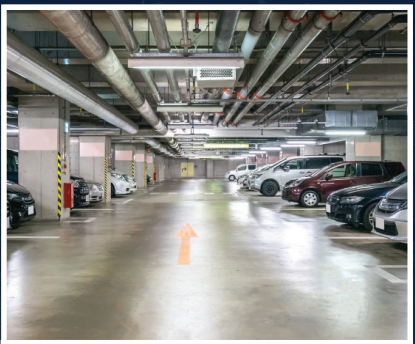
ISSUE 01 - 2023

WREXHAM MINERAL CABLES

Expecting the unexpected: specifying safety-critical circuit cables for fire survival

WHITE PAPER

Industries and Sectors

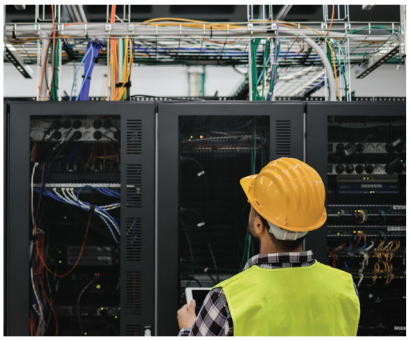


Multi-story car park

Travelators/ Escalators

Shopping Centre

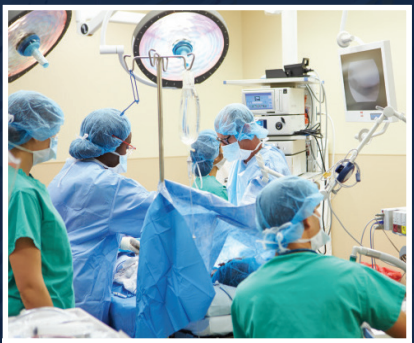
Rail networks/ Metrolinks



Data centres

Skyscraper tower blocks

Airports



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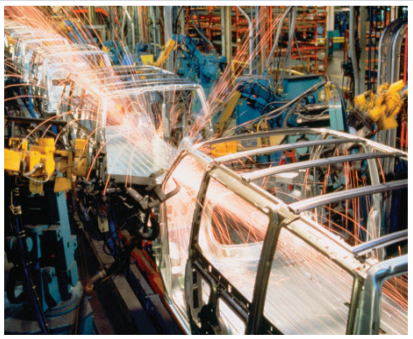
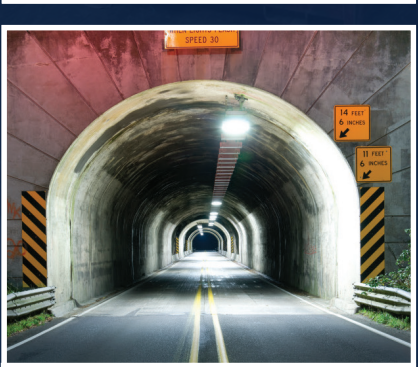


Industrial/Manufacturing



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Introduction

A post-Grenfell world: lessons are still not being learnt

"Despite ... the many lessons learned from the Grenfell Tower fire, in many cases we are sadly still not seeing a culture change with those responsible for fire safety in high rise buildings."

This was the message from London Fire Brigade [LFB] Deputy Commissioner Richard Mills in the wake of a fire at New Providence Wharf in London, in May 2021 .1

Upon investigating the cause of the fire, the LFB's initial findings showed that smoke detectors on the 8th floor communal corridor failed to operate both the automatic opening vent [AOV] and the cross-corridor fire doors.

This serious failure of a vital building safety system resulted in the building acting like a "broken chimney", leaving residents' only escape route smoke-logged.

An unclear picture when it comes to cables

Many building systems depend on the electricity supply being maintained in order to help keep occupants safe as they evacuate. As the New Providence Wharf fire showed, when critical systems fail it causes extra damage to property and puts more lives at risk. The cables that supply those systems are inherent to fire safety.

Specifiers and installers of cables to safety-critical systems are presented with a choice between polymeric cables and Mineral Insulated Copper Clad [MICC] cables. The current regime of testing means both cable types are classed as fire-resistant. It creates an impression that the two options are in some way equal.

