Cable Facts;
What you need to know

Fire Proof Wiring Seminar
Fire Safe Wiring Systems

= LIFE Safe Wiring Systems!
Synopsis

Evolution of protocols for testing fire safety electrical cables has led to an important divergence between fire performances provided by electrical cables and fire performances expected and needed.

The understanding amongst most specifiers, sellers, installers and users of fire safety cables is that the products they buy and use will provide a level of fire performance in real emergency conditions commensurate with the performance implied by the testing procedure.

Unfortunately, unless exposed to exactly the same fire conditions as in testing this is unlikely to be the case.
Before 1970 there were no common standards for testing electrical circuits for fire survival. Since 1932’s Mineral Insulated (MICC cables) had been used for high temperature resistance and it was considered almost common sense that these cables were the best option available for fire performance.

In the 1970’s new polymeric cable insulations evolved and manufacturers found that with Silicone Rubber or Glass Mica Tape insulation they could make cables to pass some flame tests. In 1970 IEC 331 was born and formed the basis for BS6387:1983 this is still the basis for most flame circuit integrity testing of cables in Europe and Asia. In UK there has been over 12 iterations since this time and today integrity tests for fire resistant cables in UK have in fact ‘reduced’ both in temperature and in duration.

In America, Canada, Australia, New Zealand, Germany and Belgium simple flame tests on cables are no longer accepted and certification requires furnace testing of full ‘wiring systems’ to the “Standard Time Temperature” protocol ISO834-1, EN1363-1, AS1530 pt4, BS476 pts 20-23 & in USA ASTM E119-75.
It is not commonly understood that fire resistant cables, where tested to common British flame test standards, are not required to perform to the same time-temperature profiles as every other structure, system or component in a building.

Specifically, where fire resistant structures, systems, partitions, fire doors, fire penetrations fire barriers, floors, walls etc. are required to be fire rated by building regulations, they are all tested to the Standard Time Temperature protocol required by BS476 parts 20 to 23 (also known as ISO834-1, EN1363-1 or in America & Canada ASTM E119-75).

Contrastingly, Fire Resistant cable test standards BS 6387CWZ, BS8343-2, BSEN 50200, BS8491 require cables to be tested to standards which have lower final temperatures (than required by BS476 pts 20 to 23) and in ‘flame’ rather than ‘fire’ conditions.

Given Fire Resistant cables are likely to be exposed in the same fire and are needed to ensure that all Life Safety and Fire Fighting systems remain operational, this fact may be surprising.
Three technologies for fire resistant wiring systems:

**MICC - surface**
1) Magnesium Oxide insulation  
2) Copper jacket

**Polymerics - surface**
1) Glass Mica Tape  
2) XLPE or EPR or Polyolefin insulation  
3) HFFR or LSOH jacket

**Thermal protection - buried**
2” of concrete  
Boxing or Trenching  
Wrapping

**High Ash Residue (HAR)**
1) Ceramifiable or Silicone based  
2) HFFR jacket
Cables are installed by many different trades for many different applications, what is not often realized is that the many miles of cables and many tons of plastic polymers which make up the cable insulation and jacketing may represent one of the biggest fixed fire loads (fuel source) in a building.

Fire Safety for Wiring Systems has 2 parts:

**Fire Resistance (wiring system)**
- Electrical Circuit Integrity
  - Life Safety systems
  - Fire Fighting systems

**Fire Performance (materials)**
- Flame & Fire propagation
- Smoke
- Fire Load:
  - Heat of Combustion
  - Oxygen depletion
- Toxic emissions:
  - Halogens = HCl, HBr, HF
  - Non halogens = CO, HCN
- Flammable gas emissions:
  - Hydrocarbon gasses...
With huge changes in construction complexity, size, urban population density during the last 20-30 years, the gap between what fire performances may be needed vs. what is currently specified and installed is widening.

