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Climate change resilience on the digital railway

As extreme weather becomes more common in the UK, the effects will present a resilience challenge for rail. How can the industry protect its communications infrastructure against extreme heat and increased rainfall in the age of digitalisation?

Compared to pre-industrial times, the world's average temperature has risen by just over 1°C. That doesn't sound like much, but the impact of global warming has already been profound and diverse. On 19 July 2022, for example, the UK saw temperatures higher than 40°C for the first time in recent history. The 40.3°C peak at Coningsby in Lincolnshire was 1.6 degrees higher than the previous record, set in Cambridge in 2019. Temperatures at 33 other locations in England also surpassed the previous national record.

Feeling the heat

Record-breaking temperatures used to be once-in-a-lifetime events. The highest temperature seen in 1911 was not surpassed until 1990, for example. Since then, the record has fallen four further times.[1] And global average temperatures are on track to be three or four degrees higher by the end of this century. Modelling by Met Office scientists suggests that will increase the probability of the UK experiencing temperatures of more than 40°C by a factor of ten.[2]

Really hot weather causes big problems for the railway industry. On the UK network, rails are prestressed to cope with average summer temperatures of 27°C. Much hotter than that and thermal expansion can cause rails to buckle, threatening derailments. During the July 2022 heatwave, speed limits were imposed on lines across the country and several services were closed altogether. Overhead powerlines also expand in the heat, potentially sagging to below safe heights.

As the industry accelerates its digital revolution, the changing climate is set to bring new challenges, because IT infrastructure is especially sensitive to high temperatures. During the July 2022 heatwave, UK hospitals suffered computer system outages as their servers overheated. And some major providers of cloud computing services were forced to take equipment offline due to cooling problems in their giant London data centres.[3]

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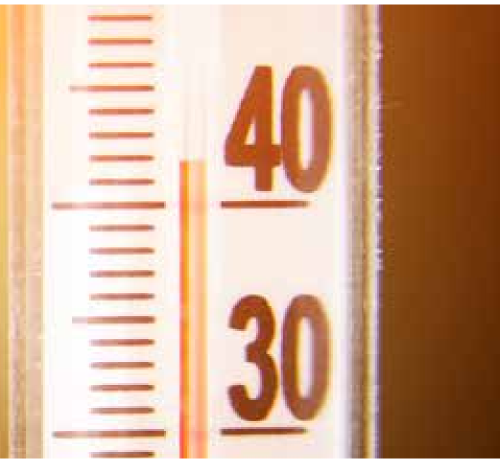

1 https://en.wikipedia.org/wiki/United_Kingdom_weather_records
2 https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/red-extreme-heat-warning-ud
3 https://www.computerweekly.com/news/252522933/UK-heatwave-sparks-cooling-system-meltdown-in-Googles-and-Oracles-London-datacentre-regions