With no requirement for better-performing MICC cables to be used in safety-critical applications, building safety continues to be put at risk.

"The New Providence Wharf fire needs to be an urgent wake-up call to all building owners and managers," continued Mr. Mills. "Look at the fire safety solutions inside your building and take action if they are not performing correctly. It is too late to wait for a fire to see if they work."

Any wake-up call is not just needed for those responsible for existing buildings. The design and specification of new buildings has to reflect change in our industry as well.

1 https://www.london-fire.gov.uk/news/2021-news/june/new-report-into-new-providence-wharf-fire-shows-serious-fire-safety-issues-in-building/

What you'll learn

For Wrexham Mineral Cables [WMC], doubt over the pace and extent of change, and the effectiveness of testing and certification, is nothing new. We have been making the case for better testing standards – especially for fire performance cables – for many years.

This technical paper looks at cable specification in the context of current attitudes towards building safety, and the shifting regulatory landscape. After reading it, you will have a better understanding of:

- How fire performance cables work and their role in the 'beating heart' of a building;
- Fire performance cable testing, and issues with that testing;
- Why cables classified as fire-resistant might not perform in 'true fire' scenarios; and
- Why MICC is the true 'fire survival' cable and can make a genuine difference to improving building safety – regardless of progress in the regulatory landscape.

The ‘beating heart’

Fire-resistant cables: essential to critical support systems and the consequences if they fail

Large and complex buildings, including high-rise residential buildings, undergo many risk assessments. These assessments have a two-fold aim: first, to reduce the probability of a fire occurring; and second, to ensure that, in the unlikely event of a fire occurring, the ‘beating heart’ of the building continues to function.

The ‘beating heart’ is a term used to describe the safety-critical electrical services that help to make evacuation of a building as safe as possible. The services comprising the ‘beating heart’ include:

Emergency Lighting and Signage

Communications

Smoke Extraction

Pressurisation Fans

Smoke Dampers and Shutters

Sprinkler Systems

Emergency Door Releases

Elevators

CCTV

Generators

Pump Circuits

Fire Alarms

Large and/or high-rise buildings are more likely to be densely populated, extending their evacuation time. The circuits of safety-critical services therefore need to function for extended periods, and fire plans are likely to be created on the basis of critical circuits continuing to perform.

However, many ‘true fire’ scenarios are not taken into consideration when these fire plans and evacuation procedures are drawn up. Examples of such scenarios are as follows:

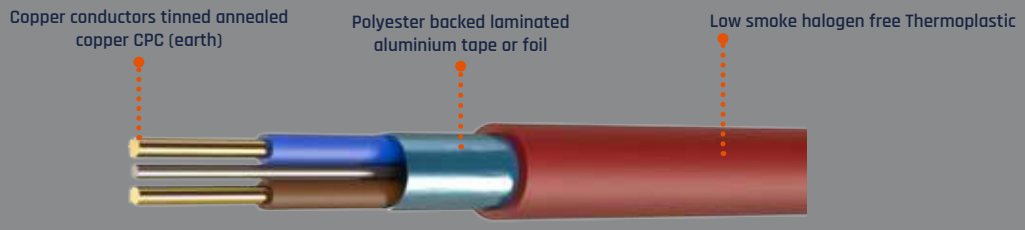
- A fire alarm cable stops working after several minutes. As a result, residents remain in the building believing it to be a false alarm after repeated false alarms the previous week.
- The sprinkler system does not activate, allowing fire to spread rapidly.
- High-powered extraction fans designed to remove smoke, fumes and dust from stairwells fail. Stairwells quickly fill with smoke, reducing visibility to zero and making it difficult to breathe.
- Emergency lighting and signage stops working, leaving means of escape dark and causing occupants to take wrong turns trying to find their way out.

How do fire-resistant cables work?

Fire-resistant cables should be able to provide extended periods of circuit integrity. The conductors that feed a circuit are protected with insulation that, in some cases, is rated to temperatures in excess of 1000˚C. Insulation types include magnesium oxide [MgO], MICA tapes and polymers. The insulation is then protected by an outer sheath.