This presentation will cover:

- What other countries are doing today.
- Review some common test standards used for fire survival cables & their relationship to real fires.
- Clarify the often misunderstood tests results on Flame Propagation, Smoke, Halogen and Toxic by-products of combustion tests.
- Discuss the critical and often ignored issues of: Fuel Element, Heat of Combustion, Oxygen depletion.
- Contribute to a clear unbiased and factual understanding of fire safe cabling systems based on technology & materials, not on manufacturer.
PART 1 Fire Resistance

Wiring Systems
What is a fire?

We know a fire requires three fundamental elements:

- A fuel source
- Air (Oxygen)
- An ignition source

It should be remembered that anything will burn if you get it hot enough so Initial / ambient temperature is critical

In a building or installation we generally consider two types of fuel/fire loads:

- The fixed fire load
- The temporary fire load

The fixed fire load is the building itself and all component parts and systems needed to make it work: This includes installed cables, conduits ceilings, walls, floors, fittings. (Often polymeric cables can represent the biggest fixed fire load in many installations)

The temporary fire load is what people bring into the building: This includes furniture, computers, curtains etc. and for shops the merchandise, decorations
Notice copper conductors have not melted.
Fire Temp < 1,083 Deg C
Fire effects in above ground building environments

- Notice aluminum window frame started to melt.
  Fire Temp > 660 Deg C

- Brass decoration melted
  Fire Temp > 950 Deg C

- Glass deformed
  Fire Temp > 750 Deg C
Common international ‘flame’ tests

IEC 60331    750˚C     180 min
BS 6387 C,  950ºC   3 hrs
SS 299 pt 1  950 ºC  3 hrs C W Z

BS EN 60332-3 pt 21-25
BS 4066-3 EN 50266-3 AS/NZS 1660-5.1
Flame propagation - cables

BS EN 60334-2+A1 AS/NZS1660-5.2
IEC61034   BS 7622    EN 50268
Smoke Obscuration (3 Meter Cube Test)

BS EN 60332-1    BS4066-1 &
EN 50265-1    AS/NZS 1660-5.6
Flame retardance - wires

BS EN 50200 842˚C
8 hrs optional W & Z
BS 8434-2  930˚C
3 hrs C W Z

Small cables: up to 2.5mm2 conductors
BS EN 50200 842˚C
PH 15min to PH 120min with mechanical shock (optional water spray)
BS 8434-2  930˚C with mechanical shock for 60 min
and then with water spray to 120 minutes

Large cables: above 2.5mm2 conductors
BS 8491:2008  842˚C
30, 60 or 120 minutes with direct mechanical shock and water spray in final 5 min
Modern ‘furnace’ tests for cables

Australia & NZ Furnace test AS 1530pt 4
AS3013 WS 5x 1040°C 2 hrs

Germany Furnace test ISO 834-1
DIN 4102 1000°C 90 min

USA & Canada Furnace test ASTM E119-75
UL 2196 wall set up 1,020 °C 2 hrs
Flame tests or Furnace test?

Flame tests BS 8434 & BS 8491

Small cables ≤ 2.5mm²  930°C to 120 min

Large cables >2.5mm²  842°C  120 min

Furnace tests ISO 843-1 & EN 1363-1

All cables and supports  1040°C  120 min

UL 2196  wall set up 1,020 ˚C  2 hrs

Small cables ≤ 2.5mm²  930°C to 120 min

Large cables >2.5mm²  842°C  120 min
Are all Fires the same?

Euro Tunnel Fire 1996
Are all Fires the same?

It has been well established that in enclosed tunnel environments fire temperatures can exhibit a very fast rise time and reach temperatures well above the parameters of the standard fire time temperature curve of: ISO 834-1 (BS 476 pts 20-23).

Based on full scale fire tests carried out in Tunnels utilizing road vehicles including passenger cars, buses, trucks with different loads and rail vehicles including Intercity and Metro/Underground carriages.
Test results are based on single coaches. The peak HRR (Heat Release Rate) is in the range of 13 to 43 MW.

