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Design of Traction-Battery Systems for Rail Vehicles and their Charging Systems

This document sets out requirements for the design of traction-battery systems on rail vehicles and their charging systems. This document also gives guidance on the storage, handling and maintenance of the battery systems used to power these rail vehicles.

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Synopsis

This document sets out requirements for the design of traction-battery systems on rail vehicles and their charging systems. This document also gives guidance on the storage, handling and maintenance of the battery systems used to power these rail vehicles.

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Part 1 Purpose and Introduction

1.1 Purpose

- 1.1.1 This document sets out requirements for the design, charging, storage, handling, and maintenance of traction-battery systems used on rail vehicles, including on-track plant (OTP) and on-track machines (OTMs).
- 1.1.2 The information contained within this standard may assist users in applying the Common Safety Method for Risk Evaluation and Assessment (CSM REA), which establishes a harmonised approach to managing safety risks across the railway sector. The CSM REA sets out procedures for the systematic identification, assessment, and control of risks whenever a change to the rail system is proposed. For more comprehensive guidance, RSSB Guidance Note GEGN8646 provides detailed, step-by-step advice on how to apply these principles in a proportionate and efficient manner.
- 1.1.3 Under the regulation, the full application of the CSM REA process with independent assessment is only mandatory where a change is assessed as significant. However, its application is also recommended for non-significant changes, as it represents current good practice and offers a scalable framework that supports compliance with other relevant domestic safety legislation. In these instances, the process is flexible and can be adapted proportionately to the nature of the change.
- 1.1.4 The Electricity at Work Regulations 1989 (EaWR) apply to all workplaces and work activities involving electrical systems or equipment in the UK. Traction battery systems can store high amounts of energy which can pose risks to staff without proper competency and training on these systems.
- 1.1.5 This document can be adopted by railway undertakings (RUs), rolling stock owners (ROSCOs) and original equipment manufacturers (OEMs) under safety and quality management systems or when specifying products and services.

1.2 Scope

- 1.2.1 This document applies to the design of traction-battery systems on rail vehicles. This document includes the design of charging interfaces between rail vehicle battery equipment and energy supply system.
- 1.2.2 The traction battery system includes:
- a) General installation;
 - b) Battery management system (BMS);
 - c) Battery thermal management system (BTMS);
 - d) Driver facing information;
 - e) Fire detection;
 - f) Fire suppression;
 - g) Off gassing features; and
 - h) Battery monitoring.

- 1.2.3 This document focuses on lithium-ion traction batteries. However, some of the guidance applies to most traction-battery chemistry types, even those with higher safety profiles that might be developed in the future for use in rail applications.
- 1.2.4 This document does not set out requirements or guidance for the control of battery management system tasks or features.
- 1.2.5 GOGN3681 gives guidance on the operational use of battery-powered rail vehicles to make use of the design features included within this document.

1.3 Application of this document

- 1.3.1 Compliance requirements and dates have not been specified because these are the subject of internal procedures or contract conditions.
- 1.3.2 If you plan to do something that does not comply with a requirement in this document, you can ask a standards committee to comment on your proposed alternative. To get their opinion, submit an application to RSSB. You can find advice and guidance on using alternative requirements on RSSB's website.

1.4 User's responsibilities

- 1.4.1 Industry experts representing railway industry stakeholders are involved in the process for setting the content of documents that are prepared in accordance with the procedures set out in the Railway Standards Code and Manual.
- 1.4.2 Users of documents published by RSSB are expected to be competent or should take specialist advice before following or applying any practices or principles contained within them and are reminded of the need to consider their own responsibilities to ensure safe systems of work and operation, health and safety at work and compliance with their own duties under health and safety legislation. While documents published by RSSB can be used to help inform and devise safe practices and systems of work, their content has not been designed or prepared for:
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1.5 Structure of this document

- 1.5.1 This document sets out a series of requirements that are sequentially numbered. This document also sets out the rationale for the requirement, explaining why the

requirement is needed and its purpose and, where relevant, guidance to support the requirement. The rationale and the guidance are prefixed by the letter 'G'.

- 1.5.2 Some subjects do not have specific requirements but the subject is addressed through guidance only and, where this is the case, it is distinguished under a heading of 'Guidance' and is prefixed by the letter 'G'.

1.6 Approval and authorisation of this document

- 1.6.1 The content of this document will be approved by Rolling Stock Standards Committee (RST SC) on 23 July 2026 [proposed].
- 1.6.2 This document will be authorised by RSSB on 30 October 2026 [proposed].

Part 2 Battery system design

2.1 General design features

Guidance

- G 2.1.1 A battery system can be integrated with other systems that support the battery design, such as fire detection and suppression but is typically composed of the following:
- Structural module and pack enclosures;
 - A number of battery cells, modules forming a pack;
 - Safety and protection systems;
 - Power distribution modules;
 - A battery management system (BMS); and
 - A battery thermal management system (BTMS);
- G 2.1.2 BS EN IEC 62928:2018 sets out requirements for onboard lithium-ion traction batteries on the design, operation parameters, safety recommendations, data exchange, marking, designations, routine and type tests.
- G 2.1.3 BS EN 50343:2024 sets out requirements and gives guidance on the installation of cabling in rolling stock. This guidance covers electrical connection, material selection, electrical safety, performance and testing and verification of installed systems.
- G 2.1.4 BS EN IEC 62864-1:2016 sets out requirements for hybrid systems containing energy storage systems (ESS) and one or more alternative power sources; the standard also specifies key design features for combining converters and motors to help perform energy management.
- G 2.1.5 In a battery pack, the BMS can include features for charging, battery control, battery discharge, battery health monitoring and on cell balancing of the complete battery system. It is good practice to use BS EN IEC 62928:2018 to develop system design control requirements needed to safely control traction-battery functions, example shown in Figure 1.
- G 2.1.6 A BMS's software architecture and validation system are referenced in BS EN IEC 62928:2018. BS EN 50128:2011+A2020 and BS EN 50126-1:2017 set out requirements for system control and protection management, and give guidance on designing software to operate effectively and safely.
- G 2.1.7 The BMS provides control for essential battery operations and can be integrated with other systems, such as a BTMS. Developing a system requirement specification by applying BS EN 50128:2011+A2020 can help determine system features and functions to maintain safety, reliability and performance.
- G 2.1.8 It is good practice to incorporate a system function that checks the battery system's health of each traction-battery pack fitted on a vehicle before using the traction-battery propulsion.
- G 2.1.9 The BTMS can provide safety, performance and life cycle cost benefits. BTMS can be used to:
- Maintain stable battery temperatures to maintain optimal temperatures;

- b) Control thermal runaway (TR) conditions;
- c) Pre-heat batteries in cold conditions; and
- d) Optimise battery performance.

G 2.1.10 A BMS can isolate strings of cells within a battery pack or the entire pack based on monitoring parameters set out in BS EN IEC 62928:2018. This isolation approach might depend on failure modes and effects analysis or failure modes, effects and criticality analysis (FMECA) or similar types of analysis on typical failure modes within the traction-battery system.