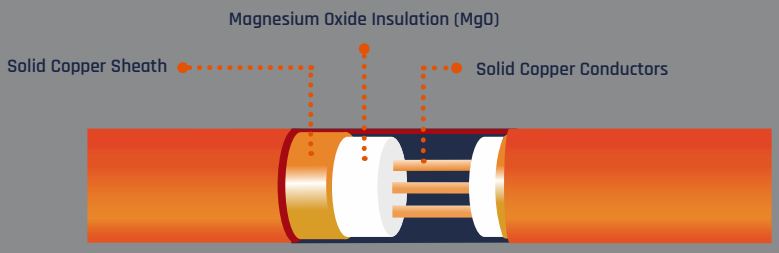
Polymeric fire-resistant cables use plastics, foils, tapes or steel wire to obtain fire-resistance approval. [Fig 1] They are unarmoured and, as a result, are referred to in the market as “soft skin” fire-resistant cables. Once the plastic burns away it’s up to the polymers, tapes and foils to maintain circuit integrity.

Fig 1 - Polymeric fire resistant cable



Mineral Insulated Copper Clad [MICC] cable consists of solid copper conductors [cores], highly-compressed powdered MgO insulation, and a solid [armoured] copper sheath [Fig 2]. This ensures melting points of 1083˚C and 2400˚C for the copper and insulation respectively. This type of cable provides fire survival, while continuing to safely carry a load in temperatures in excess of 1000˚C.

Fig 2 - MICC



Different sheath materials perform differently under fire conditions. Selecting appropriate cables for the right application is therefore critical, and British Standards are used to identify cables that are fit for purpose.

The role of fire-resistant cables

Fire-resistant cables support critical systems. Their specification and installation should provide the vital extra time needed for occupants to safely exit from a building, and allow for any shutdown procedures to take place.

However, cables can only help a fire plan to be successful if all possible hazards are identified.

Initiatives like the golden thread might make everybody in the supply chain more accountable, but if only 'identified defects' are used to inform building safety decisions, the built environment is likely to continue seeing lives endangered.

Unidentified issues, like the installation of inferior fire-resistant cables, therefore need to be put under the spotlight. This is particularly important for specifiers and designers, with whom the responsibility of product specification lies. If a fire-resistant cable fails to perform, the thread of accountability will be traced back to see how that cable came to be specified.

As a result, design professionals need to be confident that a cable:

- Is tested appropriately, using relevant tests;
- Performs in reality as it does in testing; and
- Will continue to perform in 'true fire' scenarios, even in the event of an unidentified issue occurring.

If a fire occurs and results in extensive property damage and/or loss of life, it is too late to blame testing irregularities, poorly communicated product information, and unforeseen circumstances as a way to avoid accountability.

To understand how we are already in a situation where inferior cables can be specified as fire-resistant cables, we will take a look at cable testing and relevant British Standards.

Testing and standards for fire-resistant cables

In order to be classed as a fire-resistant cable, a cable's construction must meet the British Standard appropriate to the cable type. Several fire performance standards are referred to on cables, including BS 50200, BS 8434, BS 8519 and BS 6387.

Each standard has a variant of time and temperature that cables are tested at under fire conditions. These can range from a 30-minutes rated cable tested at 830˚C [PH30 cable as per BS 50200] to a three-hours rated cable tested at 940˚C [BS 6387 category C].

BS 6387 C, W and Z tests

BS 6387:2013 Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions is typically viewed as the most comprehensive fire testing. The method is broken down into the following three separate tests, collectively referred to as C,W,Z.

Fire only. Conducted at the highest temperature, for the longest duration. Cables are mounted rigid in a test rig. No movement or exposure to any other element occurs. The cable is left for three hours at 950˚C.

Fire with water, simulating a sprinkler system. Carried out at a temperature significantly lower than test C and Z – 15 minutes fire and 15 minutes sprinkler, at 650˚C.

Fire test incorporating an indirect mechanical shock. Carried out for 15 minutes at 950˚C [the same temperature as test C]. A free-falling bar hits the test rig holding the cable every 30 seconds.