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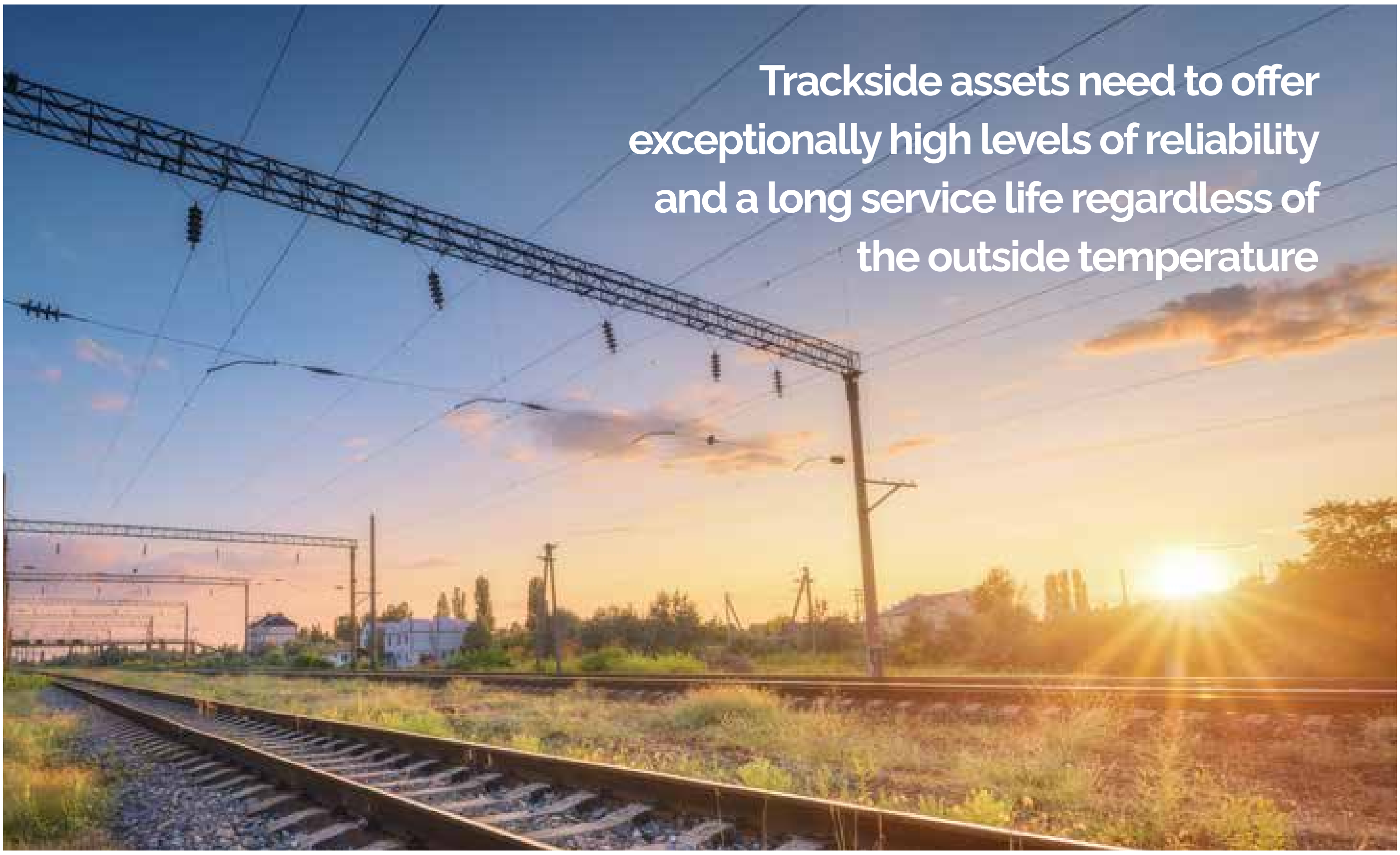

Trackside assets

And if hot weather is tough for computers installed in air-conditioned facilities, it is even tougher for the thousands of trackside assets that provide monitoring, control, and communication functions for the modern railway. Trackside assets need to offer exceptionally high levels of reliability and a long service life regardless of the outside temperature, and the industry's digitisation plans will require more, and more sophisticated, equipment to be packed into small enclosures – often in inaccessible locations.

Extreme temperatures are already forcing railway operations and maintenance teams to take extreme measures. On the hottest days, some operators dispatch crews to increase the airflow through critical enclosures by opening their doors. That's a big compromise: reducing the risk of overheating but leaving equipment exposed to the risk of dust ingress, damage, and theft. And it is a labour-intensive and time-consuming activity that companies would rather avoid.

A better way to protect equipment from temperature extremes is by using an enclosure that is designed for the purpose. That's something that Rainford has been doing for more than 40 years, serving customers in the rail, telecommunications, energy, and other sectors, and protecting equipment in some of the most demanding environments around the world.

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Better ways to stay cool

Rainford enclosures are individually engineered to address the needs of each installation. And when it comes to thermal management, our modular design approach allows us to offer the simplest, most robust, and most cost-effective solution that meets our customer's requirements.

Thermal load on an enclosure is determined by three factors: the ambient air temperature, heat from direct or reflected sunlight, and the heat generated by the equipment within. The maximum safe operating temperature will be defined by the manufacturer of that equipment.

Rainford enclosure systems are designed and tested against a thermal "worst-case scenario" defined in collaboration with the customer according to the locations they plan to deploy in. For UK applications, that is usually a temperature of 35°C (although some customers are now using 40°C). The effect of the solar load (1120W/m²) can be reduced by the colour of the enclosure as well as the location's longitude, with special coatings now available to mitigate 95% or more of this heating effect.

Enclosure systems use a range of approaches to maintain an acceptable interior temperature. Where the equipment generates low levels of heat, or is designed to operate safely at higher temperatures, passive convection airflow using carefully sized and positioned vents can be sufficient. The impact of solar loads can also be managed using a variety of passive measures, including the use of light-coloured coatings and the installation of insulation inside the walls of the enclosure. We have also worked with customers to evaluate specialised coatings designed to minimise solar absorption.

