Evolution of Cable Fire Safety Standards in Australia

INTRODUCTION

Fire safety standards for electrical cables have evolved over the past few decades to the extent that they are now well established along with cable materials and designs that meet these standards. Australian Standards have largely followed international standards such as the IEC, with many now adopting the entire content of the IEC standards.

Separately to this evolution Australia had also developed their own unique standard for fire resistant cables which more closely aligns with the requirements of the building industry.

The purpose of this paper is to (i) review the evolution of the fire safety standards in Australia, recapping the purpose of each, (ii) review how cables are constructed that meet these standards, and (iii) finally look at how the Australian industry went on their own to develop a standard for fire resistance.

BACKGROUND

Cables designed for safety systems, are commonly referred to as “Fire Rated” cables. The key elements of Fire Rated cables are as follows:-

- Flame retardant – do not propagate fire
- Low smoke – reduces obstruction to evacuation of buildings during fire
- Zero halogen – does not create toxic fumes and corrosive by-products during fire
- Maintains circuits integrity – keeps electrical equipment going during fire

We will now explore each of these key elements in a bit more detail.

FLAME RETARDANT CABLES

Flame retardant cables do not propagate fire, ie they use materials which are difficult to ignite and are self-extinguishing, they also retard the spread of fire. That is to say that if a fire starts within the cable, say due to an internal fault, the cable will not spread the fire to other areas of a building, factory etc.

Flame retardant cables are commonly used in in buildings, plants, enclosed infrastructure and ships. Another key aspect of flame retardant cables is that they avoid adding fuel to a fire. It may not be necessary to use flame retardant insulation materials, but it is most important that flame retardant materials are incorporated in the cable sheathing. When developing flame retardant cable it is important to assess the combination of insulation, sheathing materials and the other combustible components of a cable, eg fillers and bedding layers to make an overall assessment of the performance of the cable.

Standards exist that were developed a number of decades ago that detail test methods to establish the flame retardant properties of materials and cables. Some of the widely used standards are summaries briefly below.

Oxygen Index Test – AS/NZS 2122.2

This is a material test which determines the percentage of oxygen in air that supports combustion of a material. Since air contains 21% oxygen it stand to reason that any material
when test to this standard that registers an oxygen index greater than 21% will be difficult to burn and the higher the number the more difficult it is to burn the material. PVC for example has an oxygen index around 23 making standard building cables flame retardant while fire rated cables, which aim to achieve a high degree of flame retardant properties usually contain materials having an oxygen index at least 28-30, while materials in the mid 30s are not uncommon. (XLPE is a common material used in electrical cables, and has an oxygen index around 18%, which therefore indicates, that by itself, it has very poor resistance to combustion and will burn readily in open air when exposed to flame.)

**Single Cable Vertical Flame Propagation Test – AS/NZS 1660.5.6**

While the oxygen index test gives a good measure of the flame retardant properties of a material, it may not give a good indication of the flame retardant properties of a complete cable. This is due to the complex makeup of cables, and the variety of materials used, ie insulation, fillers to make cable round, bedding layers, armour and outer sheath. All of these cable materials will have an influence on the overall flame retardant properties of a cable. For this reason complete cable flame propagation tests have been developed and the first to check is the single vertical flame propagation test details in AS/NZS 1660.5.6.

Here a 600 mm length of cable is subject to flame applied by a “Bunsen Burner” type flame source as per the figure at right. The flame application time varies in line with the cable diameter and the pass criteria is such that the cable must not burn up to 50 mm from the top support of the cable, and any falling particles that fall away from the burning cable must not ignite the paper laid under the cable sample.

All cables complying with AS/NZS 5000.1 and AS/NZS 5000.2 must comply with this standard, which includes all TPS cables, single insulated building wire, XLPE/PVC SDIs, orange circular PVC/PVC cables for example.

This test standard evolved from the European standards such as the IEC and the current version (2005) adopts the entire content of the equivalent IEC 60332-1 standard. There are other standards around the world that have similar test methods, such as the UL 1581 in the USA, but Australia has largely followed European standards and practices.