The 2013 revision of BS 6387 was intended to make the C, W and Z tests more stringent. The idea being that, in the event of a fire, the cables would be subjected to fire, water [sprinkler system or fire hose] and impact [falling debris]. Theoretically, an ideal test should the cable ever need to perform in a real fire scenario.

Issues with the CWZ tests

Successfully passing the C,W,Z tests outlined in BS 6387:2013 suggests to specifiers and contractors that a cable is capable of surviving all three scenarios of fire, water and shock.

However, a key detail often not communicated by cable manufacturers is that the three tests do not have to be carried out on the same cable sample. Different samples are used for each test, meaning no single piece of cable is ever subjected to all three scenarios. This can hardly be considered a 'true fire' scenario.

In addition, there are issues with aspects of some of the individual tests which cast doubt on whether they reflect situations that could actually occur in a fire.

During Test W, the volume of water does not replicate a fire hose, or even the pressure of a standard household sprinkler. The standard requires a minimum of 0.3 litres of water per minute during the test; this is the equivalent of directing a small watering can at the sample. A fire hose discharges at in excess of 500 litres per minute.

In a typical high-rise building fire, emergency services enter at ground level and apply a fire hose that could quickly take out all of the circuits on every storey of the building.

A point of concern with Test Z is there is no direct impact on the cable sample at any point during the test. The test involves a solid bar striking the metal frame to which the cable is attached. The cable does not move during the test, and so cannot be said to replicate falling debris.

The standard also describes rubber washers that must be used in the construction of the rig for Test Z. Based on in-house testing carried out by Wrexham Mineral Cables [WMC], these washers actually act to dampen the effect of the mechanical shock and the cable remains completely rigid during the test.

Further in-house testing, supported by test results published in 2018 by Dekra in the Netherlands, has shown that many 'fire-resistant' cables cannot even survive the basic Test C.

In April 2017, concerns were raised in Hong Kong about the integrity of fire-resistant cables. Polymeric fire-resistant cables dominate the Hong Kong market (accounting for more than 80 per cent of it). Twelve samples from five leading brands were independently tested to category C only, and only three met the requirement. Of the nine failures, one survived just 26 minutes, and all nine had failed by 63 minutes.

These cables were already installed in locations such as hospitals and schools, and connected to fire-service installations such as fire alarms, emergency lighting and ventilation systems.

Issues with other test standards

Other cable test methods are not without flaws either.

BS EN 50200:2015

BS EN 50200:2015; Method of test for resistance to fire of unprotected small cables for use in emergency circuits applies to cables with an overall diameter not exceeding 20mm.

Similar to BS 6387, it describes exposure to flame [at a temperature of 842˚C], shock and water spray. Also, like BS 6387, it does not require a direct mechanical impact while also subjecting the sample to fire and water. Successfully passing this test may, therefore, also create a misleading impression of all-round cable performance.

BS 8491:2008

BS 8491:2008 has the full title; Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems. It applies to cables of rated voltage not exceeding 600/1000V.

While this test method does require a direct mechanical impact to the cable sample while also being subjected to fire and water, it only applies to cables with an overall diameter greater than 20mm. However, diameter has no relevance to the fire performance or current-carrying capacity of a cable. The test arguably favours the use of polymeric cables by encouraging the loading of unnecessary polymers into the cable design to increase the diameter beyond the 20mm threshold.

A response to Grenfell Tower – BS 8629:2019

BS 8629:2019 Code of practice for the design, installation, commissioning and maintenance of evacuation alert systems for use by fire and rescue services in buildings containing flats was introduced to provide alert systems separate from fire detection and fire alarm systems.

It describes the use of 'enhanced' fire-resistant cables that must be placed in 'protective' conduits, unless the cable is armoured or of MICC cable construction. The need to house polymeric fire-resistant cables in a conduit adds cost and lengthens the installation process.

Over and above those issues, however, it begs the question as to what issues the authors of BS 8629 recognised in polymeric cables that is not addressed in other standards, but which led them to stipulate the use of conduits to improve cable performance.

Dangers of smoke

A further issue with polymeric fire-resistant cables is the potential for the polymers to contribute to a fire and, in particular, the production of smoke. They create a dense smoke that falls to the ground, and over 63% of which comprises of explosive molecules.