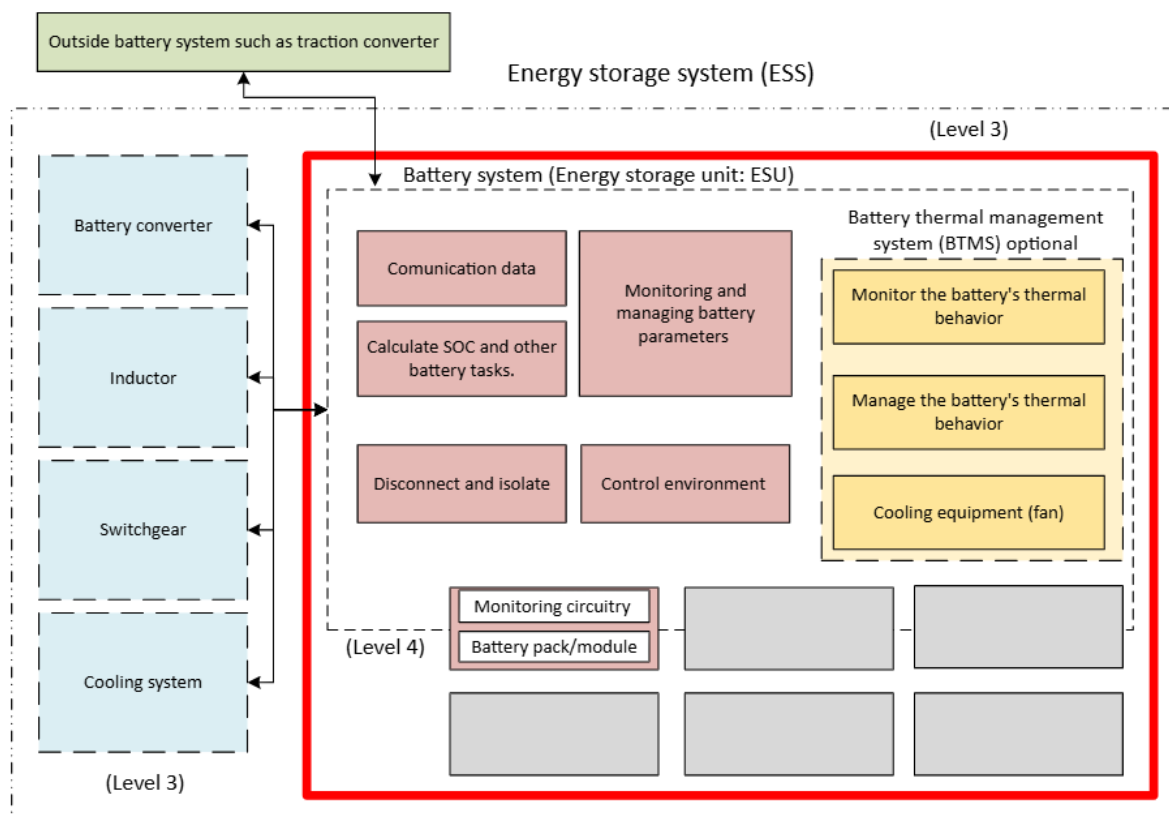


Figure 1: Functional block of a sample battery system from BS EN IEC 62928:2018

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G 2.1.11 It is good practice to use UNECE Regulation No. 100 (R100), which defines the safety requirements for the design, construction, bonding, and testing of high-voltage electrical systems used in electric power trains.

2.2 Traction power mode integration

2.2.1 An onboard traction supply shall not be able to interconnect with an external energy supply in a way that allows energy to be unintentionally exported from a source on board the rolling stock via the current collectors.

Rationale

G 2.2.2 This requirement prevents exported energy from a traction battery source adversely affecting the external supply systems and protects the traction battery against systems associated with any onboard power mode back-feeding into an external power source via the current collection equipment.

Guidance

G 2.2.3 Electrically and mechanically latching contactors controlled by software can be linked to control logic to make sure that energy is not exported off the train to the energy infrastructure when it should not be.

G 2.2.4 Power detection relays can monitor current direction and trip isolation devices when export is detected.

G 2.2.5 This requirement allows regenerative energy to be exported as part of a traction-battery system design.

G 2.2.6 If a traction battery system is integrated onto a vehicle which also has at least an electric mode traction capability, RIS-2713-RST sets out requirements and gives guidance on power changeover (PCo) and PCo strategies on multi-mode rolling stock.

2.3 Equipotential bonding

Guidance

G 2.3.1 It is good practice to use UNECE Regulation No. 100, which defines the safety requirements for the design, construction, bonding, and testing of high-voltage electrical systems used in electric power trains.

G 2.3.2 Limits for equipotential bonding resistance are set out in UNECE Regulation No. 100 which should be verified through periodic testing throughout the life of both the component and the vehicle. This ensures that potential equalisation is consistently maintained between all exposed conductive parts of the vehicle.

G 2.3.3 A high-voltage battery system is galvanically isolated from the vehicle chassis to maintain electrical separation from exposed conductive parts. This isolation minimises electric-shock hazards and ensures functional separation between high-voltage traction systems and low-voltage circuits.

G 2.3.4 The On-Board Isolation Monitoring Device (IMD), as specified in UNECE Regulation No. 100, can be used to continuously monitor the insulation resistance between the high-voltage system and the vehicle chassis. If the measured insulation resistance deteriorates below the defined design threshold, the system can initiate the safe isolation of the battery to prevent electric-shock hazards.

- G 2.3.5 Equipotential bonding for ac and dc traction systems addresses many of the same electrical safety risks as high-voltage traction battery systems. However, because ac and dc traction return current flows through the wheelsets into the running rails, which form part of the traction return circuit, the bonding strategy must also control any relevant electric shock hazards.
- G 2.3.6 Bi-mode vehicles, whether they interface with the 750 V dc or 25 kV ac subsystem or not, are required to have adequate bonding to protect from touch potentials and reduce electrical hazards to systems during fault events, such as a dewirement or derailment. GB mainline electrification is subject to the bonding requirements defined in GMRT2111 and GMRT2113 for ac and dc traction respectively.
- G 2.3.7 RIS-2715-RST also sets out requirements and gives guidance for the 25 kV ac energy subsystem. Equipotential bonding can be used to deliver a safe and consistent approach for electrical shock risks to passenger, staff and components across all vehicle operating modes and environments.
- G 2.3.8 BS EN 50153:2014 sets out requirements and gives guidance on bonding, earthing, insulation and high-voltage traction systems to reduce risks of electric shock to people inside or on trains.
-

2.4 Battery pack size and chemistry

- 2.4.1 The battery pack shall clearly display visible safety signs externally for:
- The battery chemistry fitted to the energy storage system;
 - Isolation signs;
 - Externally mounted warning and prohibition signs specified in BS EN IEC 62928:2018; and
 - The total size of the traction-battery fitted in kilowatt per hour (kWh).

Rationale

- G 2.4.2 Battery chemistry stated in a battery pack provides emergency responders with key information about the personal protective equipment they may wear and the hazards pertaining to the specific chemistry of a fitted battery.
- G 2.4.3 Safety signs are essential to alert staff of risks associated with traction batteries.
- G 2.4.4 The external identification of the total battery pack size can inform emergency service responders of the potential size of battery fire.

Guidance

- G 2.4.5 Many types of traction-battery chemistry can be used for rail applications. The operator assesses risks associated with each chemistry type. Assessments such as the examples in appendix A, allow operators to address safety issues at the design stage to reduce safety risks to persons and assets.
- G 2.4.6 Battery chemistries might be interchangeable throughout the life of the vehicle's battery system. It is good practice to review design assumptions and mitigation following a such a proposed change.

- G 2.4.7 It is good practice to review the signage in the event that traction-battery cell chemistries changes during an asset's life cycle.
- G 2.4.8 Not all lithium-ion chemistries might be suitable for rail applications based on their individual properties, but they can present broadly similar hazards. When considering safety within the design these properties can be identified through risk assessments and analysis for the specific chemistry being used.
- G 2.4.9 The safety profile of traction-battery chemistries can change with the battery chemistries evolution. This change can be identified through the correct application of the CSM REA process to identify the appropriateness of safety design features.

Note: Battery technology in general is evolving at a fast pace. Future proofing traction-battery systems when replacing cell chemistries and their related control software can reduce or remove potential costly modifications during an asset's lifecycle.

2.5 Battery enclosure crashworthiness

Guidance

- G 2.5.1 Traction-battery design encompasses enclosures and their external components such as desiccators, sight glasses, isolation switches and emergency isolator switches.
- G 2.5.2 GMRT2100 sets out structural design requirements which are applicable to battery enclosures and guidance for minimising structural damage to a vehicle, injuries to persons, and the risk of detachment. This standard sets out primary and secondary structural impacts on the exterior and the interior of a railway vehicle to demonstrate compatibility with dynamic loadings that might be imposed during a collision, derailment or sudden movement due to heavy braking.
- G 2.5.3 Traction batteries are either mounted on the roof, on the underframe of a carbody or within the carbody itself.
- G 2.5.4 GMRT2100 and RIS-2780-RST set out crashworthiness requirements to protect passengers and railway staff. The structural requirements for roofs, set out in RIS-2780-RST, include protection from falling debris.
- G 2.5.5 BS EN IEC 62928:2018 does not set out specific size requirements for battery enclosure deformation zones. It is good practice to carry out structural risk assessments of battery packs or modules. The risk to a battery pack or module can be dependent on where it is mounted on the vehicle. Compliance with GMRT2100 and RIS-2780-RST can mitigate those risks, which include collisions and derailments.
- G 2.5.6 The correct application of the CSM REA process can be used to evaluate whether the battery module and pack protect the battery's structural integrity and provide sufficient energy absorption to reduce the risk of thermal runaway (TR) from impacts or a crash.
- G 2.5.7 When applying CSM REA process in the design of battery pack, it is good practice to consider foreseeable impact protection. Related hazards include, but are not limited to:
- a) Track ballast;

- b) Tunnel debris; and
- c) Collisions with other vehicles.