Thermal load on an enclosure is determined by 3 factors:

1. Ambient air
2. Heat from direct or reflected sunlight
3. Heat generated by equipment.

If passive measures can't keep temperatures down, enclosures are often fitted with forced air ventilation systems, which use one or more fans to increase the flow of air over the equipment. To maximise operating life and minimise energy consumption, these fans are typically equipped with a control system, which activates the fan at a pre-set point and gradually ramps up its speed as temperatures rise. Fans are equipped with monitoring devices that trigger a remote alarm if air flow, temperature or energy consumption exceed pre-determined levels.

For the most sensitive equipment, active cooling using ambient air may be inadequate on the hottest days. In these situations, enclosures can be fitted with air conditioning systems that allow the precise control of internal temperature and humidity.

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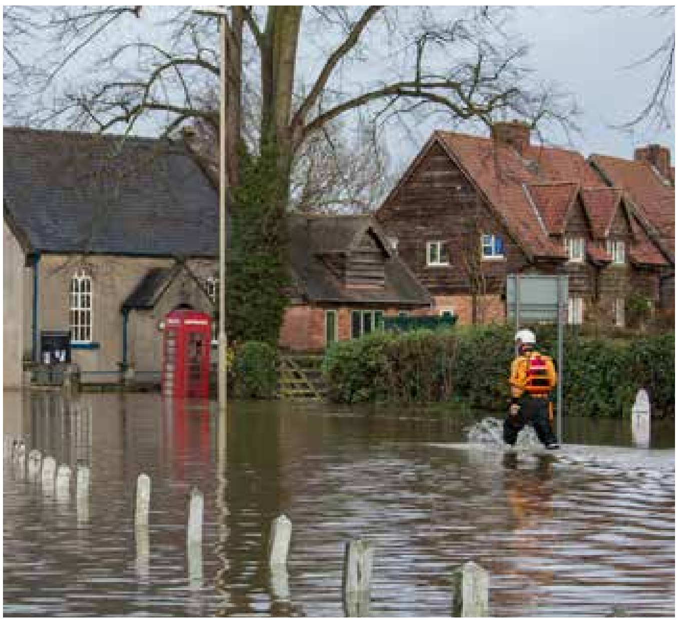
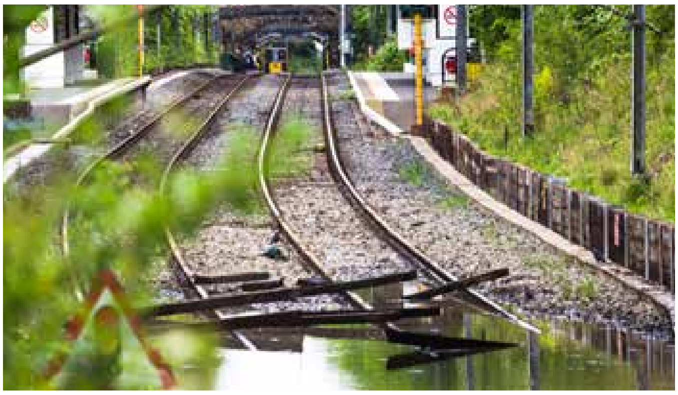
It never rains but it pours

Heat is only one part of the climate change challenge, however. All that extra thermal energy in the atmosphere is making the weather more violent, with higher windspeeds and more frequent, more severe storms. Of the ten wettest days recorded since the UK started collecting rainfall data 160 years ago, six were in the past quarter of a century.[4] Analysis of weather data has shown that autumn days with more than 50mm of rainfall are now 60% more common than at the beginning of the last century.[5] And Met Office modelling suggests that extreme rainfall events will become 29% more frequent during this one.[6]

This ongoing increase in extreme precipitation has big implications for the country's infrastructure, including its railways. Drainage systems need to be sized to cope with peak events, not averages, for example. And the risk of flooding increases substantially when more of the year's rainfall arrives all at once.





It isn't just catastrophic storms that have the potential to disrupt railway operations, however. Even everyday wet weather can cause significant problems if water is allowed to get to the wrong places. On the modern railway, electrical and electronic equipment is particularly vulnerable to moisture ingress, which can trip circuits, confuse sensors, and destroy sensitive components.

The water-resistance of an enclosure for low voltage electrical equipment is defined by part of EN 60529 (British Standard BS EN 60529:1992), the international standard for the ingress protection of electrical equipment. The water ingress protection offered by an enclosure is explained by the second number in its IP rating.