BS EN 61034-2:2005 + A2:2020 Measurement of smoke density of cables burning under defined conditions. Test procedures and requirements sets out a method called the 3m cube test. Samples of cable one metre in length are burned, and the percentage of light transmitted and received through the resulting smoke is measured.

However, the burner itself only has a length of 240mm, so the test does not even seek to assess the entire length of the sample.

A minimum transmittance of 60% has to be achieved to pass the test. This is an extremely low threshold, and could result in very high volumes of smoke – especially where several cables running in parallel start to burn together.

Is testing giving the true picture?

Standards for testing the performance of fire-resistant cables should help to reassure specifiers and contractors that a product is suitable for the building in which it is being installed. More importantly, they should give confidence that the cable will continue to work in the event of a fire.

As we have seen, though, it is all too easy for manufacturers to claim that products meet a required standard, even though the test methods themselves are not representative of 'true fire' scenarios.

Professionals in the built environment, seeking to choose products that will contribute to a better standard of fire safety, are not being given the true picture when it comes to considering all possible fire-related scenarios.

Testing needs to change, or a product that offers genuine 'fire survival' performance needs to be specified instead.

MICC cable: a fire-resistant and fire survival cable

Better testing of fire-resistant cables

Fire is a dynamic force. It moves and expands. It changes the shape, size and properties of everything it comes into contact with – and sometimes in ways that can't be predicted. Because of this dynamism, more stringent testing requirements are required for safety-critical cables.

Despite their ability to pass existing British Standard tests, many polymeric cables will not withstand exposure to true fire scenarios. The existing test methods **do not** sufficiently replicate real conditions, so specifiers and contractors are effectively being misled about product performance, at a time when they are being asked to assume greater accountability for their decisions.

There should be a single test for enhanced fire-resistant cables, and it should be applied regardless of cable size or construction. If a cable is required to function in the event of a fire, it should be tested in a 'true fire' scenario, and all relevant testing should be carried out on the same cable sample.

Higher classification of cables

Alongside an improvement in testing, a higher classification of cable should be introduced. Fire survival cables would be a new category of cable, classified above fire-resistant cables.

Such a label would help architects, construction contractors and the emergency services to better understand the marked differences in fire-resistant properties between cable types. As an industry, we can no longer aim for minimum compliance to get the job done.

Where safety-critical systems are to be relied upon for extended periods of time, giving people in large and high-rise buildings the time to escape, cables need to be capable of surviving the conditions, not just resisting fire.

Currently, no fire-resistant cable under 20mm undergoes any type of direct impact testing. There is a test for fire with water, but the actual pressure in this test is over SIXTY times less pressure than you would expect from a standard household sprinkler, let alone a commercial application or even a fire hose.

BS 8629's requirement to house non-armoured cables in a conduit demonstrates that there is awareness of issues with fire-resistant cables, but those issues aren't being communicated to the people who need to understand them. Fire survival cables would be a vital component of building safety, and yet the failure of safety-critical cables is currently an unidentified hazard.

What can be done while testing remains unchanged?

Although the Independent Review of the Construction Product Testing Regime (published in April 2023 2) may result in long-term industry change, specifiers and installers cannot wait to be told that inferior cables are unsafe. And in fact, they don't need to wait.

The marketplace already has a cable material that is tested beyond existing standards, and which is capable of acting as a genuine fire survival cable. That material is Mineral Insulated Copper Clad Cable (MICC).

The London Underground classed **MICC** as **fire survival** cable following extensive true fire scenario testing. Their testing included cables being placed under fire conditions in excess of 1000˚C, before being placed around a mandrel and formed to its minimum bend radius. The same sample was then repeatedly hit with direct hammer blows, and finally immersed in water. The sample would only pass the test if the cable could be reenergised and continue circuit integrity – MICC was the **only** cable type able to achieve that result.

[Cu, MgO] +  =

NO SMOKE
NO TOXINS
NO BURNING
ZERO FLAME SPREAD

MICC cable has already proved itself capable of passing the CWZ tests of BS 6387 with a single sample. And because MICC cable doesn't require polymer to aid fire protection, almost 90% of MICC cables are less than 20mm in diameter, meaning they don't get tested under BS 8491:2008, which is more reflective of true fire scenarios.