“If a fire spread between train coaches - the total HRR would be much higher”.

<table>
<thead>
<tr>
<th>Type of vehicle, test series, test nr, u=longitudinal ventilation m/s</th>
<th>HRR (MW)</th>
<th>Peak gas temperature (°C)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rail</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Joined Railway car; two half cars, one of aluminium and one of steel, EUREKA 499, u=6.8/3.4 m/s, A=25–35 m²</td>
<td>43</td>
<td>980</td>
<td>Eureka report [3]</td>
</tr>
<tr>
<td>German Intercity-Express railway car (ICE), EUREKA 499, u=0.5 m/s</td>
<td>19</td>
<td>830</td>
<td>Eureka report [3]</td>
</tr>
<tr>
<td>German Intercity passenger railway car (IC), EUREKA 499, u=0.5 m/s</td>
<td>13</td>
<td>720</td>
<td>Eureka report [3]</td>
</tr>
<tr>
<td><strong>Metro</strong></td>
<td>35</td>
<td>1050</td>
<td>Eureka report [3]</td>
</tr>
<tr>
<td>German subway aluminium car, EUREKA 499, u=0.5 m/s</td>
<td>NA</td>
<td>680</td>
<td>Eureka report [3]</td>
</tr>
</tbody>
</table>

Table 4 Gas temperatures measured in large scale rail tunnel fire experiments.
In the tunnel, the maximum temperature measured near the tunnel ceiling was approximately 1100 °C both in test 2 and test 3. However, the maximum temperature was somewhat higher in test 3: approximately 1120 °C measured above the centre of the carriage, while the maximum temperature in test 2 was approximately 1080 °C, measured at the position +10m (10 m downstream the centre of the carriage).
**Other time-temperature curves:**

For environments like **tunnels** or in **underground public areas** where rapid heat rise to high temperatures can occur, other fire scenarios are often chosen like the European Hydrocarbon time-temp. curve or even the Netherlands RWS-curve.

In America and Canada the RWS curve is specified since 2008 for essential circuit wiring by **NFPA 502** (Limited access highways) tunnels, bridges, cuttings etc..
International cable Fire Resistance Tests

This curve is adopted by:
- **NFPA 502:2008 USA/Canada**
  - For limited access highways, road tunnels, bridges etc.

This curve is adopted by:
- **ASNZS 3013 Australia/NZ**
- **DIN 4102 Germany as UL 2196 in USA & Canada**
- **NFPA 502:2008 USA/Canada**
  - For limited access highways, road tunnels, bridges etc.
- **BS 8434-2 UK**
- **BS8491:2008 UK**
- **BSEN 50200 UK**
But today the risk is not only about single source fires

The potential for emergencies including terrorist attacks could include the smuggling of liquid fuels in soft drink containers. This spread across several carriages, trains, busses, cars or trucks - especially simultaneously at each end of a tunnel or at each exit of a large public underground shopping center could have far more extreme consequences.

Apart from fire the mechanical integrity of essential wiring systems needs to be robust.

Terrorist attacks have also included explosions. These events create extreme pressure waves which can turn objects, glass etc. into high velocity projectiles. Sometimes cables runs may also be exposed to explosive concrete spalling.


Attacks underground potentially imply more damage and death simply because of the higher pressure and blast injuries, with the contained nature of the location also making it more difficult to escape the scene of attack and to receive help.

Although hardened glass was used the tests show that not all the glass breaks up into small pieces. Some bigger pieces with a weight of up to 65 g were found stuck in the styrodur wall opposite the window.
Should essential circuit cables be installed in conduit?

