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Critical power infrastructure

Transforming risk management

A disturbance in energy supply can have disastrous cross-industry consequences. Additional factors are piling pressure on the transmission and distribution sector to recognise and address the risks. Deborah Ritchie writes

The uninterrupted supply of electricity is often taken for granted, but behind the continuous supply of power, the risks to its generation, transmission and distribution are many. And at a time when a growing global population and the emergence of developing economies are placing an ever-increasing demand for energy, the importance of risk mitigation in the power transmission and distribution sector has never been more apparent. These external factors are well documented; other internal pressures further underline the need for power transmission and distribution companies to understand asset management and instigate the due risk analysis, not least the cost of interruption – both in safety and financial terms.

Industrial growth from the 1950s to 1980s in both the US and Europe created significant investments in critical infrastructure, in particular with electrical power supply. But in recent years energy consumption has begun to challenge power generation. Design engineers anticipate that the majority of transformer equipment engineered and installed during the boom growth years is now in the final phase of its lifecycle.

The cost of ageing infrastructure

The average cost of transformers has experienced a 5.5 per cent annualised growth rate for approximately 20 years. This typically results in a 100 per cent increase in the cost of a large transformer every 12-15 years, meaning a unit installed 30 years ago at a cost of £300,000 (EUR 390,000 / US$440,000) now has a replacement cost closer to £1.2m (EUR 1.56m / US$1.75m).

Typically, transformer failures can be caused by a combination of electrical, mechanical or thermal issues. Insurer FM Global indicates that mechanical and electrical failure of components is the main cause of unplanned outages in power transmission and distribution in the UK and Europe.

Of these failures, fire is commonly involved due to the use of a flammable liquid, such as a hydrocarbon-based mineral oil, as the dielectric and cooling agent. In the case of transformers, failure of an external piece of equipment, such as an oil filled bushing or on-load tap changer can lead to ignition of the bulk oil in the main tank. The mineral oil will then readily burn once ignited, potentially damaging surrounding equipment and the immediate environment, not to mention placing lives at risk.

A recent indoor transformer failure at a 1.6-million-square-foot (150,000-square-meter) automotive manufacturing facility shows the potential degree of the impact, in which a mineral oil-insulated transformer suffered an internal arc and ruptured, resulting in the fire that destroyed an adjacent transformer and electrical cabinets. The extremely high temperature of the arc rapidly heats up the insulating fluid, which is often combustible mineral oil. The result is a physical explosion of the transformer's outer shell which occurs from the insulating liquid being rapidly heated, vaporized and decomposed, causing a pressure buildup. The resulting blaze took an hour to be fully extinguished, but the damage was already done.

"This incident shows that a fire involving a relatively small amount of mineral oil released by an indoor transformer explosion can cause millions of dollars in damage and lost production if not properly isolated from the surrounding occupancy," notes Glenn Mahnken, former senior engineering specialist for engineering standards at FM Global.

Mahnken says it is important to understand the potential ripple effects that transformer breakdowns may have on production downtime. "Recognise that any transformer could fail and establish a contingency plan to expedite obtaining and installing a replacement, especially when high-value production operations would be impacted by the breakdown," he says.

Strategic asset management

As the electrical power network sector undergoes so much change, asset management remains one of the major challenges for most network businesses. According to the International Electrotechnical Commission (IEC) white paper, 'Strategic asset management of power networks' (2015), there are very few

International Standards that define a common language and metrics or provide examples of best practice to guide network businesses and their broader stakeholders worldwide on this topic. This underlines the need for risk management, the most common approach to which in this sector is the use of a risk matrix to analyse the potential implications. These can include the impact on human safety, the economic impact, the impact on reliability and the impact on the environment – the successful or otherwise management of which can have significant reputational and regulatory consequences.

Similarly, the demand for insurance for the power and utilities sector is growing, as service interruption represents an increasingly critical scenario – both for operators and for society.

The insurance challenges are unique in this sector, and projects require cover from planning through to construction and operation and include machinery breakdown and business interruption cover; tailored risk consulting, property 'all risks' coverage, liability coverage including environmental liability and D&O liability. Business continuity and crisis management support are increasingly standard offerings today.