Enclosures designed to meet IPX2 standards offer protection against vertical or nearly vertical water sprays, which in practical terms means rainfall. IPX3 and IPX4 standard enclosures offer additional protection against water sprays and splashes from directions other than the vertical. IPX5 and higher standards are used in applications where equipment may be exposed to high pressure water jets or total immersion.

4 https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-and-global-extreme-events-heavy-rainfall-and-floods
5 https://www.sciencedirect.com/science/article/pii/S2212094721000372?via%3Dihub
6 https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18_headline_findings_v3.pdf

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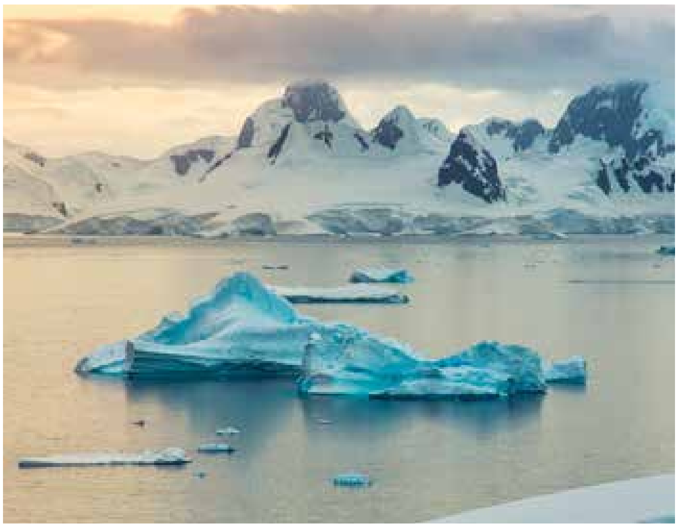
Conflicting climate challenges

One of the most significant challenges for enclosures with higher IP ratings is ensuring that the airflow necessary for cooling is not compromised. Rainford enclosures are typically equipped with IP55 rated filters that keep dust and water out of the enclosure while allowing the free flow of cooling air. And because maintenance teams don't want to spend all their time checking and replacing filters, we use a large surface area design that can be expected to offer at least three years of service in typical rail industry operating conditions.

To ensure an enclosure delivers the specified level of protection, users also need to pay attention to installation and maintenance. Cable access points must be appropriately sited and sealed where necessary, for example. Rainford enclosures are supplied with a plate that can be adapted to meet the user's cable access requirements and which will maintain the intended level of ingress protection if used with appropriate cable glands. Alternatively, users can run cable ducting directly into the enclosure, using a potting compound to prevent the ingress of water, dust, or vermin via the duct.

Advanced digital communications and control technologies are helping to create a safer, more reliable, and more cost-effective railway network. But these technologies will need to operate in a world where extreme weather is becoming an ever more common occurrence. Carefully engineered enclosure solutions will be a critical part of the industry's efforts to ensure the resilience of its operations over the coming years.



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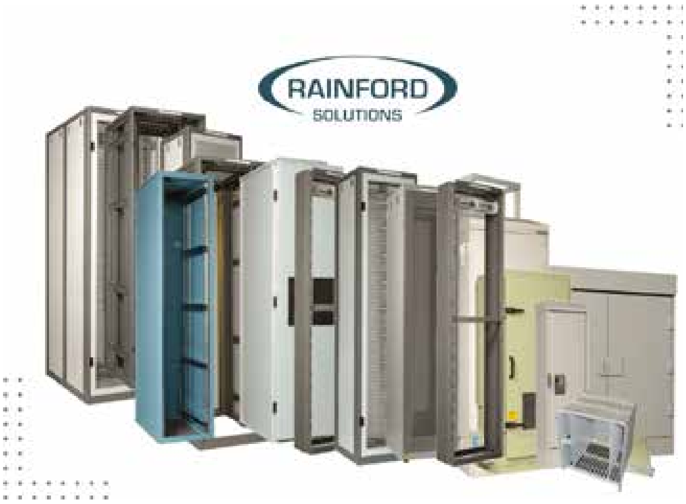

QUICK FACTS:

- Established 1982
- 114,000 sq. ft. UK manufacturing facility
- High volume capacity
- Standard range or bespoke customisations
- Value added design engineering service
- ISO 9001:2015 certified
- Continuous investment and development
- Agile design, lean manufacturing
- Equipment integration capabilities
- EU product distribution

BENEFITS TO YOU:

+ High quality = reliability = low total cost of ownership
+ Capacity for national scale projects
+ Security of working with a leading supplier
+ Flexible rapid design customisation
+ Complete end-to-end solutions
+ Deep industry experience and technical excellence

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