

Electrical safety

4. Sector overview and compliance expectations

Network rail overview

To deal with the legacy electrical assets that do not fully meet current legal requirements laid down by EaWR. Network Rail has an Electrical Safety Strategy that sets out a targeted and pragmatic approach over three funding control periods (CP5, CP6 and CP7) to deliver progressive improvements to the infrastructure and working practices. The strategy will achieve improved risk control and greater compliance with EaWR. The vision is being delivered by the Electrical Safety Delivery Programme (ESDP). It has been drawn up by analysing where risk controls and legal compliance have been historically weakest and where improvements will deliver the greatest benefits – not just for safety and legal compliance but in relation to performance and productivity. An investment decision support tool has been employed to identify which options for improvement will achieve the best combined benefits.

ORR will continue to support Network Rail's delivery of ESDP – by monitoring its greater devolution to the Regions and by ensuring, during our Periodic Reviews, that business plans propose appropriate funding based on analysis of priorities for risk control. ESDP is fully funded for CP6 and plans are in place for CP7.

An example of success of the ESDP has been the roll out of Circuit Main Shorting Devices (CMSD) on the 3rd rail system. The 3rd rail system is used to supply direct current electricity to trains via a 'contact shoe'. The 3rd rail is placed adjacent to the track and is an exposed electrical conductor charge to 750V. Network Rail takes an electrical feed from distribution network operators typically at 33kVac. This is transformed and rectified at substations to provide the 750V to the 3rd rail. Track Paralleling (TP) huts are used in between substations for switching between the electrical

sections.

Prior to the installation of CMSDs workers manually fitted straps between the 3rd rail and track rail as a part of the isolation process by walking track side to fit them. Errors in this process could lead to workers inadvertently applying earths to potentially live parts. The CMSDs use technology that electrically short the section of 3rd rail to be isolated without the need for workers to apply straps and prevent the 3rd rail from becoming live. In addition to eliminating the need for workers to apply the straps the use of the CMSDs is much quicker than manual application of straps and contributes to a faster isolation process. The roll out continues throughout the current funding period but has already demonstrated substantial safety benefits and productivity gains.

Whilst this work has had positive effects on the number of DC isolation irregularities, there are still areas where risks arise. This includes unplanned work to respond to faults, where there may not be a full appreciation of the dangers present. An incident occurred at Godinton substation in December 2018 involving distribution equipment. Two E&P staff were injured by an electrical flashover in a 750V substation when carrying out work on a circuit breaker. This led to ORR investigating the incident and ultimately carrying out enforcement action. Network Rail responded to this incident by reviewing its procedures and assessing the risk of working on or near to this electrical equipment. We will ensure that Network Rail continues to review and improve its working methods in electrical substations for all persons who work in them.

The Overhead Line Equipment (OLE) equipment used to power trains is charged to 25kV ac. Much of this equipment predates EaWR. This means it was not designed with the requirements of the Regulations in mind. The process of placing an isolation on this infrastructure whilst balancing the need to maintain this equipment and the track below it is challenging. To address these issues Network Rail has through the ESDP have increased the level of security of isolations that are placed on the system. In addition they are developing technological solutions to enhance the level of security and speed with which isolations are able to be safely applied to the infrastructure. Network Rail is developing a 'Single Approach to Isolation' (SAI). The SAI will replace NR/L3/ELP/29987 which is more commonly known as the 'Green Book'. The intention of this new standard will be to provide a framework risk-based process, with clear lines of responsibility for the application of isolations on Network Rail infrastructure. We will continue to monitor the progress made with the application of these enhancements to ensure better compliance with EaWR.

ORR has accepted that ESDP is the best means in the medium to long-term to make the operation of Network Rail's electrical assets safer and more in line with the requirements of the law. In order

to improve risk control in the short term, Network Rail developed some of its life saving rules (LSRs) to ensure that staff always checked that equipment had been dead before earthing it and starting to work. Despite several attempts to clarify and re-brief the requirements of the LSRs to 'test before touch' and 'test before earth' ORR found there were still widespread misconceptions and inconsistencies regarding the application of these rules. This has led to incidents which might have been prevented if the LSR had been effective, such as life changing burns experienced by a member of Amey staff at Kensal Green in December 2019.

A similar incident in May 2021 at Wolverton demonstrated continued lack of clarity regarding interpretation and application of LSRs regarding establishing that electrical equipment has been made dead. Further – this incident showed that there was additional potential for confusion due to varying practices to physically demarcate the limits of electrical isolations. Physical demarcation is a development that ORR has long advocated, but its introduction onto the mainline network had been piecemeal and had allowed different technology and procedures to grow.