In USA September 2012 UL® announced it would no longer classify Fire Resistant Cables to UL2196 because a number of (polymeric) cables showed persistent inconsistency in testing and re-testing:


Quote:
“A concern was brought to our attention related to the performance of these products in the presence of zinc. We validated this finding. As a result of this, we changed our Guide Information to indicate that all conduit and conduit fittings that come in contact with fire resistive cables should have an interior coating free of zinc”

The only cable technologies approved and listed by UL 2196 today for ‘Unrestricted Installation’ are: MICC and Metal Clad cables

I remind that Galvanised steel cable tray, cable ladder and conduit is a process involving the hot dipping of steel in a molten Zinc bath.
UL® Response sent to all manufacturers on June 12th 2012

UL has learned of a compatibility issue when Classified Fire-resistive Cables are used in Electrical Circuit Protective Systems where zinc is used as an interior coating in steel conduits, raceways and other system components. Specifically, at high temperatures a zinc coating may interact with copper conductors creating a brass alloy that melts at a lower temperature than copper conductors alone, thereby affecting the integrity of the electrical system. Consequently, the combination of certain Fire-resistant Cables as described in specific Electrical Circuit Protective Systems may not comply with UL 2196 in the presence of zinc. Therefore, UL is taking immediate action to revise all Electrical Circuit Protective System designs to indicate that system components that come into contact with the fire-resistant cable are to contain an interior coating free of zinc unless the designs have been so tested.
Polymeric Fire Resistant cables
Fire reaction of Polymeric fire Resistant cables with Glass Mica Tapes
Glass softens at 300°C. Becomes increasingly conductive >500°C. Melts at 650/700°C. Sintering of Mica starts at 850°C.
Fire reaction of Polymeric fire Resistant cables with Glass Mica Tapes

Effect of temperature on insulation Resistance for various materials

- Aluminium Oxide
- Mica
- Glass
- Minimum Acceptable
If glass and/or carbon penetrates between mica flakes in proximity to earth or another conductor = failure

Major contributors to failure: Voltage and Temperature
Alternatives to GMT cables use Silicone Rubber or Ceramifiable polymer insulations. (These are referred to as High Ash Residue or ‘HAR’ designs).

When subjected to fire the insulation polymer melts/burns away leaving an ash residue. As the polymer melts, the insulation resistance decreases but as it eventually burns off, the insulation resistance increases again. The ash formed at first is quite mechanically weak but will harden with time in the high heat (like firing pottery).

These cables can be most vulnerable to failure during the initial 5 to 15 minutes of fire exposure because reduced insulation resistance can lead to failure and any movement may cause the brittle ash to crumble.

**FIRE REACTION**

Movement due to heat deformation of cable supports can dislodge ash.

These cables are more sensitive to voltage failure in early stage when insulation resistance reduces as polymer burns away and ash structure is weak.

Due to the sensitivities of the design cables which may pass a furnace tests may not pass a flame test and vice-versa.
Another critical but overlooked issue is with polymeric fire resistant cables used in modern Building Management and Addressable Fire Detection, Fire Alarm, Annunciator systems.

These systems rely on the connecting cables to provide low frequency current to power the devices and transmit reliably an overlaid higher frequency digital component as each of the peripherals must have a unique address to identify themselves. The characteristic impedance of the cables is critical to ensure reliability of the data component, however during fire the degradation of the polymer significantly changes the geometry of the cables thus severely changing the characteristic impedance. Further, water spray from sprinklers or fire fighting efforts will have additional major impact on this critical characteristic.
What length of cable sample is tested in fire or flame?

- **AS3013**: ≈3.6 meters (in 3 lengths)
- **DIN 4102**: ≈7.5 meters (in 3 lengths)
- **UL 2196**: ≈3.0 meter lengths
- **BS 8491**: ≈ 500mm
- **BS 8434-2**: ≈ 500mm
- **BS EN 50200**: ≈ 500mm (new BS6387)

What length of cable is installed? Miles
Fire safe wiring systems

If a cable system failure is going to occur it will likely happen during the first 10 minutes. This is often right in the middle of the egress period. Consider how long it takes fire services to reach a fire event in a crowded metropolis.
Part 2 Fire performance

Cable materials
Flammability Tests (flame propagation)

So you think your polymeric flexible flame retardant cable won’t burn?