(IEC stands for “International Electrotechnical Commission” and is an organisation that develops standards for European industry, and therefore has contribution from the majority of European nations, and are also widely used around the world and are recognised for their high level of technical competence.)

**Multiple (Bunched) Cable Vertical Flame Propagation Test – AS/NZS 1660.5.1**

This standard goes further than the single cable flame propagation test by testing cables in bunches, which increases the amount of combustible material, which increases the amount of fuel to be burnt. This is more onerous than the single cable test, and in general will require materials with higher oxygen index to pass, typically above 28. Again careful selection of all
cable materials is necessary to achieve a pass in this test. (It is not necessary to use an insulation material of high oxygen index as the sheath material has the greatest influence on passing this test.)

There are four levels or categories associated with this test, ie Cat A, B, C and D, which relate to the volume of combustible material in a cable. Cat A being the most onerous (7 litres/metre of test sample), while Cat D is the least onerous (0.5 litres/metre of test sample.) Therefore depending on the category to be tested and the size of cable either a single large cable might be needed or a lot of small cables.

In this test 3.5 m lengths of cable are mounted on cable ladder tray vertically in a test chamber with a standard ribbon burner applied to the base of the cable assembly. (See image at right.) The cables are clamped to the ladder by steel or copper wire. The flame is applied 500 mm from the bottom of the cable samples. (Flame application time is 40 minutes for Cat A and B and 20 minutes for Cat C and D.)

A pass is achieved if flames do not propagate more than 2.5 m from position of burner.

Similar to the single vertical cable test, the bunched cable test standards evolved from the European standards and the current version (2005) adopts the entire content of the equivalent IEC 60332-3 standard.

**LOW SMOKE ZERO HALOGEN (LSZH) CABLES**

Now we look at the second and third key element of fire rated cables that being Low Smoke and Zero Halogen. What exactly does this mean?

Cables with these properties are made from materials that DO NOT contain halogens. (Halogens comprise the group of chemical elements that includes Fluorine, Chlorine, Bromine, Iodine etc.) Materials containing these elements tend to give off lots of smoke and the combustion by-products, or residue, tend to be acidic and very corrosive. Therefore PVC (Poly Vinyl Chloride) is NOT used in Fire Rated cables, while materials such as XLPE or HFI-90-TP, some rubber materials not containing Chlorine such as EPR, and specially developed thermoplastic sheathing materials, such as HFS-90-TP or HFFR.

Cables that are categorised as LSZH are those that emit a low level of smoke, toxic fumes and corrosive gases.

These cables are used in confined areas with large amount of cables within close proximity to human traffic and/or presence of sensitive electronic equipment. They avoid people getting blinded by the smoke, avoid harmful effects on humans due to inhalation of toxic fumes, and avoid corrosion of sensitive electronic equipment.
Smoke Density - AS/NZS 1660.5.2

Testing of cables for smoke emission during fire is done to AS/NZS 1660.5.2 and is done in a 3 metre cube smoke chamber. Cable samples 1 metre long, (the number of cables being determined in accordance with their diameter), are supported within the chamber over a tray of alcohol based fluid, which serves as the flame source. (See image at right.)

After ignition of the alcohol based flame source the smoke given off during combustion of the sample/s is determined by measuring the amount of light transmitted from one side of the chamber to the other using a specified light source (100 W, 2000 lm – 3000 lm), and light detector (photocell).

For a “Low Smoke” cable a pass is achieved if more than 60 % of light is transmitted through the chamber. (AS/NZS 4507 pass criteria is 50% - 70% depending on cable diameter.)

Again the Australian Standard for determining smoke density is based on the European standards, namely IEC 61034 and the current version (2006) adopts the entire content of the equivalent IEC 61034 standard, including both Part 1 and 2 of the IEC standard within the one AS/NZS 1660.5.2.