As a result of ORR's investigations of these incidents we issued two improvement notices in July 2021. Our enquiries had revealed that, despite the LSRs and introduction of physical demarcation of isolation limits, between March 2020 and February 2021 there had been over a hundred isolation irregularities on Network Rail infrastructure. Each of these is a precursor to possible serious harm and each is an illustration of failed processes.

Our enforcement required Network Rail to produce clear, unambiguous instructions to ensure staff have proved equipment dead before working on it. There were prompts for Network Rail to consider a number of scenarios where there was evidence of inconsistent understanding. We also required that roles and responsibilities are clear and underpinned by instruction and training. We required that Network Rail draw up a mechanism to assure itself of continued compliance with the procedures. In relation to physical demarcation, our enforcement required Network Rail to identify the most suitable means to warn staff of the limits of isolations and ensure their effectiveness by clear information, instruction, training and supervision. Effective implementation should be assured by monitoring.

The work required to comply with the requirements of the improvement notices has now been carried out.

When discussing findings from our inspection and investigation work we have pointed Network Rail to other sectors such as the electrical supply industry that also deal with high voltage electrical distribution systems. These sectors can provide a good source of guidance and

information on their best practice which has the potential to be applicable to mainline electrified networks.

The OLE equipment in use in the UK has a number of configurations depending on the time that it was installed. The operating temperature limits that they are designed to are 18 °C to +38 °C. This makes the systems vulnerable to extreme weather events. The summer of 2020 recorded a temperature of 37.8 °C. Whilst this was within the upper temperature limit signification disruption occurred on the network when the OLE failed. This can be attributed to other contribution factors such as the asset life, asset condition, pantograph passage and wind speed. Network Rail reviewed its preparedness for hot weather and its maintenance work specifications to mitigate the risk of OLE failure in hot weather. We will monitor the work carried out to improve the asset condition and resilience to prevent future disruptive failure of this equipment.

In addition to this there are challenges to achieving legal compliance for new electrification schemes that are overlaid and integrated on to existing infrastructure. Legacy infrastructure such as bridges and tunnels pose challenges to compliance with standards for electrical clearances. ORR has pushed hard to ensure that new electrification projects take every reasonably practicable opportunity to achieve risk control and legal compliance. This has not always been easy. We have challenged, whilst trying to be clear that we are not insisting on legal compliance at any cost.

Our efforts have prompted some welcome innovation as Network Rail has sought solutions for locations with physical constraints. We agreed, for example, to the use of surge arrestors and insulating paint at Cardiff Intersection Bridge. The trial is generating valuable empirical evidence that can be used to inform option selection for future sites with challenging characteristics. As a result of continued ORR questions during discussions with electrification projects, Network Rail has undertaken significant analysis of incidents occurring at bridges on electrified lines. This intelligence provides a better understanding of risk and can inform decisions about reasonably practicable options.

To guide projects, Network Rail has drawn up 'Safe by Design Principles' that state that Safe by Design is the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of harm throughout the construction and life of the product being designed. We will monitor the application of these principles by engaging with new electrification projects at an early stage.

References

- ORR: Overhead Line Equipment (OLE) hot weather resilience - Targeted Assurance Review (TAR) - 31 August 2021
- ORR: Safer Faster Isolation - Targeted Assurance Review (TAR) - March 2021

London Underground (LU) overview

London Underground (LU) Overview



LU has a large volume of electrical assets. Its entire network employs electric traction. It has long had a good record for workforce electrical safety due to its carrying out all planned work during 'Engineering Hours' at night, when traction current is made dead. It employed testing equipment to prove the line dead long before the mainline network adopted that measure. In terms of public safety, it has the benefit of a more compact network than the national mainline, where access can generally be restricted more easily. There is still the hazard of bare live conductors in stations. More recent line extensions have employed platform edge doors, which assist in preventing accidental contact with live rails.

LU carries out an annual survey of its assets and produces an Asset Condition Report. The output of the report is a reflection of asset health across known assets. The profile of the asset health is then used by LU to assess risk and appropriate the required resource against the requirements of LU and British standards and current legislation.

The reports highlight that an increasing number of assets are obsolete or approaching end of life. Managing such assets presents risk of uncontrolled failure that may lead to significant business interruption and a culture of reactive maintenance that may lead to a 'fix on fail' approach. For this risk to be controlled LU will need to understand the consequence of failure of assets highlighted as being obsolete or approaching end of life. ORR will engage with LU to understand how short- and medium-term plans to mitigate these risks are being implemented.