2.6 Fire compliance design

Guidance

- G 2.6.1 GMRT2130 and RIS-2730-RST set out guidance, requirements and rationale for vehicle fire safety and evacuation. The documents also cover the possibility of large volumes of toxic smoke that might impede and delay a safe train evacuation.
- G 2.6.2 BS EN 45545-3:2024 sets out requirements for fire barrier testing for various mounting locations for traction batteries. It is good practice, when carrying out risk assessments of battery system design to consider the following aspects:
- a) Battery chemistry;
 - b) Battery size and segregation; and
 - c) If the battery is single, dual or rack orientated.
- G 2.6.3 BS EN 1363-2:1999 provides alternate fire curves that can be adopted for lithium-ion batteries that can experience fast heat release rate growth if they develop TR. It is good practice to consider both the structural and fire integrity of structures to which the technical cabinets are mounted, whether internally or externally mounted.
- G 2.6.4 Using fire barriers designed to maintain the integrity of a traction-battery enclosure in the event of TR can increase the time the fire might take to develop, that allows a vehicle to be evacuated safely. A breach of containment can lead to a catastrophic thermal incident.
- G 2.6.5 It is good practice to develop a fire defence strategy which considers all aspects of the traction-battery system that contribute to fire prevention used on a rail vehicle. Inbuilt safety designs and integrated systems can contribute to reducing the risk of fire and its impact on the vehicle, passengers and staff. This can broadly take into account the following aspects which is not exhaustive:
- a) A fire prevention design;
 - i) Fire materials that comply with BS EN 45545-2;
 - ii) Thermal shielding and endothermic layering;
 - iii) Cell spacing;
 - iv) Insulation materials;
 - v) Fire barrier thickness;
 - vi) Cable routing;
 - vii) High voltage circuit separations;
 - viii) Battery enclosure design; and
 - ix) Gas venting.
 - b) A fire detection system;
 - i) Gas detection;
 - ii) Temperature detection;
 - iii) TCMS integration; and

- iv) Wayside monitoring.
- c) A fire suppression system;
 - i) Automatic systems;
 - ii) Manual fire extinguisher; and
 - iii) Effectiveness of the extinguishing agent.
- d) Containment;
 - i) Thermal insulation;
 - ii) Gas barriers;
 - iii) Pressure control and HVAC inhibit; and
 - iv) Battery capacity segregation.
- e) Evacuation and emergency response; and
 - i) Emergency access;
 - ii) Passenger escape visibility and guidance; and
 - iii) Crew training.
- f) Compliance and certification.
 - i) LOC&PAS NTSN, SRT NTSN and WAG NTSN;
 - ii) Railway Group Standards (RGSs);
 - iii) Railway Industry Standards (RISs); and
 - iv) BS EN 45545 series of standards.

Note: Even though compliance and certification could likely include many of the areas for the requirements and guidance of fire compliance, they might not cover all legal responsibilities for a project entity to place into use and for a Railway Undertaking (RU) to put into use.

- G 2.6.6 RSSB research report T1367 (2025) recommends that the fire growth curve used for testing fire barrier resistance might be better suited to the hydrocarbon (HC) fire curve. Alternative fire curves set out in BS EN 1363-2:1999 can be considered when designing effective fire barriers in taking into account [G 2.6.2](#). This can help to maintain running capability of a vehicle given that the fire growth of a lithium-ion battery can be extremely quick and can exceed the typical standard time/temperature curve set out in clause 6.1.1.1 in BS ISO 834-1:2025.

2.7 Fire suppression

Guidance

- G 2.7.1 The use of a suppression system might provide the train with a longer running capability time ([G 2.10.1](#)) in the case of a fire, or limit damage to the asset. It is good practice to consider its effectiveness at the design phase in conjunction with other design features used to minimise the propagation of fire from cell to cell during a battery TR event.
- G 2.7.2 It is good practice to provide a fire suppression system which can help limit heat and hinder re-ignition, which can assist RUs in maintaining vehicle running capability times. This might be considered by the correct application of the CSM REA process including other design techniques to mitigate fire propagating to adjacent cells.

- G 2.7.3 Automatic suppression systems are designed to slow the spread of fire and allow passengers and staff to safely evacuate the rail vehicle, as set out in RIS-2730-RST. Application of the CSM REA can help identify the risk profile of the battery chemistry and the effectiveness of the fire suppression agent against that cell chemistry. GEGN8646 gives guidance on the application of the key principles in CSM REA.
-

2.8 Fire and off-gassing detection

- 2.8.1 An off-gas detection system shall be provided on the vehicle to detect any off-gassing from any traction-battery within the train consist.
- 2.8.2 Upon activation of the off-gas detection, the onboard ventilation systems shall be inhibited from ingesting off-gasses into passenger and staff environments.
- 2.8.3 On activation of off-gas detection on any traction-battery within the train consist, an alert to the driver shall be provided.
- 2.8.4 The ventilation systems shall remain inhibited on the affected unit and reset by maintenance staff after an off-gassing alert.

Rationale

- G 2.8.5 This requirement is designed to detect off-gases and provide a method of controlling these gases from being drawn into the rail vehicle after being exhausted, which protects passenger and staff health.
- G 2.8.6 Upon off-gas detection a rail vehicle would be required to have a maintenance intervention for corrective maintenance. This function can prevent toxic fume contamination into the rail vehicle if re-ignition takes place after the initial event or an error by non competent staff resetting a system that could lead to a unit being left in traffic while being in a degraded state.

Guidance

- G 2.8.7 A method of detecting off-gas might be by detecting specific gases or by sensing an increase in pressure and be suitable to maintain a high reliability of triggering in the event of a detection.
- G 2.8.8 The BMS might provide a warning if the BMS fails to control a rise in temperature within the battery modules. Any off-gassing can be treated as the start of a fire to prevent contamination of the air conditioning system.
- G 2.8.9 BS EN 45545-6:2024 sets out requirements for fire detection systems to isolate air conditioning, preventing it from transferring external smoke and fumes into the rail vehicle.
- G 2.8.10 It is considered good practice to prevent the ingress of external air into all vehicles in the train formation upon detecting an off-gassing event. Unaffected vehicles within the train configuration can have their air conditioning systems reinstated automatically by software to allow incident recovery and allow the affected train to be removed from service. This design function can help recover unaffected vehicles in a train formation after a TR event without the need for maintenance intervention.

- G 2.8.11 Requirements for fire detection systems are set out in point 4.2.10.3.2 of the LOC&PAS NTSN and within BS EN 45545-6:2024 to cover fire control and management systems on rolling stock.
- G 2.8.12 An appropriate safety integrity level (SIL) can be determined through application of CSM REA and supported by hazard identification as set out in BS EN 50126-1:2017+A1:2024. It is good practice for the gas detection system to incorporate controls for isolating the air conditioning systems. These assessments can provide a level of assurance that the systems will reliably detect and trigger an off-gassing or fire event.
- G 2.8.13 If the Train Control and Monitoring System (TCMS) detects a fire, it sends an alert to a Human Machine Interface (HMI). This might be due to a high severity alert after an abrupt failure or might be seen developing over multiple driver-facing alerts. The alerts can be due to the BMS, which constantly monitors battery cell voltages, temperature and other battery parameters.
-

2.9 Off-gassing exhaust design

- 2.9.1 Ventilation shall be provided from the battery pack for exhausting noxious and flammable gases created by TR event.
- 2.9.2 Ventilation for off-gassing shall be designed to prevent air in passenger and driver environments from being contaminated.

Rationale

- G 2.9.3 This prevents an over pressurisation and explosion of flammable off-gases risk from battery cells undergoing a TR event within a battery module. Removing flammable off-gases to ambient air before lower explosive limits levels can be reached is essential in reducing the likelihood of a catastrophic failure.
- G 2.9.4 Large volumes of a range of noxious gases can be generated as cells move into TR; this is dependent on the chemistry being used. These gases can have detrimental effects to a person's health; these gases can be dispersed to minimise the impact as low as reasonably practicable (ALARP) to persons within close proximity.

Guidance

- G 2.9.5 As a battery cell heats and approaches TR, off-gassing occurs. This process typically relieves internal pressure through passive or active venting using pressure relief devices. The composition of the released gases depends on factors such as battery chemistry, electrolyte formulation, additives, and electrode materials. These gases often include flammable components that can ignite and cause a risk of explosion if left to build up in a battery enclosure.
- G 2.9.6 It is good practice to consider the risks and consequences of off-gassing through application of the CSM REA, taking into account aspects such as:
- Vehicle speed;
 - Vehicles that operate within tunnels;
 - Vehicle aerodynamic effects;

- d) Cell chemistry and gas composition and volume generated;
- e) Type of service; and
- f) Unique route features, such as dual height platforms.