Acidity and Corrosiveness of Smoke Emissions – AS/NZS 1660.5.3 & AS/NZS 1660.5.4

The first part of this series of test determines the amount of halogen acid gas evolved during combustion of a material. (Note that this test is done on cable materials as opposed to complete cable samples.)

The basic principle of these tests is to burn a small quantity of material in an enclosed environment which is fed with air at one end such that the smoke emissions can be collected by bubbling the smoke/air mixture through a number of water containers. The sample of water can then be checked to determine various properties such as:-

- Volume of hydrochloric acid in the water (AS/NZS 1660.5.3)
  - Halogen free cables will return a zero result under this test
- Acidity (pH) level of water (AS/NZS 1660.5.4)
  - A pass is achieved if the pH is > 3.5
- Conductivity of water (AS/NZS 1660.5.4)
  - A pass is achieved if conductivity is < 10 μS/mm
The test apparatus is depicted in the image at right.

Again the Australian Standards for determining the acidity and corrosiveness of cable materials has followed European practice and standards, namely the IEC 60754 series and the current versions AS/NZS 1660.5.3 (1998) and AS/NZS 1660.5.4 (1998), while not yet adopting the entire content of the equivalent IEC 60754 standard, Part 1 and 2, they do align with these standards.

**CIRCUIT INTEGRITY**

This is the final key element and perhaps the most important and complex element of fire rated cables and the one where differing test methods exist for determining this property of cables. The properties of cables which afford circuit integrity, or also known as “Fire Resistance” in the cable industry are listed below.

- Keeps electrical equipment going during fire
- Used in buildings, plants, enclosed infrastructure, ships and sites where the cable is expected to continue to function for essential services/mission critical applications whilst under fire.
- Fire Safety in Buildings
- Fire Alarm and Security cabling
- Emergency Exit signs and facilities
- Power and control for Fire Fighting equipment eg Water Pumps

(Note: It is implied that a Fire Resistant cable should be Flame retardant and Low Smoke Zero Halogen as well, but it is not necessarily the case. (It should also be realised that although this statement may be true it may be difficult to achieve fire resistance with cables containing halogenated materials because the acidic and conductive nature of the combustion by-products of these materials are likely to cause a failure when performing the circuit integrity test.))

There are two fundamental test methods and standards available throughout the world for determining the circuit integrity properties of cables, those that employ a ribbon type burner and those that are performed in an enclosed furnace system. The main difference is that the ribbon burner test methods do not apply the same amount of heat as the furnace test method. Therefore cables that can pass ribbon burner test may not pass the furnace test. (It is the furnace test that has been adopted by the Australian Building Industry for testing the fire resistance of building materials, which will be covered later in this article.)
Similar to the other fire safety standards for cables the AS/NZS 1660.5.5 circuit integrity test standard has followed European practice and is based on IEC 60331, which was developed and first published in 1970. Therefore this test method has quite an established track record, with its evolution being the introduction of higher temperatures, the inclusion of shock (or mechanical impact) and an optional water spray.

The test set-up for fire alone is depicted in the image at top right, while the test setup for fire with shock is depicted at bottom right. The latest version of AS/NZS 1660.5.5 (2005) adopts the entire contents of IEC 60331 and there are a number of sections/parts to the AS/NZS 1660.5.5 and IEC 60331 standards that align as listed below.

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As depicted in the images at right, for fire alone a cable sample of approximately 1200 mm long is clamped at its ends and support in the centre by two metal rings spaced approximately 300 mm apart. The burner is of a “specific” type fuelled by propane gas and has a length of 500 mm. The standards define the test setup in more detail concerning control of fuel flow, positioning of the burner, etc. The cable ends are exposed so that
continuity can be measured by powering with a suitable three phase or single phase supply which is loaded with an indicating device, such as a lamp that draws a load current of 0.25 A. In-line fuses are also installed in the circuit so that short circuits between conductors can also be detected.

A pass is achieved if both the lamp/s remain alight and no fuse fails, during the recommended flame application time, usually 90 minutes. (Temperature control is performed by means of an initial verification stage by varying the gas flow rates and measuring the flame temperature with thermocouples positioned appropriately in the location that will be occupied by the cable sample.)

