A TE Connectivity Rail white paper

A SINGLE CABLE IDENT:
That Delivers Low Fire Hazard Performance and Diesel Resistance

Why TE Connectivity created a cable ident product that meets the demands of two competing sets of standards

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AS A TECHNOLOGY LEADER, TE CONNECTIVITY DESIGNS AND MANUFACTURES THE ELECTRONIC CONNECTORS, COMPONENTS AND SYSTEMS INSIDE PRODUCTS THAT ARE CHANGING THE WORLD, MAKING THEM SMARTER, SAFER, GREENER AND BETTER CONNECTED. IN THE WORLD OF RAIL, TE CONNECTIVITY DELIVERS THE BROADEST PORTFOLIO AND SYSTEMS EXPERTISE REQUIRED TO CONNECT POWER AND DATA SAFELY AND RELIABLY, FROM THE HIGH-VOLTAGE SUPPLY AND ON THROUGHOUT THE ENTIRE TRAIN.

In this white paper, Martyn Priddle, Materials Engineering Manager, and Lee Smith, Materials Engineer, describe the characteristics of a product that truly delivers Low Fire Hazard (LFH) performance and identifies a shortfall in fire safety requirements covered by the current standards. It also introduces a new cable ident product that is the first of its kind, able to deliver diesel resistance and LFH performance.

Contents

- The importance of LFH idents
- Fire safety in rail
- The dangers of fire and smoke
- Polymer behaviour during fire
- Formation of toxic gases
- Current standards and legislation
- Products and performance
- True Low Fire Hazard product
- Idents for rail applications
- Competing standards
- LFH and diesel resistance in a single product
- About the authors
- History of TE Connectivity

THE IMPORTANCE OF LFH IDENTS

In the rail business, the act of placing markers onto cable reaps long-term value. It enables maintenance technicians to identify and resolve issues quickly and efficiently. This represents reduced outages, minimum delay and maximum availability of assets.

Any identification product has only a single purpose: to remain in place and be readable, even after exposure to its operating environment.

But in environments where there is greater potential for risk to the safety of people and property, design engineers must specify materials that give low risk of hazard in the event of fire.

This means that all materials used in such environments should meet performance standards so that there is a known:

- Impact by the environment
- Impact on the environment.

The first of these guarantees that a cable identification marker will remain in place and be readable, which is covered in TE Connectivity's companion white paper 'Making a lasting mark: cable identification products'.

But in environments where there is elevated potential for fire hazard, an understanding of impact on the environment becomes indispensable. Knowledge of a material's performance during a fire situation on board a train can mean the difference between life and death for passengers and train crew.

Many fire tests focus on the bulk performance of a material under fire conditions but cable identification markers are smaller than the product samples that typically undergo fire testing, meaning that the usual tests don't necessarily reflect performance in a real-life fire situation.

It is vital that the ident marker does not contribute to the potential for hazard in a fire.

FIRE SAFETY IN RAIL

When specifying and delivering product for any environment, the fire safety profile of that environment is the starting point. Built up from an understanding of the location, volume, ventilation, and mass and distribution of combustible material, rail engineers also consider whether a space is heavily populated and the potential for passengers and staff to make a quick escape in the event of a fire.

Fire safety standards reflect the demands of the location where materials and products are used. Passenger trains, sleeping cars and services that travel underground all demand higher fire safety requirements than open spaces with few personnel, such as signal boxes on an open section of track.

THE DANGERS OF FIRE AND SMOKE

Fires develop as a complex function of many factors, including the type, availability and properties of fuel, availability of oxygen and ventilation and the volume and shape of the compartment that contains the fire.

But it is smoke that is the most hazardous element of fire. Not only does it reduce visibility and lead to confusion and panic, but it also causes most deaths that result from fire in the form of toxic gas inhalation.

Without additional ventilation, a growing fire inside a compartment will consume most of the available oxygen, slowing the burning process but also leading to incomplete combustion and the formation of additional toxic fumes. Particulates from this process can be so small that they lodge in the lungs, causing respiratory damage. Some are actively toxic and others are irritants to the eyes and digestive system.

POLYMER BEHAVIOUR DURING FIRE

Any material in a compartment has the potential to be fuel during a fire, including cable idents and the polymeric cable insulation on which they are based.