- G 2.9.7 It is good practice to consider whether the vehicle has openable windows; these can reduce the effectiveness of HVAC systems in preventing fumes from entering a vehicle. When carrying out risk assessments open windows can diminish the effectiveness of measures for preventing fumes from entering into a vehicle in the event of off-gassing.
- G 2.9.8 It is good practice to understand the aerodynamic flows around a rail vehicle so the design of the exhaust vents does not have any negative impacts in entering into the vehicle if off-gassing was to occur and understand how the gas would disperse.
- G 2.9.9 It is good practice to consider the use of filters that might be fitted to a vehicle to neutralise and reduce the environmental impact of some harmful gases such as hydrogen fluoride and carbon monoxide. These gas-scrubbing materials might be single-use only but could support the overall fire defence strategy. This might only work for specific design were the volume of potential off-gassing might overcome any effective filtration.
-

2.10 Running capability

Guidance

- G 2.10.1 BS EN 50553:2012 is referenced in the LOC&PAS NTSN and sets out vehicle running capability requirements so that passenger rail vehicles maintain systems necessary to move it to a suitable evacuation point in the case of a fire within a specified time.
- G 2.10.2 It is good practice to route critical train control wiring away from the traction-battery and maintain a vehicle's ability to move to a safe place.
- G 2.10.3 A BMS on a battery-powered vehicle can prompt train staff to start an evacuation earlier than a fire detection system on conventional rail vehicles might. Constant monitoring of battery temperature, voltage and current cell parameters allow the BMS to detect precursor conditions that can lead to failure or fire. A BMS alerts the driver to an imminent thermal event if mitigation controls fail to stabilise a fault condition.
- G 2.10.4 Software can be programmed to detect and alert the driver to the point at which TR may occur. This can be used to start the evacuation process for the rail vehicle to help remove the unit from service and evacuate passengers and staff safely.
- G 2.10.5 It is good practice to consider off-gas and fire detection within appropriate risk assessments to allow sufficient time to evacuate a rail vehicle. Evacuation requirements are set out and guidance given in RIS-2730-RST for general vehicle design evacuation and escape which can be influenced by a number of the operational hazards.
-

2.11 Battery module and pack removal and replacement

Guidance

- G 2.11.1 Maintainability and other technical requirements that can arise from the implementation of a design are set out in BS EN50126-1:2017. Requirements separate from the systems designed function might be identified during the design process.
- G 2.11.2 A modular design allows:
- Battery chemistry to be changed;
 - Maintainability; and
 - Quick removal and replacement.
- G 2.11.3 Quick and easy removal and replacement of traction-battery modules and packs is desirable for normal maintenance tasks and for changing damaged batteries to limit risks posed by damaged traction batteries.
- G 2.11.4 Electrical and BTMS coolant pipework that can be simply and quickly disconnected can provide quick-change mechanisms for battery modules. These quick-change mechanisms also facilitate increased maintainability.
- G 2.11.5 Through application of the CSM REA process, this might include examining how the battery pack or module can be mounted on a vehicle, how easily it is to be removed if damaged and which equipment might be required to complete this task in normal and emergency conditions.
- G 2.11.6 Battery cells holding a charge post incident might be identified as electrical safety risks, with technical or process driven solutions.
-

2.12 Emergency isolation

- 2.12.1 The traction-battery system shall be fitted with emergency isolation switches or buttons that:
- Are appropriately rated to break the 'on load' current; and
 - Use polarised switching to maintain safe disconnection and arc suppression; and
 - Include dual channel wiring for redundancy.
- 2.12.2 The emergency isolation switches or buttons shall be accessible externally from the rail level by staff from both sides of a rail vehicle for emergency use.

Rationale

- G 2.12.3 If the vehicle fails to isolate batteries in an emergency, a switch or button gives a competent member of staff at depots or an emergency responder the ability to open the battery under load.
- G 2.12.4 While a vehicle is stabled in a depot or sidings, a safety isolation button can allow the traction-battery to be isolated in the event of an emergency. Only one side of the vehicle might be accessible to a member of staff within a depot or sidings.

Guidance

- G 2.12.5 Traction-battery systems can be isolated automatically by the BMS if critical parameters reach above or below designed tolerances. Isolation also allows the operator to control cell temperatures by removing or limiting load current and prevent a TR incident.
 - G 2.12.6 Emergency stop functional requirements are set out in BS EN ISO 13850:2015 that cover key principles for the emergency stop functions for machinery.
 - G 2.12.7 The resetting of a physical emergency isolation switch or button can be through a physical reset. The vehicle can be powered up to full traction power by using normal processes provided by the manufacturer of the rail vehicle.
 - G 2.12.8 A BMS can self-isolate for many reasons. In some failure modes, the battery system can be reset at a depot; some failure modes might require the battery manufacturer's intervention, depending on the failure mode.
-

2.13 Rail vehicle charging interfaces

2.13.1 Power converters and charging

- 2.13.1.1 The BMS shall be capable of protecting itself from incompatible charging equipment being used for charging onboard traction batteries.

Rationale

- G 2.13.1.2 Using a charging system that is incompatible with battery chemistry could damage the traction-battery system or lead to a fire.

Guidance

- G 2.13.1.3 BS EN 61287-1:2014 sets out requirements for power electronic converters mounted on board rail vehicles for traction circuits and auxiliary power vehicles, coaches and trailers.
 - G 2.13.1.4 BS EN 61287-1:2014 discusses these power sources:
 - a) ac contact lines;
 - b) dc contact lines; and
 - c) Onboard supplies including batteries.
 - G 2.13.1.5 It is good practice to consider the effects of different battery chemistries on the power converter rating, taking into account potential future investment in faster charging infrastructure.
-

2.13.2 External chargers and connectors

- 2.13.2.1 External plug-in chargers for traction batteries shall have a combined charging system (CCS2) interface connector fitted.
 - 2.13.2.2 The vehicle shall be prevented from taking traction if connected to an external plug-in traction-battery charger.
-

2.13.2.3 The driver's HMI shall indicate whether an external charger is connected and is charging the traction-battery.

Rationale

G 2.13.2.4 Using clearly defined charging connectors helps to prevent incompatible charging equipment from being connected to a traction-battery system. This approach can reduce the potential damage, safety risks and risks of shortening traction-battery life by using external portable charger equipment.

G 2.13.2.5 Moving a battery-powered vehicle while connected to an external charger could be dangerous.

G 2.13.2.6 It is good practice to ensure appropriate identification of external chargers to reduce the risk of a driver attempting to take traction power to move the vehicle.

Guidance

G 2.13.2.7 External chargers can be appropriately identified to reduce the risk that a charger will be connected to an incompatible traction-battery.

G 2.13.2.8 Charging technologies might be used to connect a battery manually at stations using platform-level connectors. The technology can prevent traction while the charger is connected and safely disconnect the battery before taking traction power.

G 2.13.2.9 BS EN IEC 61851-1:2019 defines charging protocols for safe connection, charging and discharging when using CCS2 connector design set out in the six parts of the BS EN IEC 62196 series for ac and dc charging connectors.

2.13.3 Shore supply charging interfaces

Guidance

G 2.13.3.1 RIS-2715-RST sets out requirements for shore supply interlock systems to prevent unintended contact with or disconnection of the live elements of the shore supply circuit. RIS-2715-RST also sets out requirements for electrical safety devices and other design requirements to maintain a safe interface between fixed infrastructure and the rail vehicle.

G 2.13.3.2 Requirements for shore supply system protective devices are set out in BS EN 50546:2024 which describe high, medium and low shore supply system power ratings and their rated operating currents.

G 2.13.3.3 Charging a battery at a depot through shore supply systems can be limited by the site's power supply capacity. The use of shore supply charging might be slow but can also help to charge a traction-battery during its maintenance exams.

G 2.13.3.4 GMRT2111 and RIS-2715-RST set out requirements and give guidance on ac shore supply safety features for shore supply connections.

G 2.13.3.5 BS EN 50546:2024 sets out requirements for shore supply system electrical safety features, power supply connector design and mechanical features used to supply

rail vehicles within depots or sidings while primary power supply is not used or unavailable.

2.13.4 ac charging interfaces

Guidance

- G 2.13.4.1 GLRT1210 supplements the Energy National Technical Specification Notice (ENE NTSN) for the 25 kV ac energy subsystem used to maintain interoperability.
 - G 2.13.4.2 Maximum traction current limits are set out in GMRT2111 for a rail vehicle charging a battery from overhead contact line (OCL) systems. GMRT2111 provides interface requirements between the rail vehicle and the 25 kV ac OCL system.
 - G 2.13.4.3 It is good practice to assess whether some areas on the GB traction supply infrastructure can supply greater than the 300 A limit set out in GMRT2111.
 - G 2.13.4.4 It is good practice for the RU and the infrastructure manager (IM), as part of the route compatibility assessment process set out in RIS-8270-RST(see [G 2.18.1](#)), to consider where increased or reduced current limits might apply. Increased limits might be able to supplement traction-battery charging strategies. However, the GB mainline has lower capacities and design considerations that predate the Rail Interoperability Regulations 2011 (RIS 2011) and applicable NTSNs and RGSs. These limits might be included in the Register of Infrastructure (RINF) or can be obtained through engagement with the IM.
 - G 2.13.4.5 It is good practice to assess whether extra electrical capacity is available, and how different limits could be used by the vehicle battery charging system.
 - G 2.13.4.6 RIS-1853-ENE gives guidance on maximum standstill current limits on OCL used for static power consumption loads.
 - G 2.13.4.7 For a rail vehicle operating under the 25 kV electrified railway, RIS-2715-RST sets out requirements on current regulation and regenerative braking and also provides guidance on regenerative braking and power frequency harmonics.
-

2.13.5 dc charging interfaces

Guidance

- G 2.13.5.1 New, renewed or upgraded rail subsystems compliant with RIR 2011 can use all applicable NTSNs and their associated RGSs, Guidance Note (GNs) and RISs. However, systems built before 2011 are likely to have been designed to different standards. It is good practice, as part of the RIS-8270-RST process, for the IM and RU to consider the relevant design parameters.
 - G 2.13.5.2 Some areas of the rail power network might have electrical limitations based on the equipment and the system design, for example a part of a route can have lower traction power supply currents than other parts. Information on design parameters could be found in the RINF or held by the IM.
 - G 2.13.5.3 GLRT1212 supplements the ENE NTSN and sets out requirements and gives guidance on maximum train current limits.
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- G 2.13.5.4 GMRT2113 sets out requirements and gives guidance on electrical and mechanical criteria for rail vehicles interfacing with the dc electrified railway. Current limits for rail vehicles interfacing with dc systems are set out in GMRT2113 to help development of dc charging strategies.
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2.13.6 Ground based charging interfaces

- 2.13.6.1 Rail vehicles using ground-based charging technologies for charging traction batteries shall have a method of handshaking with compatible infrastructure to determine safe charging conditions are met before carrying out charging activities.
- 2.13.6.2 The vehicle using ground-based charging shall have a method or process for confirming the unit is positioned correctly prior to charging.