There are two ways a polymeric cable can burn:

- **External heat / fire**
- **Internal heat (overload / short circuit)**

Common tests to evaluate flame propagation on cables are:

<table>
<thead>
<tr>
<th>International Standards</th>
<th>United States Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60332-1 BS 4066-1</td>
<td>USA: UL1581, UL2556-pt 9.1, 9.3, 9.4 &amp; NFPA 262</td>
</tr>
<tr>
<td>IEC 60332-3 BS 4066-3 AS/NZS 1660-5.1</td>
<td>USA: UL1666, UL 1685, UL2556- pt 9.6 &amp; IEEE 383</td>
</tr>
</tbody>
</table>

**External heat/fire:** All these test are conducted on cables starting at ambient temperature but in practice they will be likely be at operating temperature 60, 70 or 90°C (if cables were tested preconditioned at operating temperature many would fail!)

**Internal heat:** There are “NO” flame propagation tests done or required by any Standard or AHJ for cables under short circuit or overload! (given that reports by Fire Authorities often cite cables as the source of many fires this oversight is concerning!)

**Note:** once the fire reaches flashover temperatures 300°C to 400°C – all polymeric cables burn
Today we understand that Holistic cable Fire Safety is NOT just about circuit integrity fire tests.

What actually kills people in fires?

- Smoke inhalation
- Oxygen depletion
- Temperature rise
The Low Smoke myth

Many polymeric cable manufacturers claim the polymers they use for insulation and jackets are low smoke. They often justify this by claiming compliance to tests like BS EN 61034.

These smoke obscuration tests are dependent on a specific sample weight of cable burned in a specific room / air volume.

These results are not predictive end use simulations.
(Smoke generation can be greater on high heating before flame and smoke volume is directly related to amount of material burnt)

Singapore MRT 2013 - Newton Underground Station. Cable overloaded and caught fire
The Low Smoke myth

So how can a BS-EN 61034 low smoke cable give off so much smoke?

PVC gives more smoke in flame but PE / XLPE gives more smoke on heating without flame.

Smoke emissions in US-NBS Smoke Chamber (BS6401 conditions)

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (mm)</th>
<th>Maximum Specific Optical Density (DM) Non Flaming</th>
<th>Flaming</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLASTICS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UPVC</td>
<td>3</td>
<td>400</td>
<td>580</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>3</td>
<td>590</td>
<td>83</td>
</tr>
<tr>
<td>FR Polyethylene</td>
<td>3</td>
<td>790</td>
<td>780</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>3</td>
<td>550</td>
<td>162</td>
</tr>
<tr>
<td>FR Polypropylene</td>
<td>3</td>
<td>820</td>
<td>600</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>3</td>
<td>476</td>
<td>960</td>
</tr>
<tr>
<td>PMMA</td>
<td>3</td>
<td>63</td>
<td>117</td>
</tr>
<tr>
<td>Plasticised PVC</td>
<td>0.75</td>
<td>430</td>
<td>650</td>
</tr>
</tbody>
</table>

The Halogen myth

Halogens are Bromine, Chlorine, Fluorine as well as Astatine and Iodine. The first three are commonly used in electric cable insulations as flame retardants.

Whilst highly toxic when combined with hydrogen as halides: HBr, HCl, HF these gasses are rather more immediately dangerous as irritants when the gasses condense with moisture in the eyes, throat and lungs. In such cases the acid effect is highly debilitating and can significantly hinder evacuation.

Toxic effects of Halogens can be also lethal but the time is dependent on concentration, absorption and physical size.