As a fire starts, heat warms the compartment and the materials within become the fuel, including cable idents, which are polymers. Polymers do not act as fuel themselves but when their structure is heated, it breaks down into smaller molecules, forming a vapour. It is this vapour that acts as the fuel in the form of volatile gases.

A growing fire needs both oxygen and fuel, which will cause the temperature to build up, releasing more heat. Fire can grow either by the spread of flames or by the ignition of other fuel in the fire compartment.

The key to understanding whether ident markers will contribute to the burning process is in knowledge of the performance of the polymer and its additives in a fire situation.

FORMATION OF TOXIC GASES

Of the toxic gases that form during combustion, one of the most common is carbon monoxide (CO), which replaces oxygen in the bloodstream and starves the body of oxygen. It is deadly in small quantities.

Another notable gas in smoke is hydrogen cyanide (HCN), which is highly toxic and interferes with cellular respiration. It is a combustion product of melamine cyanurate, which is commonly used in out dated and low cost LFH insulation and cable identification products. This highlights the importance of specifying non-toxic LFH product, rather than a zero halogen derivative.

As previously stated, when oxygen levels are depleted, the potential for more toxic fumes increase and it has been estimated that many fire tests underestimate the yields of gas fumes by a factor of up to 100.

Current good practice in tunnel design is to increase the ventilation in a bid to clear the smoke away and give people clear and clean air with good visibility to help them escape. This may also act to ventilate the fire and decrease the possibility of toxic fume formation.

CURRENT STANDARDS AND LEGISLATION

Any single individual marker is insignificant in terms of its contribution to fire safety but an installation may extend to hundreds of terminations in close proximity and design engineers have the responsibility of not only ensuring that the installation meets safety standards, but a critical fire risk assessment has been made.

In Europe, EN45545-2:2013 is the standard for fire protection in rail vehicles and it sets out the minimum requirements for flammability of all materials and components used on board railcars.

As a small component, the criteria, following mass, area and grouping rules leads to a hazard classification which is defined by requirement set R24. At present, the only fire test required is the Oxygen Index (OI) hazard rating that products must achieve. The OI measures how much oxygen is needed to support combustion in a material, and is useful for monitoring the quality of a material, but TE Connectivity believes that this does not give a full picture of the potential hazards.

PRODUCTS AND PERFORMANCE

Only by understanding the balance between fire retardancy and generation of smoke can an engineer specify product that will not add to the hazard of fire. Over time, engineers have taken different approaches to minimising hazard and used in the wrong combination, these have potential to increase risk to personnel.

Some products are designed not to burn at all. This is achieved by dosing the polymer base with halogens, which are self-extinguishing. However, this comes at the cost of high toxicity as these products will release relatively large amounts of toxic fumes while resisting flame.

Most rail manufacturers and operators have moved away from halogenated flame retardant systems, now preferring ‘halogen-free’ or ‘zero halogen’ products. However care should be taken when specifying and purchasing these. While it’s true that they don’t contain halogens, they may have poor fire retardancy, leading to propagation of the fire by flaming droplets landing on other pieces of equipment, and some even contain melamine’s, which lead to the formation of highly toxic HCN gas.

TRUE LOW FIRE HAZARD PRODUCT

True LFH idents contain mineral fillers and inorganic compounds that hold water bound in their structures (bound water) such as magnesium hydroxide or aluminium tri hydrate. In a fire situation, they have three mechanisms to resist fire:

- Firstly, 60 percent of the product is inert to fire
- When heated, the bound water is released and will smother flames
- The steam released will absorb the energy from the fire, lowering the temperature and therefore reducing flammability

Adding mineral fillers will resist flaming and reduce toxicity in the event of fire but can also impact on the idents’ mechanical performance, which is why TE Connectivity used its materials and compounding knowledge and experience to develop a product which delivers a product that is a true LFH material with the added benefits of diesel resistance and improved mechanical properties.

IDENTS FOR RAIL APPLICATIONS

Broadly speaking, TE Connectivity produces five categories of cable identification products: Low Fire Hazard (LFH), diesel resistance, high temperature resistance, UV resistance and military grade.

Of these, two categories are commonly specified in the rail industry.

Diesel resistant products perform after prolonged exposure to diesel or other fluids such as transformer oil, whereas Low Fire Hazard (LFH) products are typically specified for applications where passengers and rail operating staff would need to be protected from the dangers of fire, should it break out.

Each type of product has been developed and proven by rigorous testing so that TE's customers can use them with confidence.

