Passive Fire Protection in tunnels – the costs of history repeating itself

Wilf Butcher, CEO of the Association for Specialist Fire Protection, wonders why the Eurotunnel Group is not tapping into existing fire protection expertise.

Wilf Butcher, Chief Executive Officer of the Association for Specialist Fire Protection and Strategy Council Member of the Passive Fire Protection Federation (PFPF).

It is not unreasonable to assume that fires in tunnels are a relatively rare event. In fact in the last 30 years there have been over 20 major tunnel fires around the world, accounting for some 2,000 lives. Many smaller tunnel fires have gone unnoticed.

Fortunately not all such fires result in death or injury, but the cost of reinstatement and the cost to commerce while tunnels are out of commission are incalculable.

Built-in, or passive fire protection measures are used in most modern construction, determined by an assessment of the risk to those working, living or travelling within the environment or the potential value placed on the goods carried and the value of the overall asset. The main principle of passive protection is compartmentation – built-in measures to prevent fire spread, maintain fire separation and avoid catastrophic collapse. It's the backbone of any protection strategy, maintaining the stability of a structure, allowing people time to escape and firefighters to get in.

In the case of tunnel protection no less than Seven EU funded research projects have been instigated in recent years - (FIT, DARTS, UPTUN, SAFE'T', SAFE TUNNEL, SIRTAKI and VIRTUAL FIRES) leading the EU in 2006 to address the issue of fire safety in tunnels by the introduction of EU Directive 2004/54/EC – Minimum Safety Requirements for Tunnels. This Directive aims at ensuring a minimum level of safety for road users in tunnels in the Trans-European Road Network by the prevention of critical events that may endanger human life, the environment and tunnel installations, as well as providing protection in case of accidents.

Irrespective of this new EU legislation, some tunnels are unlikely to require passive fire protection measures, eg those bored through solid rock such as the Alpine tunnels (this in spite of the major fire in 1999 in the Mount Blanc tunnel where the fire burned for 53 hours destroying 1.2 kilometres of concrete lining!).

From a firefighter's perspective a tunnel fire is likely to be one of the most difficult and dangerous types of fire to control and extinguish. Often many kilometres from any primary support facility, those tackling the incident have to work within restricted and life threatening conditions, with the constant additional risks associated with explosive, spalling concrete and elevated hydrocarbon fire temperatures.

The Eurotunnel Group will shortly present its proposed fire safety solutions to the Inter-governmental Commission Safety Authority.

The Channel Tunnel is a case in point. At its inception the need for any passive fire protection measures to the tunnel lining were deemed unnecessary, and at a cost of £20 million, prohibitive.

Ironically, the cost of reinstating damage caused to the concrete lining by the first fire alone amounted to in excess of £200 million (10 times the cost to protect the entire tunnel!) and this without determining the cost to industry and the British economy.

It was believed this catastrophic event was statistically very rare; a one in a hundred year occasion. Sadly, this proved not to be the case and a second major fire in 2008, reputedly even greater in its severity than the first fire, saw history repeating itself.

With hindsight the original proposal to protect the lining of the tunnel with a passive fire protection solution, (as in the case of the Ørusend Tunnel which opened in July 2000), would have been value for money. Although the Channel Tunnel is now fully functional, any future fire will continue to pose the same devastating scenarios as before. So how can an effective solution be determined that doesn't impose prohibitive costs to its owner, Eurotunnel Group?

The risks of open lattice rolling stock

Most tunnels are designed for road or rail traffic, or as in the case of the Ørusend Tunnel, both. The Channel Tunnel is designed to facilitate the passage of all traffic, whether passenger, private vehicles or commercial freight via purpose designed rolling stock.

All non-freight vehicles are transported in fully enclosed rolling stock, with appropriate passive fire protection compartmentation. To date no reported fire incident has needed emergency action while rolling stock has travelled through the tunnel.

The risk issue rests with freight vehicles, which are transported via open lattice constructed rolling stock. These are designed to ensure minimum interruption to loading and offloading lorries.

In reality, this design affords none of the benefits of the passive fire protection containment on the Eurostar and the passenger vehicle rolling stock. It leaves any fire to spread in an uncontrolled manner, fanned by the velocity of the rolling stock as it passes through the tunnel. And in each Channel Tunnel fire the fire started in or around one of the freight vehicles in an open shuttle.

Moreover, in both of the previous major tunnel fires the train was brought to a standstill several kilometres into the tunnel, evacuating all of the lorry driver passengers and train crew into the confines of a smoke-filled tunnel to access one of the emergency exits, before finally reaching the safety of the central service tunnel.

The UK fire protection industry has developed a wealth of knowledge and expertise in the evaluation and resolution of complex fire related issues, which include those associated with hostile environmental conditions. The Association for Specialist fire Protection (ASFP) has also set up a Tunnel Task Group, able to call upon specialist expertise from industry, testing/certification bodies, academia and other tailored expertise from its industry body partner the Passive Fire Protection Federation (PFPF) and the active fire protection community.