Despite this, where extended exit times are required and where fire suppression systems are in place, MICC are the only viable option for ensuring safety-critical systems continue to function. Samples as small as 5.7mm in diameter have maintained circuit integrity for over 3 hours.

The copper sheath of **MICC** cable acts as its own **built-in conduit**, so no extra mechanical protection is required. MICC cables can be surface mounted, which has added benefits in terms of reducing inspection times and costs.

The construction of MICC cable does not aid flame spread, and releases zero acidic or toxic smoke or gases. Tested to BS EN 61034-2, four samples of MICC cable with a diameter of 9.1mm achieved 98.6% light received.

2 https://www.gov.uk/government/publications/independent-review-of-the-construction-product-testing-regime

Ensure specifications are installed as intended

A key aspect of the 'golden thread' concept is that it should ensure design decisions are followed through to construction and installation. For specifiers looking to select a cable capable of surviving fire, water, and direct impact, MICC cable is the choice.

When MICC cable is specified, it cannot be swapped out for something cheaper or 'similar approved' – because such an alternative simply doesn't exist. MICC cable lasts up to four times longer than polymeric cable and delivers significant long-term savings in terms of labour and building maintenance costs

Polymeric mineral cable durability comparison:

	Polymeric Cable	MICC Cable
Replacement Cycle	Climate depending 3-6 years	30 Years
Warranty	<3 years	30 Years
UV Resistance	Poor	Excellent
Resistance to corrosion / Rodents	Poor	Excellent

Polymeric mineral cable safety comparison:

	Polymeric Cable	MICC Cable
Duration under true fire conditions	<60 mins	180 mins
Adds to fire load?	Yes	No
Produces toxic smoke when burning?	Yes	No
Resistance to impact	Poor	Excellent
Water resistance	Poor	Excellent
Resistance to ionising radiation	Poor	Excellent

MICC cable from Wrexham Mineral Cables delivers true fire survival capability and superb return on investment

- Fire performance.
- Resistance to water and impact damage.
- Unbeatable smoke emission.
- Resistance to corrosion and UV damage.
- No need for secondary mechanical or fire protection.
- No need to rewire every 3 to 7 years.
- Reduced building maintenance costs.
- Reduced operational downtime.
- Minimum 30-years life expectancy from installation.

In conclusion

Scrutiny of the construction product testing regime is much needed. Manufacturers must be able to provide confidence that products installed, especially in tall buildings or anywhere that requires extended evacuation times, are safe and perform as marketed. As we have argued here, for specifiers looking to select a cable that is capable of surviving fire, water, and direct impact, MICC cable is the choice.

But until such a time as the system actually changes, the only way to prevent lives being put at greater risk is to focus now on understanding the pivotal role that fire performance cables play in building safety.

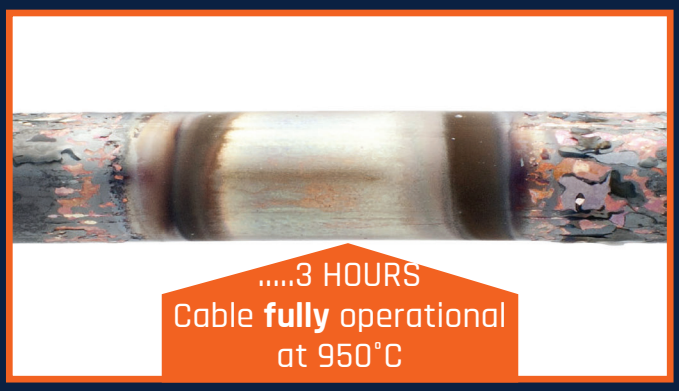
Wrexham Mineral Cables [WMC] welcomes conversations with building specifiers, consultants or anyone else concerned with the specification of fire performance cables. Our experts are happy to share even more detailed information than is possible to cover in this paper either via TEAMS or face-to-face at your facilities or our own.

We look forward to the opportunity for a discussion about your own projects / buildings or challenges.

