WHITE PAPER

Fire & safety performance standards

LOROM

CABLE & SYSTEM DESIGN

Terminologies describing Fire Performance

Terminologies describing Fire Performance often present a challenge to understand as how they apply to a cable's fire performance in the intended application. This paper will provide a basic understanding of national as well as international fire performance standards and regulations and how important it is to select the correct cable with the right fire and safety performance. Terminology commonly used in the cable industry are, Flame Retardant, Low Smoke, Low smoke Zero Halogen, Low Smoke Fume (LSF) and Fire Resistant Cables which are commonly known as Fire Survival Cables.

Below is a general explanation of what these Fire Performance Terminologies entails:

Flame Retardant

Fire retardant cables are designed for use in fire situations where the spread of flames along a cable route needs to be retarded. Due to relative low cost, fire retardant cables are widely used as cables compliant with the National Electrical Code (NEC). Regardless of cables installed in single wire or in bundles, during a fire, the flame spread will be limited; hence the fire will be confined to a small area, reducing the fire hazard due to fire propagation.

Low Smoke & Halogen Free & Fire Retardant (LSZH)

LSZH cables are not only characterized by the fire retardant performance but also by the halogen free properties, thus offering low corrosivity and toxicity. During a fire, the LSZH cables will emit less smoke and acid gases which may affect human health and damage expensive communication equipment. Compared with normal PVC cables, LSZH cables outperform PVC cables by providing low corrosivity and low smoke emission properties.

Low Smoke Fume (LSF)

The low halogen content and low corrosivity of low smoke fume cables lies somewhat in between that of fire retardant cables and LSZH cables. LSF cables also contain halogen but the content is much less than that of PVC cables. LSF cables are designed to reduce the spread of fire, toxic gases and smoke during fire. The LSF cables are usually manufactured from flame retardant PVC blended with HCL additive and smoke absorbent. These materials help improve the fire performance of the LSF cables.

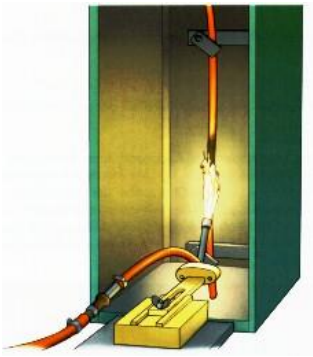
Fire Resistant (FR)

Fire resistant cables are designed to maintain circuit integrity of those vital emergency services during the fire. The individual conductors are wrapped with a layer of fire resisting mica/glass tape, which prevents phase to phase, and phase to earth contact even after the insulation has been burnt away. The fire resistant cables can maintain performance even under fire with water spray or mechanical shock.

Fire Performance Class

The main concerns for the cables in their fire survival properties are their flame spread, smoke characterization and gas toxicity. In American fire standard, the concern lies more on the first two and it differs from the European standard, which concerns all these aspects. In USA, it is believed that the fire hazard is mainly due to CO toxic gas emitted and the heat release during the conversion of CO to CO2 during the fire. Therefore, to control the heat release is the most important concern for reducing the fire hazard. However, in European countries, halogen content, the corrosivity of the gases, the smoke density and the toxicity of the gas are equally important factors affecting the human safety during and after the fire.

IEC Standards for Fire performance



IEC 60332-1 CENELEC HD 405 (Flame Test on Single Vertical Insulated Wires/Cables)

IEC60332-1 defines test method defining the flame propagation characteristics of a single wire or cable.
Test comprises a DUT (Device under test) of 60cm cable fixed vertically inside a Metal enclosure.
A 175mm long flame is applied at 45° angle applied by a Bunsen burner positioned in a distance of 450mm from the clamping point.
The DUT is classified as passing the test, if after burning has ceased, the charred or affected position does not exceed a distance greater than 50mm measured from the top clamp.
Caution should be made applying this test method to thin wire sizes, as the insulation material (depending on compound, except for high temperature materials such as fluorinated compounds) will most likely melt during the test.