COMPETING STANDARDS

In the real world of rail procurement, operators and trainset builders work to their own preferred sets of standards, in addition to any national or European standard. As manufacturers become more global, the incumbent national standards can sometimes conflict.

By adopting conventions, many operators across Europe have developed a preference for cable and identification products that are specified to meet the standards of diesel resistance. This dates from the heyday of diesel locomotives when ident products had to demonstrate that they should keep their mark after prolonged exposure to diesel at high temperature.

In the modern era, electrified rail travel means that diesel and other fluids are less common in the rail environment, and rail builders and leasing companies are often keen to use LFH product universally to protect passengers.

Awareness and use of substances and materials has pressed UNIFE, the association of the European rail industry, to provide a comprehensive Railway Industry Substance List. This defines and categorises substances that are used in the industry and the locations where restrictions must be considered. The result is that rail operators in the European Union are now moving towards Low Fire Hazard.

LFH AND DIESEL RESISTANCE IN A SINGLE PRODUCT

This dilemma inspired TE to develop a single product that meets the standards of both. Using its unique knowledge of materials science and manufacture, TE has created a product that meets the minimum standards of two categories of rail product using of its two existing products as the basis of the new product.

HX is the ultimate in low fire hazard, whereas D-SCE gives the highest possible diesel resistance. Combining the qualities of the two, ZHD-SCE is a cable identification product that performs well in diesel and meets LFH standards.

TE Connectivity has already received significant interest from a major trainset manufacturer for one of Europe's best-known national operators.

ABOUT THE AUTHORS

Materials Engineering Manager Martyn Priddle is a leading polymer expert for TE Connectivity and has been instrumental in developing a number of breakthrough products over his career. His career started in 1979 when he joined Raychem as a graduate and since then he has been central to polymer science and technology at Raychem and subsequently TE Connectivity.

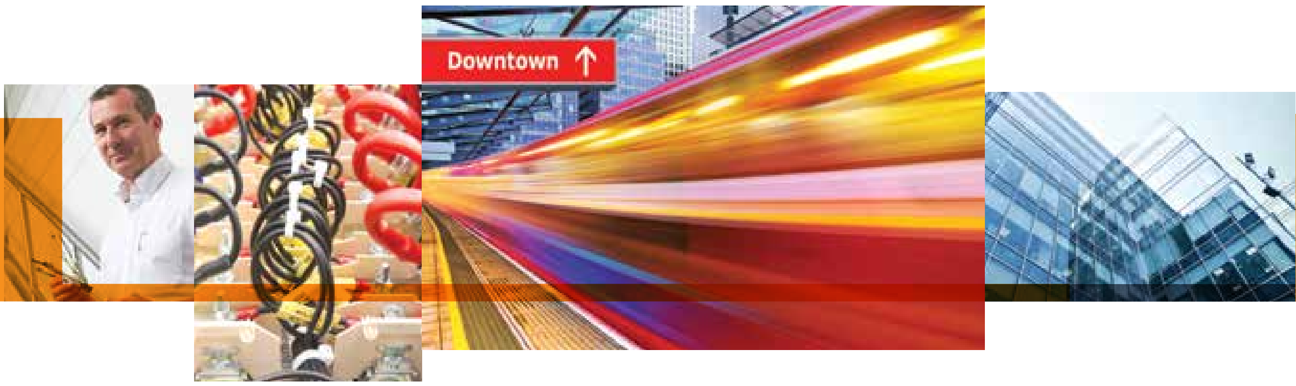
Lee Smith, Materials Engineer, started his career in the development group at Critchley Ltd, and now with TE Connectivity and has worked with heat shrink systems for over 27 years.

HISTORY OF TE CONNECTIVITY

TE Connectivity is a technology leader that designs and manufactures the electronic connectors, components and systems inside the products that are changing the world – making them smarter, safer, greener and more connected.

It is a leading supplier of high-voltage components to the rail industry that deliver proven longevity and performance in diverse and harsh environments. TE Connectivity's unique knowledge of materials science positions it at the forefront in developing the insulation materials that perform the essential task of insulating line power from the train structure.

Its legacy dates back to the 1950s when Raychem, which has since joined the TE Connectivity group, first used the technique of radiation chemistry to develop products. Since then, the firm has undergone a number of changes of name and structure. These include the name of Tyco Electronics, which the firm bore until March 2011 when it took the name TE Connectivity to reflect its role as a component and communications manufacturer.



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