Focusing on risk prevention and becoming proactive in reducing the number of accidents has additional benefits when it comes to employee safety. Studies have showed that when employees perceive that safety is not a priority of the company, their behaviours and attitudes are adversely affected. According to a report from Zurich Insurance, this can lead to increased workplace injuries, lower morale and decreased profitability. "An investment in a safety programme that focuses on hazard identification, training, prevention and assessment will not only help reduce losses and increase overall safety compliance records, but it could be the difference between being an industry leader or just another run-of-the-mill company," it says.

Smart move

Smart electrification will allow us to make better use of energy, reduce emissions and ultimately help mitigate climate change. This is the view of the IEC, highlighting the growth of urban conurbations and the rise of the smart city, of which power and utilities companies will ultimately form the backbone.

One National Grid transformer substation is already minimising energy waste in London's densely populated area of Highbury. As part of a complex 400 kV cable expansion programme across the capital, National Grid, the owner and operator of the electricity transmission system in England and Wales, was faced with the task of convincing planning authorities that it could build a 400 kV electricity substation in a densely populated urban area. The requirement for a reduced fire risk, along with recommendations from FM Global to use non-flammable fluids, led to the decision to utilise an alternative insulating/cooling fluid for the transformers. Instead of mineral oil, which is the industry norm, a synthetic organic ester was used. This is because, in comparison to mineral oil, synthetic organic esters have much higher flash and fire points, significantly reducing the risk of fire within transformers.

Energy demand is growing worldwide, particularly in the emerging economies. In developed countries, operators need to maintain existing infrastructure and are under pressure to deliver ever cleaner, greener, cheaper and more efficient supplies. At the same time, regulations are tightening and competition is freeing up almost everywhere. These developments represent an opportunity for risk managers and insurers that are ready to face both the operational and strategic challenges.

Deborah Ritchie is Editor of CIR Magazine

Reducing risk and liability in critical power infrastructure

Barry Menzies looks at the measures that can be taken to mitigate damage to power transformers, and the role that insurers play in providing cover for this critical equipment

Between 2008 and 2013, damage to power transformers cost FM Global clients a combined US$339 million in lost revenue. With production downtime estimated at approximately US$1 million a day and the price of replacing a failed unit ranging from US$2-4 million, transformers are regularly cited as one of the top five high risk pieces of equipment in terms of claims. But what role do transformers play in everyday life, and what can be done to reduce the likelihood of failures that can result in expensive claims?

Transformers are important electrical assets found in every industry and sector. Working to ensure a continual supply of electricity is available, the role of a transformer is to step the voltage of electricity up or down as required. For example, power stations usually generate electricity at 25,000 volts (25kV), but to ensure maximum efficiency and prevent excess energy from being lost during transmission over long distances, transformers are used to step up the voltage to 420kV. Once the power reaches its final destination, such as a house, office building or manufacturing facility, it is stepped back down to a level that is safe to use – 240V.

Risky business

So what makes transformers such high-risk assets? One of the main causes of unplanned outages in power transmission and distribution across Europe is mechanical and electrical failure of individual components, such as transformers. This can be the result of a number of events, from unexpected design defects and voltage surges, to environmental damage such as lightning strikes or floods, and even intentional vandalism. Whatever the cause, the resulting consequences can be severe, and many quickly lead to the ignition of the dielectric cooling fluids (usually mineral oil) used to prevent the transformers from overheating.

Although mineral oil offers excellent insulating and cooling properties, the petroleum-based fluid also has a number of disadvantages. Mineral oil's main drawback is its flammability and high calorific value. Mineral oil will ignite at around 170°C and, due to the amount of energy it releases when burning, will burn readily, quickly creating intense fires and potentially catastrophic damage. As mineral oil is also non-biodegradable and toxic, it presents a serious hazard to aquatic life and surrounding ecosystems in the event of a fire or spill. Clean up processes are not only extremely expensive and lengthy, but can also have a serious impact on the offending company's public image, resulting in significant financial consequences in terms of lost income and litigation costs, on top of any repairs or replacements that may be required.