IEC 60332-3/BS 4066-3 (Flame Test on Bunched Cables)

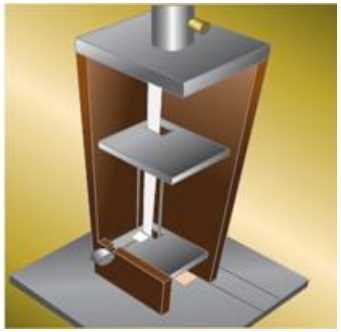
IEC60332-3C describes a test method establishing fire propagation of bunched cables or bunched single wires.
Test conducted by a DUT, comprising a selected number of 3.5m long DUT's placed on a metal vertical ladder tray The DUT is be subjected a flame from a burner in a specified times under controlled airflow.
Dependent on the DUT fire propagation behavior the test result in four categories (A, B, C & D) based upon and distinguished by test duration and the volume of non-metallic material of the (DUT) sample under test.
The (DUT)/ cable specimen is classified as passing the test if, after burning has ceased, the charred or affected portion does not exceed 2.5m measured from the above the bottom edge of the burner.

UL Standards for Fire performance

The National Fire Protection Agency (NFPA) publishes flame-resistance standards through its published National Electrical Code (NEC). Other agencies, such as UL and CSA also publish standards and define certain tests to determine flame resistance (or lack thereof). Flame resistance requirements are for the most part governed by local and national codes which define the various levels of flame hazard, plus the severity of the fires to which cables may be exposed. The important considerations are propagation of flame, support of further combustion, generation and propagation of smoke. The NEC deals primarily with fire hazards in buildings, whereas UL and CSA deal with requirements based on use.

CL2P, CL3P, CMP (Plenum Flame Test/ Steiner Tunnel Test, FT6)

The most severe and stringent test requirement of fire performance testing. Plenum rated cables meet the NFPA -262 FT6 standard (formerly known as UL910)
DUT/Cable samples on a horizontal metal tray in a Steiner tunnel chamber and are being exposed of 87.9KW (300,000 BTU/Hr) flame for 20 minutes.
To pass the and have the CMP plenum rating marking, the DUT/ cable specimen can not exhibit flame spread exceeding 5 feet or 1.5 meters, over and above the smoke density is measured during the test with values not exceeding (a) 0.5 peak and (b) 0.15 maximum average.
Plenum CMP rated cables are typically installed in air ventilation ducts, suspended ceilings, raised computer flooring etc, without any electrical tubing
Plenum rated cables are predominantly used and applied in Canada and USA.
Compared to other fie performance cables, fire retardant properties of CMP cables are significantly superior to those of LSZH cables complying with IEC 60332-1 and IEC 60332-3.



CMR (Riser Flame Test, FT4)

To pass and have the CMR plenum rating and marking cables with CMR, the DUT/Cable has to pass UL1666.
DUT/ Cable samples on a metallic vertical shaft are exposed to a burner generating 154.5KW (527,500 BTU/Hr) for 30 minutes. The DUT/Cable samples qualifying for a riser rating, Flame spread cannot exceed 12ft beyond the ignition point
The CMR riser flame test does not consider smoke density or toxicity index unlike that of CMP Plenum rated cables
Riser rated marked approved cables are suitable where cables are used in vertical runs in a shaft that may penetrate more than one floor.

CM, CL2, CL3, CM, CMG, PLTC (Vertical Tray Flame Test)

General-purpose cables meet UL 1581.
The DUT/Cable samples placed on a 8 feet metal vertical tray are burned at 20KW (70,000 BTU/hr.) for 20 minutes.
The DUT/Cable samples pass the test if the flame spread will not exceed 8ft and fire extinguish by itself.
UL 1581 is similar to IEC 60332-3C except for that the number of testing samples is different.
This standard and test does consider smoke density or toxicity.

CMG (Vertical Tray Flame Test) FT-4/UL2556

The DUT/ Cable samples on a vertical tray and are burned at 20KW (70,000 BTU/hr.) for 20 minutes.
The DUT/Cable Samples pass the test if the flame spread will not exceed 1.5m (4.92 ft.)
These general-purpose cables also meet CSA FT-4/UL2556 CM and CMG are similar and both are recognized in Canada and USA. This test does not look at the smoke density or toxicity as a requirement.

CMX (Vertical Wire Flame Test)

The restricted cables meet UL1581 Limited-use.
The test consists of 25 feet long ventilated tunnel. The DUT/ cable specimen is placed on a metallic ladder inside the tunnel and the flame of 30,000 BTU/Hr is applied to the cable with intervals of 15 seconds on and 15 seconds off, this is repeated five times for a total exposure to the flame of 1 minute and 15 seconds.
Compliance to CMX requires meeting the following; after the test flame is removed the cable specimen can flame for not more than 60 seconds and the charred portion will not exceed by 25%.
UL 1581 VW-1 is similar to IEC 60332-1 except for the difference in the time for flame applied.
This test does not look at the smoke density or toxicity.
The CMG cables are suitable for use in dwellings and for use in raceway.
These cables cannot be installed in bundles and must be protected in metal conduit.
This type of cable is chosen as the minimum requirement for commercial installations.