Rationale

- G 2.13.6.3 Electrocutation risks of ground-based mounted charging systems can be reduced by making the equipment electrically isolated for track workers or trespassers until such systems detect a compatible rail vehicle with which to commence battery charging.
- G 2.13.6.4 A design safe interface between the rail vehicles electrical collector equipment and the fixed infrastructure electrical conductor interface helps to prevent thermal build-up that can lead to a fire.

Guidance

- G 2.13.6.5 The CSM REA process can help identify an appropriate process and methodology of traction-battery charging for a battery rail vehicle to safely start charging between fixed infrastructure and the rail vehicles BMS.
- G 2.13.6.6 It is good practice to include human factors aspects in the design of the rail vehicle's traction-battery charging system.
- G 2.13.6.7 A suitable method for positioning the rail vehicle ready for charging can be through a technological means or process. This can help repeatability and performance of this task.
-

2.14 Internal vehicle battery charging strategies

Guidance

Note: CLC/TS 50729:2025 defines interface requirements between charging infrastructure and electric traction units in railway systems. It is good practice to refer to this technical specification to gain understanding of the state of the art.

- G 2.14.1 It is good practice to review the maximum charging rate of an installed traction-battery and to check its compatibility with the energy supply capabilities along the route to ensure it can support this maximum charging rate. This approach can maintain controls that can help sustain optimal battery charging when moving through different energy supply systems on the rail network.

- G 2.14.2 It is good practice to consider the use of the following systems to determine electrical sections current limitations or permissible current draw limits as part of the RIS-8270-RST process that might be agreed by the IM, such as:
- a) Rail frequency identification (RFID) set out in RIS-2795-RST;
 - b) Packet 44 set out in RIS-0784-CCS;
 - c) GPS geo-fencing; or
 - d) Alternative technologies.
- G 2.14.3 It is good practice to consider the benefits of additional onboard power sources, such as diesel engines, to support the charging of traction batteries and provide some additional flexibility for operational resilience and contingency planning.
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2.15 Power conserving modes

2.15.1 Battery efficiency modes

Guidance

- G 2.15.1.1 Providing a variety of power-efficiency modes can reduce energy consumption during degraded operation to provide operational flexibility and reduce the risk of a train becoming stranded. In some scenarios, the flexibility of selecting modes can allow a unit to recover by itself and provide the operational, sustainability and cost benefits highlighted within Table 1.

Mode type	Description
Range extension mode 1	Limiting power consumption from auxiliary loads and non-essential systems.
Range extension mode 2	Diving optimisation by limiting speed or acceleration parameters as an example.
Recovery mode	This mode can include using the battery below its normal lower state of charge (SoC) limit. This might be agreed by the battery manufacture with limits on frequency and the depth of discharge that might be used to prevent a train from becoming stranded.
Load shedding	Battery load shedding might be used by a typical auxiliary battery or a traction-battery can be used to supply this. However the use of the traction-battery during a load shedding can diminish or deplete battery energy that might be required for a vehicle to return to charging infrastructure.
Empty coaching stock (ECS) mode	Empty back to depot to preserve energy on an empty train by removing non essential loads.
Turn around location modes	This turn-around might be driver controlled or an automated function; its function can be to allow a system or driver to switch the rail vehicle under traction-battery propulsion to save power while temporally stabled between journeys in a non-electrified location.
Energy saving stabling mode	Stabling mode to preserve energy before a journey and minimise energy in sidings or within depots.

Table 1: Battery efficiency modes

- G 2.15.1.2 Efficiency modes can be reset automatically or by a driver. The use of efficiency modes can depend on assessing the design function of these approaches and whether they should have temporary use or be used until they are not required, for example.
- G 2.15.1.3 Automation control examples could include:
 - a) Using a train reporting number (headcode); or
 - b) Using geofencing.
- G 2.15.1.4 An example of automation could be to include the use of a train reporting number for a turn around location. While the unit waits, it can reduce the power consumption or to use geofencing on a siding or depot to allow automatic switching to a stabling mode.
- G 2.15.1.5 RIS-3437-TOM sets out guidance and requirements for developing defective on train equipment (DOTE) contingency plans that typically cover critical onboard systems such as battery-traction systems and vehicle's degraded running requirements.

- G 2.15.1.6 General battery efficiency modes might be used as a part of DOTE contingency plans and actions in managing defective onboard equipment.
- G 2.15.1.7 Using traction-battery energy to support vehicle load shedding can have benefits. It is good practice to apply the CSM REA process to assess the appropriateness of, for example, applying an upper limit of SoC where the battery stops feeding load-shedding circuits. Stopping the traction-battery from feeding these circuits can prevent the traction batteries from discharging to allow the unit to be recoverable after an energy system isolation.
- G 2.15.1.8 It is good practice to consider the effect and frequency of use of any recovery mode where the battery SoC is reduced below normal limits.
- G 2.15.1.9 Stabling modes can be used to reduce consumption of non-essential power loads while a battery-traction vehicle not in service remains at a depot or siding. Stabling can help reduce the power required from local infrastructure for charging and maintaining traction batteries.
- G 2.15.1.10 Power saving modes can be used to help reduce energy consumption when trains might arrive and wait at a location, as part of a turnaround service, before proceeding onto the next part of the journey. The reduction in energy use in this mode can complement the impact of decreased capacity on operational capabilities.

2.16 Cyber security

2.16.1 Cyber security resilience

- 2.16.1.1 There shall be an authorisation process for securely accessing the battery diagnostic system.
- 2.16.1.2 The digital maintenance tool used to interface with the BMS shall be protected against cyber-attack and other malicious interference.

Rationale

- G 2.16.1.3 Unauthorised access to the BMS for maintenance tasks such as uploading software can present a safety consequence. The BMS can provide a cyber-attack surface whereby a malicious actor might attempt to take advantage of this access point.
- G 2.16.1.4 Preventing specific devices from connecting to a BMS can reduce common methods of connection by increasing the complexity of access by an outside entity, contributing to an overall cyber security resilience for the battery system.

Guidance

- G 2.16.1.5 Requirement [2.16.1.1](#) can provide a method for controlling access to allow only trained and competent maintenance staff to maintain the traction-battery system within an RU's competency management system.
- G 2.16.1.6 Requirement [2.16.1.2](#) can provide a method for segregating a device used to access the battery diagnostic system from Wi-Fi networks and maintain operational independence.

- G 2.16.1.7 Cyber security risks are mitigated by the application of legislation, standards and frameworks. These documents also describe good practice for operational technology on the GB mainline railway:
- a) The Network and Information Systems (NIS) Regulations 2018;
 - b) IEC 62443 series;
 - c) PD CLC/TS 50701:2023 ;
 - d) BS EN ISO/IEC 27001:2023+A1:2024;
 - e) The National Cyber Security Centre (NCSC) Cyber Assessment Framework (CAF); and
 - f) The National Institute of Standards and Technology (NIST) framework.
- G 2.16.1.8 The Railways Act 1993 part III point 119 and the NIS regulations set out an operator's responsibilities for cyber security, which includes design, training and contingency plans for cyber-attacks or breaches which are to be reported to the Secretary of State for Transport. If an assessment reveals gaps, it is good practice for an RU to apply countermeasures to prevent any impact on the safety of passengers and either reduce or remove any risk of disruption across the network because of a cyber-attack.
- G 2.16.1.9 RIS-2700-RST sets out and gives guidance on the process of verification of conformity of engineering change. RIS-2700-RST can be used for new or modifications to traction-battery equipment to capture any risks that can be associated with proposed changes in the system design or functionality that can have an adverse effect on cyber security resilience.
- G 2.16.1.10 It is good practice to undertake or to review cyber security and resilience assessments for remote and physical cyber threats to the train and infrastructure systems, to reduce the risk of any cyber-attack on the safe operation of the network.
- G 2.16.1.11 As a part of a cyber security assessment, an RU can query how to prevent physical access to a battery's computer systems by the public.
- G 2.16.1.12 Maintenance laptops used for updating software or transferring information from the BMS might prevent connection to enterprise networks to reduce vulnerabilities that could be exploited.
- G 2.16.1.13 It is good practice to include methods for battery fallback into a safe mode after a security breach associated with the battery system. Breaches can occur in a vehicle, in data used to control a battery-powered rail vehicle's movement or in the monitoring of battery health and safety. The use of hardwired connections rather than a fully digital system might provide a fallback mode, in the event of a security breach.
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2.17 On train monitoring recorder

Guidance

- G 2.17.1 RIS-2472-RST sets out requirements and gives guidance for the equipment and function of data recorders on trains that support point 4.2.9.6 of the LOC&PAS NTSN.
- G 2.17.2 BS EN IEC 62625-1:2013+A11:2017 is cited in RIS-2472-RST, Table F.1 in BS EN IEC 62625-1:2013+A11:2017 lists data to be recorded by the OTMR.