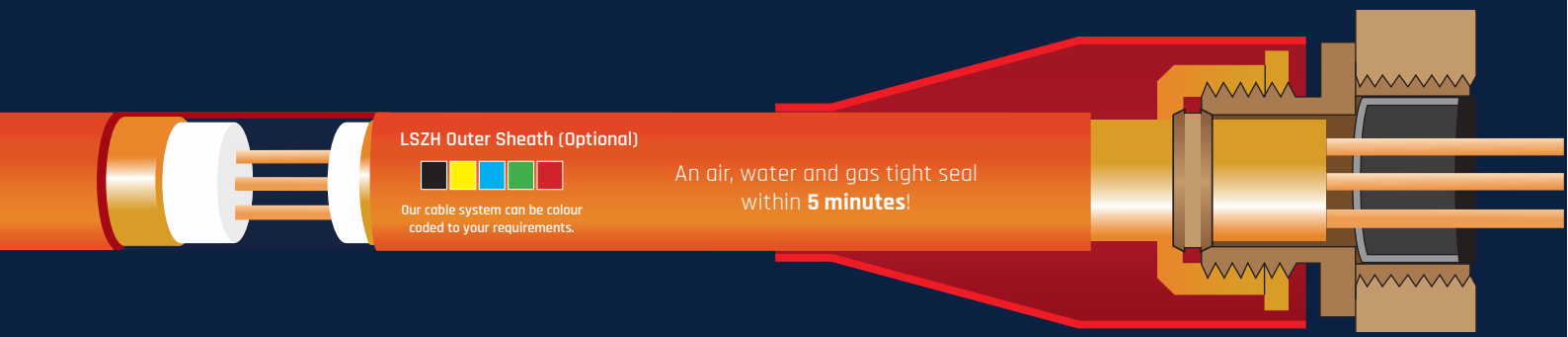
Fire performance cable like no other

SAFE EVACUATION TAKES...

Polymeric Enhanced 'Fire Resistant' Cables



Wrexham Mineral Insulated Copper Cables



TWO ELEMENTS. ZERO WASTE ZERO TOXINS

MICC cable is the **ONLY** fire performance cable that does not use **plastics** or **polymers** to aid **fire protection!**

SWA 4 Core 4mm sq

CONTAINS **270g** OF PLASTIC PER 1m LENGTH

= 54 PLASTIC BAGS*

WMC 4H4 Bare

CONTAINS **0g** OF PLASTIC PER 1m LENGTH

= 0 PLASTIC BAGS*

[Cu, MgO] + 🔥 =

NO SMOKE
NO TOXINS
NO BURNING
ZERO FLAME SPREAD

THE **ONLY** TRUE FIRE SURVIVAL CABLE

When "resistant" is not enough!
Specify Wrexham Mineral Cables (WMC)
SAVE LIVES AND THE PLANET.

About Wrexham Mineral Cables

Wrexham Mineral Cables [WMC] was founded in 1989 with a purpose to develop a totally new and unique process for the continuous manufacture of Mineral Insulated Copper Clad [MICC] Cables – the only true fire survival cable. Today, we remain the only UK manufacturer of MICC Cables.

Manufactured to BS EN 60702-1 the quality and reliability of WMC is recognised worldwide – supplying to over 30 countries - and throughout the electrical industry. Our MICC cables are manufactured to exceed the British and European standards, achieving endorsements and certifications from many regulatory bodies. This includes BS 6387 category C, W & Z which demands that cables perform safely for 3 hours at 930˚C. Our MICC Cable is the ONLY fire-resistant cable under 20mm to exceed BS 6387 C, W & Z test on ONE single cable sample. We are very proud that in over 30 years of manufacturing, WMC has had zero 'in field' failures.

Our LPCB product approval registration has been maintained for over 25 years, one of the longest in Europe for any fire performance cable manufacturer. Our quality system is also certified to ISO 9001 through LPCB.

We are committed to environmental and social sustainability and our manufacturing processes and methods reflect this. Not only are we working towards reductions in our carbon impacts, our products also contribute to the circular economy. For example, we have 'designed out' waste because there is no need for plastics or coverings and we can return materials into the cycle - including copper which is infinitely recyclable.

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