**Focus**

King’s Cross tube station is the largest and busiest interchange on the London Underground network. Every year, more than 47 million people use the station, which links to King’s Cross and St Pancras mainline stations, and a massive £800m redevelopment to transform King’s Cross into a world-class transport hub to meet anticipated growth in future demand has recently been completed.

With memories of the catastrophic fire at King’s Cross tube station in 1987, which started underneath an escalator and led to the deaths of 31 people, an essential requirement for Transport for London, the body responsible for the Underground system, has been the constant monitoring of escalators by protection systems capable of giving accurate measurement of temperature and early warning of fire.

**Tube disaster**

The ferocity of the 1987 fire, which rapidly spread to flashover and filled the ticket hall with flames and smoke, was reported to be similar to a blowtorch. Temperatures reached 600°C, with the underground system acting as ‘an efficient furnace’ due to a combination of combustion phenomena. The fire was initially fuelled by a build-up of grease and fibrous detritus, fanned by a 12mph wind caused by arriving and departing trains. This ‘piston effect’ was aided by heat-driven convection once the fire took hold on the wooden escalator.

The findings of the Fennell Enquiry into the fire prompted the introduction of the Fire Precautions (Sub-surface Railway Stations) Regulations 1989 in the UK (more familiarly known as Section 12 Regulations of the Fire Precautions Act 1971). The result was the replacement of all wooden escalators in sub-surface underground stations with metal ones, and the mandatory installation of automatic fire sprinklers and heat detectors within the escalator frame and enclosure.

**Control system**

Central to the King’s Cross redevelopment project is the installation of a fully developed Escalator Water Suppression System. Integrated to this is a bespoke control system that has been developed specifically for this application and incorporates the latest developments in linear detection cable.

The control system, from Kentec Electronics, is designed to give a greater degree of control over the escalator sprinkler system as it allows sprinkler activation to be more localised, while providing a fire-safe environment and minimising service disruption from false alarms.

The linear heat detection system features a sensor cable with special integrated temperature sensors, enabling sensitive and reliable monitoring under harsh environmental conditions. The linear heat detection interface is linked to an addressable control system for ease of configurability. This connectivity is delivered through the serial communication port of a single/two-loop analogue addressable fire control panel, so that the individual elements of the linear heat detection cable can be represented as addressable points.

Airborne tunnel dust is just one of the variables that must be evaluated in fire detection if unwanted alarms are to be minimised, and is why linear fire detection systems are best suited for the early recognition of fires in harsh, inhospitable surroundings, where dust, dirt, fumes, humidity, fog, freezing and vibration have to be taken into account.

The temperature sensor cable system has been used extensively to detect hazards associated with track signalling and rail fire detection in train depots, such as fire detection in tunnels and stations, and temperature monitoring in inaccessible areas underground. The cable is particularly applicable in sites where access after installation is not possible and there is a need for the sensor to be maintenance-free.

Inputs from all points on the linear heat detection cable can be configured to have an event type, address, zone, 40 character
location text message, and can participate in cause and effects with all other elements of the fire detection system.

**Overcoming hazards**

Some special problems needed to be overcome in this application, beyond producing a reliable and robust control system suitable for this harsh underground environment. These included more stringent railway specifications, electromagnetic compatibility immunity requirements, and smoothly integrating the cable’s central sensor control unit with the fire panel firmware and configuration software.

A temperature measuring and fire detection system operating under such harsh conditions, which has to function dependably without high costs for years to come, calls for an adaptable sensing solution. The linear heat detection cable, integrated to the addressable control system, answers this need with the advantage of accurate temperature acquisition over long distances or in confined areas, and in challenging environments that prohibit the use of other forms of detection. The linear sensor cable system also yields substantial installation cost savings over traditional hard-wired fire detection systems.

**Addressibility and alarm criteria**

The cable consists of a 4-core flat cable with hybrid printed circuit boards mounted at predetermined intervals. The hybrids contain an application-specific integrated circuit. There are two different user-specific integrated circuits and a semiconductor temperature sensor. The application determines the distance between sensors (measuring points). The cable can also be branched according to the application.

Measuring points have fixed addresses, enabling their physical location to be addressed. An aluminium shield screens the cable from electromagnetic interference. The functioning of this maintenance-free cable is not impaired at temperatures of up to 120°C. The central sensor control unit directs electric power to the sensor cable, performs the cyclic addressing of the connected sensors, reads the measured temperature values, and evaluates the data with reference to different alarm criteria.

Two alarm criteria are recognised by the cable system: the exceeding of a maximum temperature, or the exceeding of a differential alarm threshold (that is, a sudden change in temperature referred to a reference profile; the reference profile accommodates natural temperature variations). Thus, both fixed temperature and rate of rise detection are monitored at the same time.

Currently, ten of these systems are installed at King’s Cross, with the control system used extensively in other Transport for London underground stations, including Moorgate, Bank, Embankment, Holborn, Bond Street, St Pauls, Leicester Square, Colliers Wood, South Wimbledon and Shepherd’s Bush.

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