Ester based alternatives

A safer alternative to mineral oil – ester based fluids – are increasingly being used, as they are fire safe and readily biodegradable, and so can significantly reduce the damage caused by transformer failures. Falling into two categories, synthetic organic and natural, esters offer similar qualities to mineral oil in terms of their insulating and cooling properties, but without the associated risks. Derived from organic raw materials, synthetic organic esters were first introduced in the 1970s to replace fire safe but toxic Polychlorinated Biphenyls (PCBs) in existing transformers. Natural esters, meanwhile, originate from sources such as soya bean or rapeseed oil, and were developed in the 1990s.

Both natural and synthetic organic esters are readily biodegradable and fire safe fluids. They offer superior protection, with flash and fire points that are much higher than those of mineral oil. For example, mineral oil's flash point (that is, the temperature at which it gives off sufficient vapour to ignite in air) is 150°C, compared with 260°C for synthetic organic esters and in excess of 260°C for natural esters. The corresponding fire points – the lowest temperature at which the vapour of the fuel will burn for at least

five seconds after ignition – are 170°C (mineral oil), but greater than 300°C (synthetic organic and natural esters). The result is a fire safe alternative to mineral oil, and since their first use in the 1970s, MIDEL fluids have a 100 per cent fire safety record.

The chemistry of esters means they also reduce the potential risk to the environment. They are biodegradable, non-water hazardous, nontoxic and not harmful to aquatic life. All MIDEL fluids are readily biodegradable according to OECD 301 and fully biodegradable according to IEC 61039, meaning that in the event of either a leak or catastrophic loss, the clean-up costs and any associated claims will be significantly reduced or eliminated.

Esters can also help extend the lifespan of a transformer. There is evidence that insulating paper immersed in an ester fluid will have a lifespan up to 25 per cent longer compared to mineral oil, helping to minimise maintenance requirements and reduce the overall cost of installation when considered over the asset's whole lifecycle; as while mineral oil becomes saturated with water at around 60 parts per million at ambient temperature, ester fluids have a much higher moisture tolerance and so can absorb far greater amounts of water without compromising their dielectric strength. As a result, both the transformer and insulating paper within it – which is most commonly damaged by water or moisture ingress – will experience a longer lifespan compared with conventional mineral oil.

Changing regulations

The use of ester fluids can also directly impact installation considerations and the associated safety records are influencing guidance from insurers. For example, FM Global's guidance document for transformer installations says that, when using an approved fluid such as MIDEL in the volume range of 19,000 to 38,000 litres, transformers can be installed with no fire walls, only 1.5 metres from a building with non-combustible construction. With mineral oil and the addition of fire walls, the required spacing would be 7.6 metres and the fire walls would need to extend to 15.2 metres either side of the bunded area. Clearly then, there's a huge role for ester fluids to play.