Standard for Fire Resistance

IEC60331 Fire Resistance Test

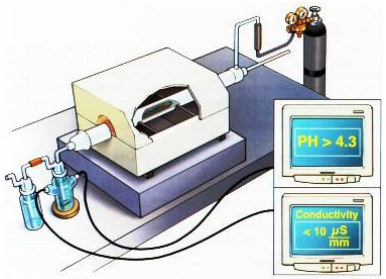
A cable sample is placed over a gas burner and connected to an electrical supply at its rated voltage. Fire is applied for a period of 3 hours.
The temperature on the cable is between 750°C and 800°C. After 3 hours, the fire and the power is switched off. 12 hours later, the cable sample is reenergized and must maintain its circuit integrity.

IEC 60754-1 (Emission of Halogen)

This specifies a test for determination of the amount of halogen acid gas other than the hydrofluoric acid evolved during combustion of compound based on halogenated polymers and compounds containing halogenated additives taken from cable constructions.

Halogen includes Fluorine, Chlorine, Bromine, Iodine and Astatine. All these chemicals are toxic by their nature.
In this test, when the burner is heated to 800°C, 1g sample is placed inside and the HCL is absorbed into water inside the chamber fed with air flow.
The water is then being tested for acidity.
If the hydrochloric acid yield is less than 5 mg/g, the cable specimen is categorized as LSZH. If the hydrochloric acid yield lies between 5mg/g to 15mg/g, the cable specimen is categorized as LSF.
IEC60754-1 cannot be used for measuring the exact HCL yield if the yield is less than 5mg/g.
This test cannot determine if the cable is 100% halogen free or not.
To determine if the cable specimen is 100% halogen free or not, IEC60754-2 has to be employed.

IEC 60754-2 (Corrosivity)



This test specifies a method for the determination of degree of acidity of gases evolved during combustion of the cable specimen by measuring its pH and conductivity. The specimen is deemed to pass this test if the pH value is not less than 4.3 when related to 1 liter of water and conductivity is less than 10us/min. When the HCL yield lies between 2mg/g and 5mg/g, a cable specimen can pass IEC 60754-1 but its pH value will likely be less than 4.3 and therefore cannot pass the IEC 60754-2 test.

IEC 61034-1/ASTM E662 (Emission of Smoke)

This specifies a test for determination of smoke density. The 3-meter cube test measures the generation of smoke from electric cables during fire. A light beam emitted from a window is projected across the enclosure to a photocell connected to a recorder at the opposite window. The recorder is adjusted to register from 0% for complete obscuration to 100% luminous transmissions. A 1-meter cable sample is placed in the center of the enclosure and is applied with a fire. The minimum light transmission is recorded. The result is expressed as percentage of light transmitted. The specimen is deemed to pass this test (IEC61034-1 & 2) if the value is greater than 60%. The higher the light transmittance, the less smoke emitted during a fire.

ISO4589-2/BS2863 (Oxygen Index LOI)

This is a test for assessing the oxygen index of the material in accordance with the test method specified in ASTM D2863-95 (Measuring the minimum oxygen concentration to support candle-like combustion of plastics). At room temperature when the oxygen content in the air exceeds the oxygen index, the material will burn by itself automatically. The higher the oxygen index, the more retardant the cable will be. For example, if the oxygen index of a material is 21%, it means that the material will burn by itself even at room temperature because at room temperature the normal oxygen content is 21%. In general, the oxygen index of a LSZH cables ranges from 33% to 42%.

ISO4589-3/BS2782.1 (Temperature Index TI)

This is a test for assessing the performance of a material when it is tested in accordance with BS2782 Part 1 Method 143A and 143B. The oxygen index of a material will drop when the temperature rises. When the temperature rises and the oxygen index drops to 21%, the material will burn automatically. This temperature is defined as temperature index. For example, the temperature index of coal is 50%. When the temperature climbs to 150℃, its oxygen index drop to 21% and the coal will burn by itself automatically. The temperature index of the coal will then be defined as 150 ℃. In general, the temperature index of LSZH cables ranges from 250 ℃ to 300℃.