The test method for fire with shock involves mounting the cable sample to a metallic frame as depicted in the image on previous page, the cable being installed with a 180 degree bend at the cable manufacturer’s minimum bend radius. A metal bar is employed as a shock producing device that strikes the frame every 5 minutes throughout the duration of the test. In this test the flame applications is usually 120 minutes and the pass criteria is the same as for fire alone.

**Ribbon Burner Standards - BS 6387**

There are certainly many other international standards that exist that deal with circuit integrity testing of cables, German VDE, French NFC, most of which adopt similar ribbon test methods as the IEC 60331 standard. The British Standard BS 6387 is one such example of a widely accepted international standard. This standard also describes a ribbon burner test with the test apparatus being similar to IEC 60331. For fire alone this is known as Cat A, B or C, which relate to the test temperature, of 650 °C, 750 °C or 950 °C respectively. There is a difference in the test for fire with shock in that the cable sample is mounted on a fire rated board (see image at right), rather than the frame as shown in the image on the previous page. Shock is achieved by a metal bar striking the board at regular intervals, ie 30 seconds.

Note the two 90 degree bends in the cable sample which are done at the cable manufacturer’s minimum bend radius. Fire with shock use the same test temperatures as fire alone, but use the letters X, Y, or Z respectively.

An optional water test can be performed where the sample is sprayed with water from a sprinkler system (similar to the type used in building fire sprinkler systems), see image at right.
Further details of the test durations, sample setup, sprinkler application time, etc, can be obtained from the relevant standards.

The details provided in this article are simply to give the reader an insight into the principles of the various test methods that exist around the world.

**Furnace Standards – AS/NZS 3013**

As an alternative to the ribbon burner test that I have described in the previous pages, Australia has also developed and adopted a more onerous furnace test based on that used for the testing of building materials.

The key features of the AS/NZS 3013 test method, not only include the use of a furnace, but include the following elements:-

- Test method includes both testing under fire conditions and mechanical (impact and cutting) testing
- Test method can be used to test cables, busways, cable supports (trays) and fixing (saddles, ties etc)
- Fire test on cables require cable to be mounted on designated cable tray
- Test temperature is continuously monitored and controlled throughout the fire test and follows the time/temperature curve of AS 1530.4
- Fire test method includes an option water spray test at the end to simulate practical fire extinguishing methods
- Purpose is to develop a circuit integrity classification for the wiring system, ie not just cable

The point above regarding the classification of the wiring system is important as this allows users and installers a simplified means to describe the rating of the wiring system required by a particular installation. The wiring system “WS” classification system of AS/NZS 3013 is described below. (eg WS52W being the most common for cables.)

First numeral indicates time for which cables or busways are able to maintain circuit integrity.

- 1 = 15 minutes
- 2 = 30 minutes
- 3 = 60 minutes
- 4 = 90 minutes
- 5 = 120 minutes (2 hours commonly requested)

Second numeral represents degree of mechanical impact and cutting force that wiring system element can withstand without failure

- 1 = Light (2.5 Joule Impact & 0.3 kN Cutting)
- 2 = Moderate (15 Joule Impact & 1.0 kN Cutting) (2 is common for cables)
- 3 = Heavy (50 Joule Impact & 5.0 kN Cutting)
- 4 = Very Heavy (500 Joule Impact & 5.0 kN Cutting)
- 5 = Extremely Heavy (5000 Joule Impact & 5.0 kN Cutting)

Supplementary letter “W” represents additional water spray test.
The picture below shows the furnace (fire chamber) after completion of the two hour fire test, where the chamber roof is removed, complete with cable tray and cable in readiness for the water spray test. Circuit integrity of the test component is monitored through the fire test by means of a multiphase or single phase supply applied to each conductor of the cable under test connected to a 60 W lamp. In addition in line fuses are used to detect conductor to conductor contact, with additional indicating lamps connected across each fuse as a visible sign of the fuse opening.

