible losses.

What is the Relationship Between Fire Resistant Cables and Construction Products Regulation?

The Construction Products Regulation (CPR: Regulation (EU) No 305/2011) sets harmonized rules for the marketing of building products in the EU. It provides a common technical language for evaluating the performance of building products. It provides reliable information for professionals, public authorities and consumers so that different manufacturers in different countries can compare the performance of their products. However, users of building products can better define their performance demands, market surveillance can be based on a common information structure.

In the CPR, the regulation numbered EU 2016/364 for the reaction to fire performance was first published regarding the cable. In Table-4 of this communique, reaction to fire performance classes for cables are specified. A series of harmonized standards have been published to cover the basic requirements of the 305/2011 regulation and the 2016/364 annex. Power, control and communication and fiber optic cables used for general applications in construction works are certified according to their reaction to fire performance classes in line with the EN 50575 standard. This situation has become mandatory in the EU in order to attach CE labels to the products.

Cables used for electricity, communication and fire detection and alarm supply in buildings and other civil engineering works, which are places where power and/or signal supply should be continuous, to security installations such as alarm and fire fighting installations are not covered by the EN 50575 standard. According to the standards, there is no requirement to document the reaction to fire class performance for fire resistant cables. However, as mentioned in the "Heat Dissipation and Smoke Formation Measurements and Limitation" section, it should not be considered to separate the response and durability characteristics. When determining the fire resistant cables to be used in the building, it is important for the professionals doing the project and application work to be careful that the fixed installation cables used in the same place are compatible with the reaction classes. They cannot request documents for these cables, but it can be requested that the cable design is in the response class compatible with that region and this situation can be supported with the test report.

Key Words: *weak current cable, fire resistant cables, flame retartand, halogen free flame retardant, fire performance test, construction products regulation, CPR*