We believe that the severity of the damage to the tunnel, as well as the risk to passengers, crew and firefighters can be minimised in future incidents if a different fire protection strategy is adopted. If

The PFPF (www.pfpf.org) acts in support of the UK built-in fire protection industry, and is dedicated to increasing awareness of fire protection. Membership includes the Chief Fire Officers Association, the DCLG and Local Authority Building Control .

vehicles on the existing rolling stock are protected so a fire can be contained long enough (in practice, 30 minutes) for the entire freight train to be transported out of the tunnel to a siding, then the fire can be tackled there in a controlled manner by the fire service. This approach would ensure:

- No lives would be put at risk in the urgency and confusion of evacuation within a confined, hostile environment filled with smoke and hot, toxic gasses;
- The fire service would not be faced with fighting a potentially hydrocarbon fire in a highly restricted environment;
- There would be no damage caused to the tunnel lining, catenary or infrastructure, and therefore no closure to the tunnel with all the associated multi-million pound costs, and disruption to the economy.

A solution can be determined to encase the existing open lattice rolling stock, but also allow freedom to load and offload freight vehicles and avoid a weight restriction on the loads. Encasement isn't the entire solution, but a means to facilitate active protection solutions which can only work within an enclosed environment.

Key questions for Eurotunnel plans

The Eurotunnel Group is currently investigating options in the development of a future fire strategy for the Channel Tunnel, in which it proposes to construct "extinguishing stations".

Within the proposal, when a fire is detected on a train, it will continue to the next extinguishing station, where passengers and crew will be evacuated into the service tunnel and an automatic deluging system will control the fire with high pressure jets of water or foam, until the fire services can reach the scene.

Such a proposition raises a number of important questions that will need to be addressed, for example:

- How will the driver ensure he stops the train in exactly the right place (these zones are likely to be 40 metres long)?
- Given the length of the train and the potential for fire spread, how will it be known precisely where the fire is?
- How will a sprinkler system respond to what may be a fully established hydrocarbon fire, i.e. could such a system be overwhelmed?
- How would a sprinkler system ensure the fire doesn't disrupt the catenary power supply, rendering the train immobile?

The UK fire protection industry is concerned this proposal will achieve little more than treating the symptom rather than acting as a realistic and effective cure. Many of the risks generated by fighting the fire in the tunnel remain unchanged. People will still have to evacuate the train into a hostile environment, and firefighters will still have to fight the fire within the tunnel, as opposed to a controlled environment. Last but not least, this process must involve the closure of the tunnel.

While the UK fire protection industry, via the ASFP Tunnel Task Group has made approaches to the Eurotunnel Group for them to take advantage of its knowledge base, no response has been forthcoming. The Eurotunnel Group will present its proposed fire safety solutions to the Intergovernmental Commission Safety Authority later this year, at which point the UK Fire Protection Industry will also express its views.

In the meantime we continue to offer our support and expertise.

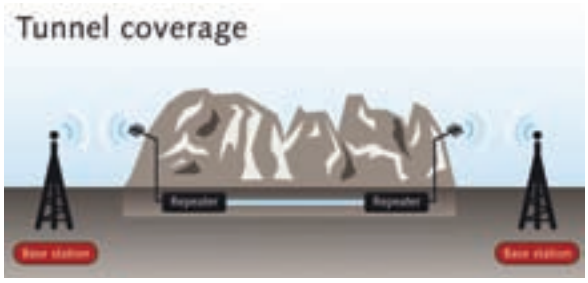
Achieving mission critical tunnel comms

The tunnels on the new E18, between Helsinki and Turku, have been equipped with the latest radio coverage for a TETRA safety network.

Founded in 2004, Creowave is a Finnish company that operates with radio frequency and microwave electronics, offering various products and services in industrial measurement, radio testing and professional radio. Its professional radio business unit offers solutions to enhance the TETRA network coverage in extreme and hazardous environments with indoor-, outdoor- and ATEX repeaters, as well as with the company's new hybrid repeaters.

Today a major challenge facing the construction of new tunnels is ensuring that communications inside these closed environments remain open even during emergencies. Inadequate FM, GSM or TETRA radio coverage inside a tunnel can result in critical and life-threatening situations. Consequently tunnels should have broadcasting services for personal and emergency communications.

In terms of mission critical communications in European and Asian countries, TETRA is the leading technology for use by government agencies and emergency services.



In the recent E18 project, seven different tunnels were built for a 51 km stretch of the E18 highway from Turku to the Finnish capital Helsinki. The longest of these was the 2.3km Karnainen tunnel – the longest highway tunnel ever built in Finland.

As an average, around 600 people worked on the project over three years and safety requirements for the new tunnels were set high from the start. All the tunnels had to be covered for several radio frequency service: FM radio signal was required to relay important traffic and accident reports: GSM network was required for instant emergency calls made inside the tunnel. Last, but not least, complete TETRA-coverage was required for all the tunnels by emergency services including police, fire brigade and emergency medical response.

TETRA-coverage for the longest tunnels was provided by in close co-operation with other radio frequency service suppliers. Creowave's first contribution was in coverage enhancement, ensuring the tunnels had TETRA network coverage which did not compromise GSM and FM frequency services.

To achieve the solution, the TETRA signal was amplified with Creowave indoor repeaters (230VAC power supply) that were distributed inside the tunnels using leaky feeders and indoor antennas (depending on the tunnel length and topology). Leaky feeders consist of a coaxial cable with open slots in the shielding of the cable - from these open slots the signal "leaks" out much in the same way as water would leak out of a punctured hose pipe.

The TETRA coverage was built to redundant status ie able to withstand a sudden malfunction of a TETRA base station, or repeater. The redundancy in the longest tunnel was achieved by feeding the same tunnel from both ends with separate repeaters. These repeaters were connected to different base stations, so in the tunnel there was coverage from two separate base stations.