Trams overview

Trams Overview



Tramway overhead line electrification (OLE): Tramway OLE shares many of the same issues as the mainline railway system. There are additional risks in the tramway context given that they run in streets to which the public have access and run close to and under buildings. This can give increased risk of contact with road vehicles, construction work and maintenance such as window cleaning. Additionally, where tramway overhead line becomes dislodged and drops below its normal height this will not be detected unless it contacts the running rails or other bonded tramway structures; low hanging wires are a risk to the public.

The Light Rail Safety and Standards Board (LRSSB) has developed a risk model for the sector. The model contains four hazardous events and two precursors for electrical matters. ORR will continue to support the sector as it matures its responses to the risks in the model. Additionally, we have engaged on emerging issues around the safe storage and charging of batteries.

Docklands Light Railway overview

Dockland Light Railway (DLR) Overview



DLR employs DC traction. It illustrates how traction systems can be designed to avoid the shortcomings of older electrified networks. It benefits from being a more recent network than either LU or Network Rail. It has been designed to achieve compliance with EaWR and deliver high levels of risk control. The collector shoe on trains is positioned so that it does not make contact with the top of the conductor rail – allowing the rail to be shrouded to prevent electric shock should there be accidental contact. Its network is raised up or in tunnels, so public access is more tightly controlled, thereby reducing the opportunity for trespass and accidental contact.

Eurotunnel and Eleclink Overview

Eurotunnel and Eleclink Overview



The Channel Tunnel is a 35-mile sub-sea railway system that entered service in 1994 and connects Folkestone with Calais in France. Many of the electrical power and control assets used to supply electricity to the rolling stock and tunnel auxiliary systems are approaching mid to end of life. Eurotunnel have a program in place to renew aged assets. This program requires careful oversight to ensure that electrical assets at a high risk of failure are identified, and their maintenance and replacement is appropriately prioritised, to ensure that the consequence of failure of equipment does not lead to an increased risk to passengers or workers.

The cable system for the 325kV, 1GW capacity HVDC Eleclink interconnector system is installed in the Running Tunnel North (UK to France) with converter stations located on the both the UK and French terminals. The authorisation of this project presented numerous significant regulatory and technical challenges given its 'World first' novel nature. The system was commissioned and entered service during the first half of 2022. Given that the system is now operational, It is important that the operational risks identified during the authorisation process are mitigated, and that monitoring and assurance activities are embedded in Eurotunnel's safety management systems and activities.

Future and 'infill' schemes

Our role is to ensure that dutyholders comply with application health and safety legislation when schemes are proposed. It is for the dutyholder to demonstrate how they will do this. For third rail electrification system's, ORR's policy (refer to Annex A) indicates that there needs to be appropriate safety systems in place to comply with health and safety law. There are safety risks from third rail electrification and so there is a duty to demonstrate that risks are sufficiently controlled to meet legal requirements.

The policy includes the phrase of 'a presumption against', recognising the serious risks posed by third rail. However, it is not a 'no' or 'never' position – where dutyholders believe this is viable option, they need to work out how to mitigate the real risks. For example, systems such as the DLR have designed their traction arrangements so that the conductor rail is insulated or shrouded. Access to third rail by the public on this system is also more restricted than on the mainline railway as it is raised or underground and has no level crossings. Similarly, this has been the case where London Underground has expanded its fourth rail network. Physical limitations and compatibility considerations have constrained adoption of alternative traction current arrangements, but this is set against the already greater levels of compliance achieved on that network, such as no live working and greater separation of members of the public from the network.

Our policy reflects the reality that it is a significant challenge to demonstrate that any new third rail electrification in its current form would satisfy the requirements of current legislation. We make no apology for holding the industry to a standard which seeks to protect people from harm.

We understand the practical challenges involved, ORR was a part of an RSSB led research project that examined cost effective options for electrification and decarbonisation of third rail systems, including infill.

The aim was to deliver a better understanding of the appropriateness of different traction options to remove diesel operations on the unelectrified portions of the network adjacent to the third rail network. This included exploring options to improve the safety of third rail systems, developing a better understanding of the circumstances where a new third rail scheme would be an appropriate solution, and examining the legal obligations related to the extension and introduction of third rail systems. More information can be found in DECARB: 21st Century DC electrification infill.

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