In the USA Halogen Free is an infrequent requirement:
It is often considered that a small fire with Halogens is better than a large fire without.
(Takes into account the non Halogen toxic gasses: CO, HCN etc.)
Toxicity LC 50 levels acc. NES 713
Lethal Concentration index for 50% occupants within 30 minutes

<table>
<thead>
<tr>
<th>Gas</th>
<th>LC 50 index in ppm</th>
<th>ppm</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>4,000</td>
<td>1,000,000</td>
<td>0.40%</td>
</tr>
<tr>
<td>HCN</td>
<td>150</td>
<td>1,000,000</td>
<td>0.02%</td>
</tr>
<tr>
<td>HBr</td>
<td>150</td>
<td>1,000,000</td>
<td>0.02%</td>
</tr>
<tr>
<td>HCl</td>
<td>500</td>
<td>1,000,000</td>
<td>0.05%</td>
</tr>
<tr>
<td>HF</td>
<td>100</td>
<td>1,000,000</td>
<td>0.01%</td>
</tr>
</tbody>
</table>

BS6425-1 calling for Halogen Acid Gas to be less than 5mg/g may not be very useful for determining human safety.

BS 6425-2 provides a more accurate method based on tests for pH with measurement requirements of between 5 and 7 and with conductivity <1.0 micro siemens per mm
Ratio of heat release to oxygen consumption is proportional.

### Heat release values

<table>
<thead>
<tr>
<th>Cable Material</th>
<th>Halogen</th>
<th>Flame Retardant</th>
<th>MJ/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIMS / MICC</td>
<td>Y</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>TEFLOM PTFE</td>
<td>H</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>HFFR cable materials</td>
<td>H</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>TEFZEL ETFE</td>
<td>H</td>
<td></td>
<td>13.8</td>
</tr>
<tr>
<td>SILICONE RUBBER SI</td>
<td>H</td>
<td></td>
<td>15.5</td>
</tr>
<tr>
<td>Polyvinyl chloride PVC</td>
<td>H</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Wood</td>
<td></td>
<td></td>
<td>18.5</td>
</tr>
<tr>
<td>NEOPRENE RUBBER PCP</td>
<td>H</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Coal</td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>EPR</td>
<td></td>
<td></td>
<td>28.5</td>
</tr>
<tr>
<td>CSP</td>
<td>H</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>NYLON 66</td>
<td></td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>POLYPROPYLENE PP</td>
<td></td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>PE and XLPE</td>
<td></td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Petrol</td>
<td></td>
<td></td>
<td>48</td>
</tr>
</tbody>
</table>
Mitigating the risk

So what if I choose to install my cables in Steel conduits?
(not Fire Resistant Cables because of the zinc effect)

This will certainly help localized flame spread because inside the conduit oxygen is limited; however this is not a solution. The smoke and many of the gasses from the decomposing polymeric insulations inside the conduits are highly flammable.

These gases will migrate along the conduits to junction boxes, switch panels, distribution boards, motor control centers, lamps, switches, fire alarm panels and the like.

On entering these, the gases can be ignited by any arcing such as the make/break of a circuit breaker, contactor, switch or relay. The gasses can ignite or even explode causing the fire to spread to another location.
Mitigating the risk

Smoke
Cables which emit NO smoke will provide significantly improved evacuation speed and save lives

Temperature rise and Oxygen depletion
Cables with NO calorific value which have a ZERO heat of combustion per Kg will eat NO oxygen and generate NO heat

Toxic and irritant gasses
Cables with NO organic content, NO calorific values and Halogen Free will generate NO toxic or irritant gasses at all including Carbon Monoxide

*statistically CO is responsible for >90% of toxicity deaths in fires*
What does all this mean?

Most cables made in UK and imported from reputable manufacturers comply with all cable construction standards and current test standards. Their performance to these tests is not disputed. What we must understand is fire performance is largely dictated by the materials used, not how well they are made.

Our built environments are getting bigger & more complex, we move to more underground, high rise and more complex environments, often evacuation times are longer and fire scenarios or the consequences of fire in these environments can be far more severe.

Are cable fire test standards as used today representative of likely fire scenarios? Do they provide a realistic simulation of expected fire performance?