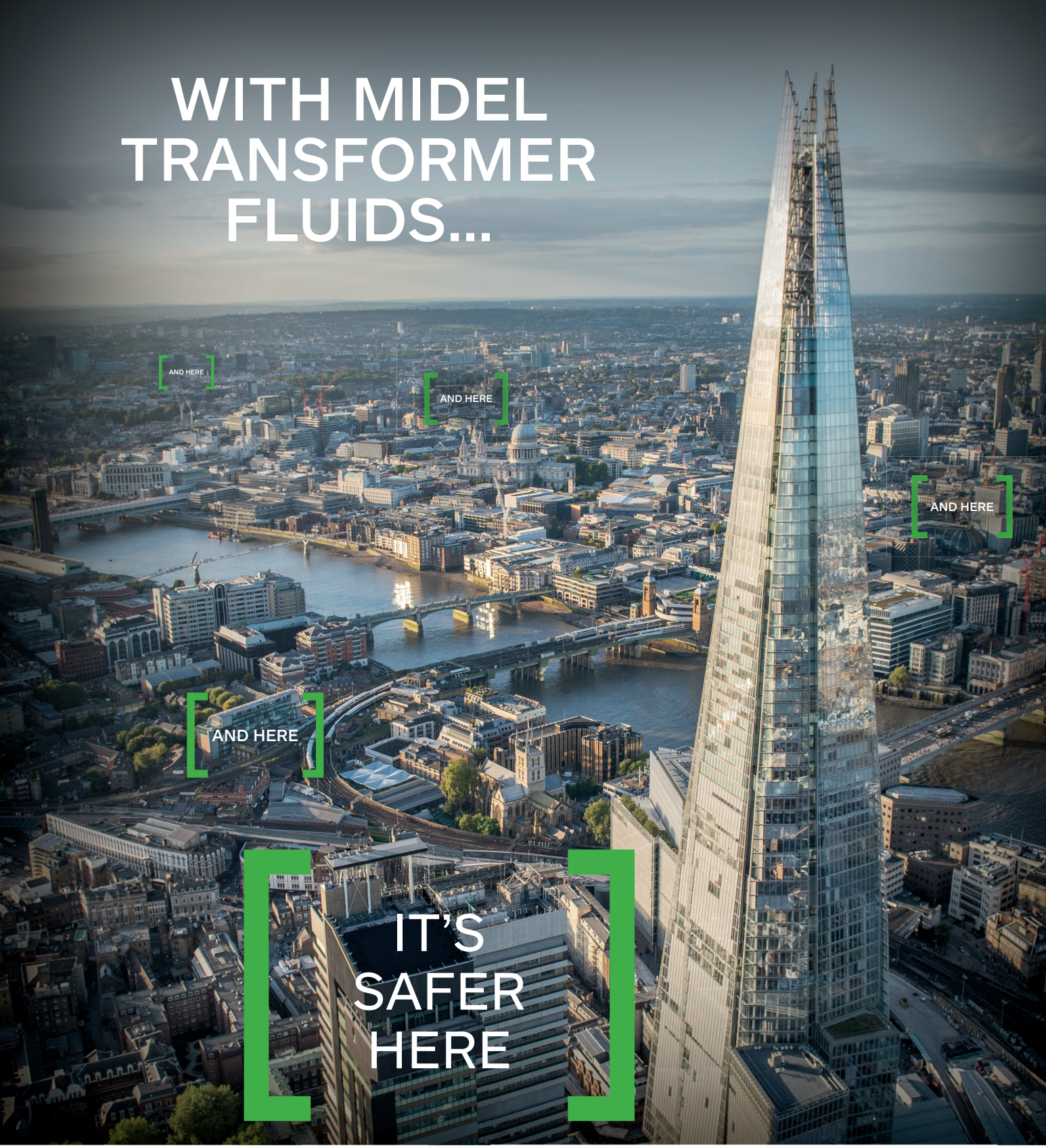
Introducing the experts

M&I Materials manufactures the MIDEL range of ester based transformer fluids. With extensive experience in the industry, the team of engineers and chemists behind MIDEL is able to offer expert guidance on how to best protect your clients' assets and what measures can be put in place to reduce the likelihood of claims. Furthermore, MIDEL fluids can be retrofilled into existing transformers as well as new installations, improving the performance, safety and lifespan of current networks.

With its built-in fire and environmental protection, MIDEL fluids are designed to help mitigate risk for critical power infrastructure, property and life, in turn reducing liability.

Barry Menzies is Commercial Director and Head of Dielectric Fluids at specialist transformer fluid manufacturer, M&I Materials

To find out how MIDEL can help protect you, visit: midelsafetyinside.com/insurance



When it comes to protecting what matters, there can be no compromises. MIDEL ester transformer fluids offer superior risk mitigation for power transmission and distribution assets; in addition, the fluids can be used to retrofill older fleets. Fire safe and biodegradable, MIDEL reduces liability, the threat of losses and costly business interruptions. It's time to go beyond mineral oil for a safer, more efficient future. MIDEL is transforming asset performance, reducing risk and delivering cost savings every day across the world. Let's make it safer together.

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