- G 2.17.3 It is good practice to provide a facility to test any battery system signals monitored by the OTMR, as part of general maintenance, as set out in BS EN IEC 62625-1:2013+A11:2017 and 2.8.1. The test confirms that the relevant traction-battery signals are being recorded correctly by the OTMR. It is good practice to repeat the test as part of an OTMR replacement.
-

2.18 Battery vehicle route compatibility

Guidance

- G 2.18.1 RIS-8270-RST sets out requirements for determining the route compatibility between vehicles and infrastructure and gives guidance on any new or modified infrastructure or vehicle put into use on a specific route. If infrastructure or vehicles is changed, the change is assessed to determine the technical compatibility between assets.
- G 2.18.2 Assessments for battery traction vehicles typically includes the examination of the:
- Electromagnetic compatibility (EMC);
 - Track circuit assisters (TCAs) ;
 - Electrical bonding; and
 - Impact to rail energy subsystem.
- G 2.18.3 A traction-battery train's electromagnetic compatibility with parts of the non-electrified route is part of the overall application of the CSM REA. A traction-battery system can influence signalling systems and can do so if the battery system has a failure, such as an unintended return path, which can create lineside signalling problems.
- G 2.18.4 To assist RUs in maintaining safe and reliable train detection while operating in a battery-powered mode on the GB mainline, RIS-0728-CCS sets out requirements and gives guidance on the interface for infrastructure-based train detection. GKRT0028 sets out requirements and gives guidance on infrastructure based detection systems.
- G 2.18.5 Requirements are set out and guidance given in GMRT2477 to achieve technical compatibility when using a TCA train detection system on the GB mainline railway. Requirements and guidance on TCA functionality and management are laid out in RIS-2777-RST.
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2.19 Energy metering

Guidance

- G 2.19.1 The LOC&PAS NTSN sets out requirements for onboard energy measurement systems (EMS) on rail vehicles; it also sets out requirements for measuring regenerative energy not used by the battery or dissipated through brake resistor elements. The ENE NTSN sets out regiments for the compiled energy billing data to an on-ground energy data collection system.
- G 2.19.2 To comply with the LOC&PAS NTSN, the energy metering circuits or system within the battery system can be designed to accurately provide billing data to the supplier considering all electrical energy subsystems onboard.
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- G 2.19.3 GMRT2132 sets out requirements and gives guidance on energy metering and data handling requirements on electric traction units when fitted with energy metering systems.
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2.20 Battery data to wayside

2.20.1 General battery system data integration

Guidance

- G 2.20.1.1 TCMS fault alerts generated by the BMS are usually supplied to a driver's HMI if the fault prompts a need for the driver to respond. The fault might degrade the battery system and reduce traction performance.
- G 2.20.1.2 Onboard TCMS data is usually transferred to a wayside data storage repository ready for use by a digital platform tool, which primarily monitors a vehicle's performance and subsystem's health. Digital tools can examine general performance trends and be used for fault-finding or for maintenance and operational tasks.
- G 2.20.1.3 BMS data can also be transferred wayside separately from the TCMS and monitored by a battery integrator for analysis of traction-battery health, lifecycle and performance trends.
- G 2.20.1.4 Data throughput capabilities and size vary, based on the system design and functions offered. Sample rates can influence the size of data pushed from the train. Data throughput can be planned if expanding the battery system capabilities and alter remote data refresh rates for real time displays.
- G 2.20.1.5 To use data to control trains on the GB mainline network, an RU applies the Telematics Application for Passenger Services (TAP) NTSN and Telematics Application for Freight (TAF) NTSN. A system operating under these NTSNs incorporates fixed-energy infrastructure to help to determine if a train can charge after moving out of a non-electrified route.
- G 2.20.1.6 Battery system data might be combined with fixed-energy infrastructure data to help prompt a confidence to proceed (CtP) command for allowing the battery rail vehicle to enter a non-electrified section. Other data, such as fixed-energy infrastructure health information, can be used in combination with battery system data. It might be necessary to provide a fallback or redundant data monitoring system in case part or all of the system fails or becomes degraded.
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2.20.2 Traction-battery information for operational control

- 2.20.2.1 The driver of a traction-battery vehicle shall have access to a CtP indicator or follow a safe process before transitioning into a non-electrified section of the route.
- 2.20.2.2 A traction-battery train's HMIs shall have the facility to indicate each battery's SoC.

Rationale

- G 2.20.2.3 Using human machine interfaces, traffic management systems or digital data tools from a central control point to monitor and prevent traction-battery trains from being stranded can reduce the railways' performance risks.
- G 2.20.2.4 If the CtP process or system becomes unavailable, degraded, compromised by cyber crime or by equipment failure, a fallback mode can be used to continue to manage the vehicle temporary or for a sustained time. It is good practice for the RU to determine on the fallback mode to maintain temporary safe operation.

Guidance

- G 2.20.2.5 A driver-facing indicator can provide a simple 'ok' or 'not ok' illumination, which can inform the driver of a battery-traction vehicle's status with a minimal impact on driver workload.
- G 2.20.2.6 Providing the driver with battery-traction range might be helpful in some operations, but can also lead to detrimental effect on driver anxiety and become more distracting to a driver. An assessment of human factors can help to highlight any risks when incorporating an appropriate design.
- G 2.20.2.7 This indication can also be linked to an appropriate TCMS alert advising the driver that the unit cannot proceed into a non-electrified route with appropriate actions for a driver to follow.

2.20.3 Wayside traction-battery data requirements

- 2.20.3.1 Remote monitoring of the battery system shall be provided for battery safety and operational control.
- 2.20.3.2 Data parameters for each onboard battery traction system contained in Table 2 shall be made available for use by onboard systems controlling a CtP command.
- 2.20.3.3 Data in Table 2 shall be sent to the wayside system for operational control and safe monitoring of the battery system.

Data parameter	Description
Cell voltages	Monitoring under or over voltage cell conditions
Cell temperatures	Individual cell temperatures
Ambient air temperature	Support battery operation in extreme weather conditions
Cell currents	Identifying thermal build up and short circuits
Battery pack temperatures	Average battery pack temperature
Off gassing alarm	Detected gassing of a cell
Fire alarm	Likely precursor alert of a fire derived from the BMS
SoC of all battery energy storage systems	State of charge of each traction-battery pack
SoH of all battery energy storage systems	State of health of each battery pack

Table 2: Monitored battery parameters

Rationale

- G 2.20.3.4 Alerting a central control point if a traction-battery degrades or develops TR can speed an evacuation response, and minimise an event's impact. A central control point alert can allow a situation to be managed at the earliest opportunity. The parameters in monitored battery parameters Table 2 can help provide data to help the operational factors.
- G 2.20.3.5 Many approaches might be used to allow battery-traction vehicles to move onto non-electrified routes and prevent rail vehicles from becoming stranded. Some battery parameters might be required onboard or used from wayside digital tools to control battery-powered vehicles and minimise any impact to the railway. These parameters can also be used to help develop fallback modes if a primary system fails.

Guidance

- G 2.20.3.6 [2.20.3.1](#) and [2.20.3.2](#) support quick identification of battery system failures or decreased performance for management and control while the rail vehicle is in operation.
- G 2.20.3.7 Table 2 provides essential data parameters that can support the safe operation of a traction-battery rail vehicle for an RU. These parameters can also be used to help develop fallback modes if a primary system fails.