A pass is achieved if the lamp/s remain alight and no fuse fails, for the duration of the fire test, usually 120 minutes for most fire rated cable used in Australia.

The photo at right shows the same fire chamber roof during application of the water spray test, which is performed as prescribed in the standard for a period of 180 s. The standard prescribes such elements as elapsed time after fire test to start water spray test, environment where the water spray test is to be performed, water flow rate, etc. Throughout the water spray test the circuit integrity of the cable system is monitored is monitored in the same way as for the fire test.
The next two photos show a typical test configuration for cable and cable tray prior to fire testing and then post fire testing. Note the bends in the cable, which is similar to the requirements of the IEC 60331 and the BS 6387, where two 90 degree bends must be placed in the cable at the cable manufacturers minimum bend radius.

The principle behind the development of fire test method described in AS/NZS 3013, and the manner in which the cable sample is setup, is to ensure that the test method as much as is possible closely matches the method in which a cable system is likely to be installed in practice.

In addition, as eluded to at the start of this section on AS/NZS 3013, the fire test is performed according to a controlled time/temperature curve which is also used by the building industry for the testing of building materials, ie walls, floors, roofs, columns, beams, door assemblies, ducts, critical services, etc. The time/temperature curve is detailed in AS/NZS 1530.4, see graph below, and therefore there is a direct link between the building standards as defined by the ABCB (Australian Building Code Board) National Construction Code (NCC) and AS/NZS 3013, where AS/NZS 3013 is referenced with the NCC.
Some key points to note about the time/temperature curve defined in AS/NZS 1530.4.

- The curve itself was based on the characteristics of a cellulose fire, cellulose being a material common to building products, e.g., wood.
- Although AS/NZS 3013 caters for testing of wiring system components up to two hours, the curve itself extends to six hours. However, only cable with copper conductors will pass the two-hour test since the melting point of copper is just above the two-hour test temperature (melting point of copper = 1085 °C).
- The temperature attained after two hours is over 1000 °C, which exceeds the test temperature of all of the IEC and BS standards.

The second part of the AS/NZS 3013 WS rating system rating is the mechanical rating. The test method adopted for checking the mechanical integrity of a cable involves an impact and a cutting test.

The impact test involves dropping a defined mass a prescribed distance onto a cable sample using a defined shaped impact head. See image of test setup at right.

The drop height and weight to be dropped is selected in accordance with the mechanical category level (1 – 5), the test piece must be conditioned at its rated operating temperature e.g., 110 °C, and within 60 seconds the sample is subjected to three such impacts, within a 300 second time period. Circuit integrity monitoring is similar to that used for the fire test, except that it is reconfigured to use an ELV voltage of between 18 volts and 30 volts for safety reasons.

A pass is achieved if the cable continues to carry the test current, and conductor has NOT made contact with another conductor, a screen, an armour or other earthed metal layer, or the impact test load assembly.

The cutting test involves applying a constant force to a defined shaped steel wedge onto a cable sample using a compression testing machine capable of measuring the load force. See image below. The force to be applied is selected according to the mechanical category level (1-5) and again the test piece is conditioned according to its rated operating temperature. The cutting test is performed at four locations with the test piece rotated 90 degrees about its axis after testing at each location.
The contact monitoring system is depicted in the above sketch and consists of a voltage source providing a supply of nominal 9 volts dc and an indicating device such as a lamp or audible buzzer. A pass is achieved if the sample of cable has survived the level of cutting force, ie the wedge has not made contact with the conductor as indicated by the contact monitoring system.

AS/NZS 3013 was first published in 1990, the current version being 2005. The most notable development in the latest version being the change to allow testing of individual components to be combined to construct a wiring system.

A good example of this was the change in the standard that sees the cable being tested on cable tray as opposed to being tested by itself where the cable was clipped to the underside of the furnace roof.

**Circuit Integrity – Supplementary Note**

It can be concluded from the above discussion, regarding test methods to establish the circuit integrity performance of cables, that the pass criteria is based only on continuity of the power supply voltage and current. This includes the testing of data cables as described in AS/NZS 1660.5.5 Section 5 and in IEC 30331 Part 23, where similar currents and voltages are applied through the test as for power cables.