Areas of Special Risk

In America today NFPA 502 requires much higher performances for essential wiring systems in road tunnels and for limited access highways. (tests to 1,350°C)

In the UK British Standard 8519:2010 now highlights underground environments as “areas of special risk” requiring higher levels of fire protection for wiring than current British Standards specify.
What does this mean?

Our understanding of real fire environments is improving and the performance given by different wiring system technologies is today better understood and with a more holistic perspective.

We can today relate this learning to what real fire performance the application and the public might need from a wiring system under accident or deliberate emergencies.
The economic factor:

Does it cost more to install MICC cables?

- MICC cables ‘installed cost’ is not more expensive:
  - No conduit required (no zinc),
  - Less fixings,
  - Life time / Total Cost of Ownership.
  - ESR (earth sheath return) system can be employed,
  - No health and safety issues as with Glass Mica cables
- Installation training in classroom & on site is provided.

Is it more difficult to install MICC cables?

20 years ago MICC cables were installed all the time and by many contractors without problems MICC cables are still installed frequently today.

- MICC are not more difficult to install, they simply have different techniques.
- MICC cables require less fixings and can easily be formed to follow specific profiles.
- MICC cables can be pulled in like plastic cables, bent by hand or with common pipe benders and jointed if necessary with fire resistant joints.
- Moisture ingress is not an issue with new improved water blocking insulations.

MICC cable is not difficult, its just different - video
Polymeric Fire resistant cables:

20 to 30 years ago we all used MICC cables but over the past years we have been told and even convinced that polymeric fire performance cables are equal.

- Polymeric cables do not & can not provide equal fire performance to MICC
- This does not mean polymeric fire safety cables should not be used, simply that they should be used where the performance they provide is aligned to the level of protection they provide.
Life Safety & Fire Fighting Circuits

RSET > 15 min use MICC cable

RSET = Required Safe Evacuation Time
Real fire circuit integrity performance by furnace testing
(Furnace testing 2 hours to 1,040°C + water spray)

Zero toxic emissions  (not: just low halogen & high CO)

Zero flame propagation  (not: limited flame propagation for external fire only)

Zero smoke  (not: just ‘claimed’ low smoke)

Zero heat of combustion  (not: high fuel element & high heat of combustion, & high oxygen consumption & high CO emissions)

Zero environmental impact in installation, service life & disposal  (100% recyclable)

Zero impact from rodents, termites and insects  (not just no damage under the outer steel armour)

High Short Circuit Ratings  (high safety - no self ignition)

High Overload resistance  (high safety - no self ignition)

Characteristic Impedance  (no significant change during fire or water-spray)
<table>
<thead>
<tr>
<th>Feature</th>
<th>MICC cable vs Polymeric FR cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical integrity across normal and abnormal operating temperature range</td>
<td>(Cable does not soften at operating or overload temperatures)</td>
</tr>
<tr>
<td>Non aging</td>
<td>(not reduction in elongation at break to 50% absolute in 2.3 years at rated temp.)</td>
</tr>
<tr>
<td>Small Size (diameter)</td>
<td>(less installation space needed)</td>
</tr>
<tr>
<td>Less fixings required</td>
<td>(longer fixing distances due to less sag)</td>
</tr>
<tr>
<td>Water proof</td>
<td>(LOSH materials are hydroscopic due to flame retardant fillers)</td>
</tr>
<tr>
<td>Radiation proof</td>
<td>(use permitted in reactor chamber of Nuclear Power Station)</td>
</tr>
<tr>
<td>Bio/Chemical Hazard safe</td>
<td>(fully sealed cable at each end and through full length)</td>
</tr>
<tr>
<td>Sharps &amp; Crush resistant</td>
<td>(not just unidirectional cut resistant)</td>
</tr>
<tr>
<td>No OHS issues</td>
<td>(Occupational Health &amp; Safety for installation and handling)</td>
</tr>
<tr>
<td>Proven fire protection performance</td>
<td>(in service over 80 years)</td>
</tr>
</tbody>
</table>
Thank you, Any questions?