Part 3 Traction-batteries within depots

3.1 Traction-battery storage assessments

Guidance

- G 3.1.1 The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 is set out under the Health and Safety at Work Act 1974 to maintain safety within the workplace and to control risks of fires, explosions emissions or leaks of dangerous substances.
- G 3.1.2 Employers are required to provide adequate risk assessments to identify and assess risks from dangerous substances. Part of an employer's duties is developing control measures to remove or reduce risks in so far as is reasonably practicable.
- G 3.1.3 It is good practice to carry out a site assessment using the CSM REA process to identify a location that can be used to store traction batteries within a depot. That site assessment can evaluate the risks identified before investment begins by using local fire brigades or competent fire assessors to provide an independent report that all risks have been identified and reduced ALARP.
- G 3.1.4 Authorities in the area near a depot might require separate authorisations, based on the size and location of storage structures near other sensitive structures, such as schools or hospitals.
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3.2 Depot storage and control of traction-batteries

Guidance

- G 3.2.1 If traction batteries pose a risk of explosion, a risk assessment is carried out under the DSEAR. A competent person can locate and assess storage sites, evaluating fire and explosion risks and protections within depots.
- G 3.2.2 DSEAR sets out requirements and duties for RUs and entities in charge of maintenance (ECM). DSEAR L138 Approved Code of Practice (ACoP) issued by the Health and Safety Executive, gives guidance and advice on how to comply with DSEAR 2002.
- G 3.2.3 Storing large traction batteries within depots can require segregation between damaged and healthy battery packs and modules to reduce the risks of TR in a damaged battery from potentially affecting healthy batteries. It is good practice for the ECM and RU to coordinate to provide a risk-assessed area for storing traction batteries.
- G 3.2.4 It is good practice to segregate damaged batteries from healthy ones; battery packs, modules and cells are each assessed for segregation.
- G 3.2.5 It is good practice for the ECM and RU to coordinate assesses the:
- Impact on railway neighbours;
 - Storage ventilation;
 - Facilities;
 - Evacuation routes;

- e) Environmental protection features; and
 - f) Access to storage by emergency services.
- G 3.2.6 When storing traction batteries on-site, it is good practice for an ECM or RU to monitor traction-battery parameters. For example, temperature monitoring can allow a depot control point to be alerted to a rising in temperature that leads to a safety issue that might pose a risk to staff or depot infrastructure, and allow emergency services to be called.
- G 3.2.7 Technical note TN2316 (2025) provides some information on aspects of using, storing, handling and maintaining traction batteries on and off board of rail vehicles within depots.
- G 3.2.8 Temporary battery storage locations can be assessed and used to allow an ECM time to identify permanent storage sites. Third-party contracts might be in place, and a temporary location would allow for a battery to be removed and fitted to a rail vehicle while the removed battery is package appropriately and loaded for transporting to a supplier.
- G 3.2.9 It is good practice to keep batteries on a rail vehicle or to store them in an approved permanent or temporary location site; see [3.3.1](#). A site segregated from a depot's working areas reduces the risk of impact to the battery pack or module from workers or equipment and buffers the workers and equipment from any potential TR event.
- G 3.2.10 It is good practice for the ECM in coordination with the RU to develop emergency plans and embed them in daily work processes and company procedures for responding to an incident at a traction-battery storage location. These practices can be shared through training and competency management of staff.
-

3.3 Traction-battery storage locations

- 3.3.1 A depot that stores traction batteries on site shall include separate containment areas for serviceable and damaged batteries.
- 3.3.2 A depot that maintains battery-powered trains but does not store traction batteries on site shall include a temporary battery containment area.

Rationale

- G 3.3.3 Segregating low and high risk batteries on sites will reduce the impact of a fire that can be caused by a damaged battery and spreading to other batteries. The way that a battery is damaged will determine the risks it presents. Staff can be informed about the risks and the safety precautions to deploy before entering a containment area.
- G 3.3.4 Thermal runaways can occur at any time and their impact can be severe. Maintaining a safe and controlled storage site can help minimise the impact of a thermal incident.
- G 3.3.5 Temporary storage locations are areas where a damaged battery might be stored temporarily before it is loaded for transport to be recycled or repaired. This temporary storage site for damaged batteries can be used if traction batteries are not stored on the site. Storing a battery temporarily in an area that allows a thermal incident to be controlled can also reduce the hazards of damaged batteries.

Guidance

- G 3.3.6 Temporary locations can be used if batteries are not kept on site other than for delivery or pick up by a courier for transportation to a supplier or repairer.
- G 3.3.7 Managing temporary or permanent battery storage safely involves provisions for:
- The BMS;
 - The BTMS;
 - Fire detection;
 - Fire barriers to prevent the propagation of fire to other depot infrastructure;
 - Gas monitoring;
 - Ventilation for off-gassing;
 - Safety signage;
 - External hazard indicators to inform staff of danger inside a container or structure; and
 - Remote monitoring.
-

3.4 Handling traction-batteries

Guidance

- G 3.4.1 It is good practice to transfer traction-batteries removed from a rail vehicle immediately to a battery storage location; see 3.3. Keeping traction-batteries in areas that have a risk of collision or in the event of a TR incident cause a larger potential risk to persons or assets which can be prevented.
- G 3.4.2 Battery packs or modules might require specialist jigs to fit traction-battery components to the vehicle mounting locations. It is good practice to consider the potential risks to the battery modules or packs when lifting.
- G 3.4.3 Handling large-format traction-batteries in a depot presents risks; batteries can be dropped or damaged through handling practices. This can lead to physical impact by depot equipment, potentially puncturing or crushing the pack or module when they are removed. It is good practice for the RU in coordination with the ECM to apply CSM REA to identify depot risks and build mitigation into depot processes and maintenance instructions.
- G 3.4.4 Removing traction-batteries and storing them within the depot can pose risks to staff and depot assets. A battery's thermal management system might not be connected which otherwise offers the function to remove heat from the battery cells, likely increasing the overall risk when a battery is left on a pallet or floor. It is good practice for the RU to coordinating with the ECM to remove battery packs or modules and store them immediately in a permanent storage area to reduce the risk of TR in the depot as a result of damaging the battery pack or module while stored on the depot floor.
- G 3.4.5 It is good practice to cover terminals to prevent any contamination to pins or terminal fixings that might lead to corrosion or a premature equipment failure.
- G 3.4.6 It is good practice for an ECM in coordination with the RU to manage their maintenance staff in removing or refitting processes to prevent battery impact and

dropping hazards. An approach can be to plan maintenance activities of battery packs or modules with appropriate lifting and staff to control risks, if appropriate.

3.5 Safe maintenance working practices

- 3.5.1 Traction batteries shall have a structured isolation process to be followed in a defined sequence, to prevent the system's live or dead state from changing accidentally during maintenance.
- 3.5.2 System isolation shall be protected by a lock-off device on each battery pack to easily disconnect a traction-battery pack from the vehicle's internal electrical circuitry.

Rationale

- G 3.5.3 A traction-battery stores large amounts of energy and presents an electrocution risk if an isolation process for deactivation and activation is not maintained. This provides a clear structured isolation process prevents an unintended change of state.
- G 3.5.4 Simple and quick isolation of the battery system can allow frequent maintenance over the battery system's life cycle. A lock-off device can be built into a battery pack for an ECM to prevent the state from changing without the maintainer's knowledge.

Guidance

- G 3.5.5 Rail Delivery Group's good practice guide RDG-OPS-GN-007 gives guidance to the RU and ECM when introducing new battery vehicles into a depot.
- G 3.5.6 Traction-batteries can be at low to medium voltages (see BS EN IEC 60038:2011). The ECM, in coordination with the RU, typically includes safe working and isolating practices in its safety management system to comply with the Electricity at Work Regulations (EaWR)1989 and the potential electrocution risks that are associated with these large energy storage devices.
- G 3.5.7 BS EN 50153:2014+A2:2020 sets out requirements for the electrical design and manufacture of electrical installations to protect persons from electrical shocks. The design features along with maintenance processes can help battery operators safely isolate systems for maintenance.
- G 3.5.8 Isolating the battery system is one part of making the vehicle safe for maintenance. A vehicle might have multiple traction power sources. It might be suitable for a series proving circuit to prevent the vehicle leaving a depot with a traction mode in a degraded state.
- G 3.5.9 The RU in coordination with the ECM can help demonstrate safe working practices by delivering training for and assessing the competency of staff that are working on and around traction batteries.
- G 3.5.10 It is good practice for the RU in coordination with the ECM where applicable, to develop appropriate plans for changing damaged traction batteries after a thermal incident.

3.6 Training and competency

Guidance

- G 3.6.1 It is good practice for the manufacturer to provide training material for staff working with traction batteries, particularly for battery packs with large amounts of stored energy. Good practice is to understand the risks of routine maintenance such as, replacing damaged batteries and mitigation measures applied to these different risks.
 - G 3.6.2 Training and competency development can be added to an RU's competency management system to focus on handling, maintaining and storing traction batteries and apply local rules to manage these risks.
 - G 3.6.3 It is good practice for ECMs to provide training about the storage risks and the organisation's battery storage practices.
-

3.7 Depot vehicle charging practices

Guidance

- G 3.7.1 Depots might impose current limits on traction-battery charging, especially on older infrastructure refreshed for battery-traction rail vehicles that use load management techniques to optimise low-capacity energy infrastructure.
 - G 3.7.2 It is good practice for RUs and IMs to assess a depot's charging infrastructure before introducing battery rail vehicles to confirm that it will allow the charging of traction batteries to meet a train's operational commitments.
 - G 3.7.3 When carrying out risk assessments on charging current restrictions it is good practice for the RU to define charging constraints. If this is the case, the RU can define charging times and develop processes to capture and overcome depot charging limitations.
 - G 3.7.4 It is good practice for the RU to build into local instructions energy saving mode capabilities of a rail vehicle to help reduce auxiliary power consumption within depots. This can reduce overall power used to charge traction batteries which can provide cost savings by reducing energy consumption.
 - G 3.7.5 The development or changes to the RU's operational plans can include provisions for using risk assessments to determine what minimum SoC levels are required for battery rail vehicles that are ready for service.
 - G 3.7.6 It is good practice to provide depot procedures and policies that might be required to prevent a train from operating close to or beyond a battery's capacity. The battery-powered train operator develops these policies based on the unique circumstances of both the train and depot.
 - G 3.7.7 Various charging interfaces can be used; examples of these interfaces are listed in [2.13](#). The maximum current draw and affect charging times.
 - G 3.7.8 Battery rail vehicles might have a range of methods for limiting current demand from the vehicle manually or through automation on arriving to a maintenance depot.
-

Part 4 Electromagnetic compatibility

4.1 Electromagnetic compatibility in a rail vehicle

4.1.1 The battery return circuit shall not use the running rails as a return path at any time.

Rationale

G 4.1.2 A battery return circuit path through the running rails results in an undefined amount of dc current flowing through the rails. In ac electrified or non-electrified sections, this can affect dc track circuits causing performance and unsafe conditions. In dc electrified systems this would also be undesirable and present increased corrosion risks to railway infrastructure.