This test method has gained acceptance in the industry for power cables that enables comparative results to be obtained, and this is where the major development in standards and test methods has occurred over the past few decades. However these established test methods may not be so relevant for determining the change in signal transfer quality in fire rated data and signal cables.

To fill this gap there is currently work being undertaken to establish a suitable procedure and test criteria for data, signal and including coaxial cables in the “EN” range of standards. For example under the umbrella of EN 50289, which documents the test methods for communications cable, sub part 4-16 (ie EN 50289-4-16) documents the criteria for determining the circuit integrity of control and communications cables when using the fire test methods of the relevant EN fire test standards, ie EN 50200 burner standard, and EN 50577 furnace standard.

Draft standard EN 50289-4-16 details pass criteria for different cable types (twisted pair and coaxial), and differing signal frequency ranges (<100kHz, 100 kHz – 100 MHz, and 100 MHz – 1000 MHz) where depending on the operating frequency limits for the cable, differing criteria is applied, ie continuity, capacitance attenuation, return loss, and near end cross-talk.
**CONSTRUCTION OF FIRE RATED CABLES**

In a discussion on the construction of fire rated cables there are two fundamental components of their construction.

i. That component that allows the cable to continue to function during a fire (circuit integrity). This is usually determined by the material that is wrapped around or encloses the conductor.

ii. That component that fulfils all the other features of a fire rated cable, ie flame propagation, low smoke and halogen free. This is determined by the materials used for the insulation and sheath of the cable.

It is fair to say that in over one hundred years of cable development, only three designs exist that cater for component (i).

**MIMS (Mineral Insulated Metal Sheathed) Cables**

These cables employ copper conductors enclosed in a Magnesium Oxide (mineral) insulation which is capable of surviving extreme temperatures well over 1000 °C. A copper sheath encloses the conductors and insulation, which may be further protected by an outer plastic sheath to improve corrosion performance of the copper sheath.

This design was invented in 1896 and is still in use today albeit with issues in handling, terminating and availability. The main advantages of the design were its inherent fire survival characteristics which were not realised until many decades after its invention. In addition the MIMS cable has good mechanical properties and has inherent electromagnetic noise reduction characteristics due to the copper sheath.

**Mica/Glass Tape**

The development of mica/glass taped conductors began around the same time as the development of standards for circuit integrity, which was in the early 1970s. Special fire resistant conductor barrier tapes containing mica and glass protect the conductor during fire, after all of the insulation and sheathing material have burnt away.

Mica is a naturally occurring mineral and has an extremely high melting point typically over 1000 °C.

Mica tapes used in the electrical cable industry usually comprise mica paper bonded to an electrical grade glass cloth backing tape. The number of tapes to be applied to a conductor will depend on the fire test standard that the cable is designed to meet. Mica tapered cables that pass the IEC 60331 standard may not pass the AS/NZS 3013 furnace test.
The main disadvantages to the use of Mica in cables are associated with OH&S issues as the mica can flake and crumble into very small fragments during cable stripping and the extra time involved in stripping the mica and cleaning the conductor.

Insulation and sheathing materials can be selected from a large range, provided they meet the requirements of being flame retardant, low smoke and halogen free. Common materials used in fire rated cables are XLPE or rubber (eg HFFR – Halogen Free Flame Retardant) for insulation and HFS (Halogen Free sheath) or again rubber based materials (eg HFFR).

Whichever materials are used it is important to ensure that they are aligned with the maximum operating temperature of the cable, ie the combination X-HF-110/HFS-110-TP insulation/sheath for a 110 °C rated cable. (It is also of interest to note that the temperature of the insulation and sheathing material does not relate to the circuit integrity performance of the cable.)

Ceramifiable® Materials

This is the newest development in cable material for fire safety, being those materials that “ceramify” or turn into a hard ceramic like material during a fire. They are a special proprietary compound developed by Olex and the CSIRO in 2004 which do not rely on a flame barrier tape to afford protection of the conductor during fire. The cable therefore comprises only two layers, the Ceramifying insulation and the sheath.

The special Ceramifying insulation complies with an AS/NZS 3808 material type such as R-E-110, HFI-90-TP, depending on the individual product type and would typically include a halogen free, flame retardant HFS-90-TP sheath.

Apart from the obvious advantages of simplicity of design (two layers), ease of stripping and the avoidance of the OH&S issues associated with the Mica tape design, a little known advantage of the Ceramifiable® design is the reduction in calorific content in the cable.

For example XLPE as used in Mica taped cables, has a low oxygen index and will readily combust in air if subject to fire. Therefore these designs require a good (high oxygen index) flame retardant sheath material to ensure they meet the required flame propagation tests. The insulation material of the Ceramifiable® design has a much higher oxygen index in comparison to XLPE and exhibits lower heat release levels during combustion. In other words the Ceramifiable® design has a lower propensity to keep a fire going. (In fact XLPE has equivalent energy content to that of petrol, for the same weight, whereas the Ceramifiable® has less than half.)

LINKING CABLE FIRE SAFETY STANDARDS AND THE BUILDING INDUSTRY

I had briefly mentioned the link between the time/temperature defined in AS/NZS 1530.4 and the building standards in the previous section on the AS/NZS 3013 furnace standard for circuit integrity. This will be expanded a little further in this final section of this article.
A review of the ABCB National Construction Code shows that all of the key elements of a fire rated cable are included. Flame propagation and smoke emission of building materials are detailed within the NCC which references AS/NZS 1530.3. This standard determines the “Spread-of-Flame Index” and “Smoke-Development Index” of building materials. However only the test for fire resistance of building materials as defined in AS/NZS 1530.4 is shared with the cable test standard AS/NZS 3013.

Building materials, such as walls, floors, roofs, columns, beams, door assemblies, ducts, critical services, etc, as required by the NCC must be tested to the requirements of AS/NZS 1530.4. Furthermore The NCC defines a similar fire resistance category system as AS/NZS 3013. The NCC defines an “FRL” of a material, where FRL stands for Fire Resistance Level in a format xx/yy/zz, where the letters represent the time in minutes to failure of the test, ie:-

- **xx** = Structural adequacy (eg as applied to load bearing elements, beams and columns
- **yy** = Integrity (eg maintains barrier to prevent flames or hot gases passing through)
- **zz** = Insulation (minimises temperature rise of the exposed face of building element)

Some typical examples of the FRL system as defined in the NCC, emergency lift shafts are required to have an FRL of 120/120/120 when tested in accordance with AS/NZS 1530.4. And main switchboards supplying emergency equipment are required to have an FRL of 120/120/120.

**SUMMARY**

The overall message intended by this article is that although the characteristics of fire and the way that materials behave during a fire are complex, much research and development has gone into preparing standards that enable scientific and repeatable test methods to be documented within these standards to allow cables to be tested to determine their performance during a fire. And many of these standards have been in use for many decades.

Secondly the development of fire rated cables has come a long way in the past few decades such that cable manufacturers are well placed today with the knowledge of materials and cable designs that ensure that these fire safety standards can be met. Nonetheless users and installation contractors must remain diligent in ensuring that the cable manufacturer has the necessary test reports to support any claims for the performance during fire of their fire rated cables and the standards that they meet.

(When conducting fire tests on fire rated cables it is not necessary to conduct the test on every cable size, nor for every order. In the case of AS/NZS 3013, the standard dictates the cable (conductor) size that is to be tested, which is deemed to qualify a range of sizes as detailed in the standard. In the case of other standards, such as the IEC, qualification guidelines are not included and the process of determining a qualification criteria is usually left to negotiation between the supplier and customer. Some fundamental principles are usually adopted, such that the cable size tested will qualify other cable sizes provided that they employ the same materials and are of essentially the same design, the only difference being the conductor size.)