Guidance

G 4.1.3 Electromagnetic Compatibility Regulations 2016 (SI 2016/1091) provide the UK legal framework for preventing electrical and electronic equipment from generating excessive electromagnetic disturbances that can interfere with other equipment. This framework also includes requirements for providing equipment immunity from electromagnetic disturbances so it can operate as intended.

G 4.1.4 The IEC 62236 series sets out requirements for emission limits and immunity levels within rolling stock and infrastructure to protect the operation of electronic equipment that might be susceptible to interference that can degrade operation.

G 4.1.5 BS EN 50121-3-2:2016+A1:2019 sets out requirements for emission limits. Electronic systems associated with the traction-battery system typically comply with BS EN 50121-3-2:2016+A1:2019 and good EMC practice applied in their installation to demonstrate compliance with the Electromagnetic Compatibility Regulations 2016 (SI 2016/1091).

G 4.1.6 It is good practice to include electromagnetic compatibility (EMC) testing of a traction-battery system in both normal and degraded operations to put it into use, this can include testing:

- a) Radiated emissions;
- b) Radiated immunity;
- c) Conducted emissions;
- d) Conducted immunity;
- e) Electrostatic discharge (ESD);
- f) Radiated immunity; or
- g) Surge and burst.

G 4.1.7 It is good practice to consider specific testing that might be required to satisfy historical interference issues or assess the proximity to sensitive infrastructure that the vehicle might operate next to, such as lineside signalling.

G 4.1.8 GMGN2694 gives guidance on EMC compatibility among rail vehicles, control command and signalling subsystems and infrastructure. This guidance references BS EN 50121-3-1:2017+A1:2019, which sets emission and immunity limits for rail vehicles and trains.

4.2 Depot electromagnetic compatibility

Guidance

- G 4.2.1 BS EN 50121-3-1:2017+A1:2019 sets out immunity requirements and emission limits for charging multiple vehicles within depots and yards. Showing how the planned charging of traction-battery vehicles in the depot complies with these immunity and emission limits can provide evidence that there is no detrimental influence between the traction-battery vehicle and fixed infrastructure.
- G 4.2.2 If new charging infrastructure is being commissioned, then a traction-battery vehicle's compliance with BS EN 50121-2:2017 can also demonstrate its electromagnetic compatibility with other electrical equipment in the depot. It is good practice to apply current requirements and limits set out in EN50121-2:2017, and these limits are applied to the maximum train formation for a particular class of rail vehicle.
- G 4.2.3 ENA EREC G5/5 is mandated in the UK electricity industry through its incorporation into the Distribution Code, which is a statutory requirement for all licensed electricity distributors and generators.
- G 4.2.4 ENA EREC G5/5 sets out planning levels for harmonic voltage distortion and provides guidance on the connection of non-linear equipment to electrical transmission and distribution networks. Detrimental impact of non-linear equipment on grid power quality can be influenced by battery fleet charging.
- G 4.2.5 ENA EREC G5/5 applies at the point of common connection to the grid. If the charging location has a segregated connection to the grid when all trains are charging, it needs to meet the requirements of G5/5. If the charging interface is paralleled with other railway loads then it is only allowed a subset of the G5/5 limits, to be decided by parties responsible for the point of common connection.
- G 4.2.6 EMC is essential to prevent the unintended influence or operations of other railway systems that the battery rail vehicle interfaces directly or indirectly with. For example, the signalling systems on routes in which the vehicle operates in a battery mode might interfere with the signalling system.
- G 4.2.7 It is good practice to use BS EN 50121-5:2017+A1:2019 to demonstrate the EMC of dedicated battery-charging equipment. This equipment can store power for fast-charging to aid battery-traction operation.
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4.3 Electromagnetic fields

Guidance

- G 4.3.1 Battery charging can create electromagnetic fields (EMF) that can have a detrimental impact on rail subsystems, passengers and staff.
- G 4.3.2 Strong electromagnetic fields can couple with electrical circuits, leading to component damage, signal degradation, false triggering and, in general, unintended consequences.

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G 4.3.3 GLGN1620 gives guidance on control of EMF at Work Regulations 2016 in the railway environment. It is good practice for an RU to assess exposure limits of and persons susceptible to EMF to identify and mitigate any risks.

Appendices

Appendix A High-level risk assessment example

A.1 Risk assessment table

Note: This appendix provides a guidance example of a high-level risk assessment, limited to the areas included. This example can provide a helpful base to initially identify risks when introducing a new or retrofitted battery vehicle onto the GB mainline.

Guidance

- G A.1.1 Table 3 is not necessarily exhaustive and provides general examples of factors for an RU to assess when procuring, retro-fitting or introducing battery-traction rail vehicles into the GB mainline railway.
- G A.1.2 The RU can expand the high-level risk assessment to include greater detail within the broad areas included in Table 3. The RU or rail vehicle manufacturer might identify other common and unique risks to address in the design specification and proposed operational usage and storage of traction batteries. Some of the listed items might not have significant risks for the RU's operation and use of battery-powered vehicles. This is for the RU to decide and mitigate where appropriate.
- G A.1.3 The RSSB precursor indicator model (PIM) tool can be used to track the impact of safety improvements and to identify concerns that require further investigation or action. A PIM monitors the underlying risk of train accidents by tracking a range of accident precursors and using the Safety Risk Model (SRM) to weight them by risk. Outputs are presented nationally and regionally in the PIM dashboard so users can explore aspects of train accident risks.
- G A.1.4 The SRM tool will include the output of research report T1375 (2026) [proposed] once published for battery-powered rail vehicles. This research will help to provide extra details and specific risks to the use of battery-traction systems.
- G A.1.5 CSM REA provides a framework for a 'proposer' to undertake an overarching risk assessment, whereby using information from this document, it will help to prompt the proposer to identify applicable hazards in those corresponding areas. However, there are many specific risks that are likely to be identified whilst completing these assessments that might not be generic to all designs.
- G A.1.6 The Common Hazards for the Management Of Industry Safety (CHAMOIS) helps baseline and improve consistency in hazard identification and risk assessment. Using a common way of classifying hazards promotes a consistent approach to hazard identification and understanding of risk, leading to an efficient, consistent and robust way of managing safety. The CHAMOIS hazard and ontology list can be downloaded in Microsoft ExcelTM format from the RSSB website.

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#	Causes	Hazardous event	Potential controls and safety measures
1	Energy storage system (ESS) equipment detaches from a vehicle underframe	Derailment (catastrophic)	Compliance with GMRT2100
2	Equipment exceeds gauge including open covers or plugs left connected	Collision with infrastructure (catastrophic) or person (critical)	Compliance with GMRT2173, RIS-8273-RST and GIRT7073 to maintain lower and upper sector gauges
3	Fire – thermal runaway of battery	Burns (catastrophic)	<ul style="list-style-type: none"> a) Safety process in accordance with CSM REA. b) BMS with appropriate hardware and software integrity c) Fire barrier d) Fire detection e) Fire suppression f) Management of exhaust gases g) Over-pressure detection and gassing detection h) Fire alarms i) Evacuation procedures j) Correct rating of components and cabling k) Off-train risks - correct storage and handling of batteries l) Compliance with GMRT2130 and EN 45545

#	Causes	Hazardous event	Potential controls and safety measures
4	Toxic fumes – produced as a precursor to thermal runaway	Asphyxiation (catastrophic)	HVAC control to manage smoke and, by design, reduce risk of Minimise any means of exhaust gases from the battery entering the saloon by design
5	Contact with live parts	Electrocution (catastrophic)	a) Design of isolation b) Isolation procedures c) Training, competence d) Correct personal protective equipment , set by an RU's internal risk assessments and manufacturer's recommendations e) Appropriate tools set by RU's internal risk assessments and manufacturer's recommendations
6	Malicious interference with programmable electronics causing thermal runaway	Burns (catastrophic)	Cyber security assessment
7	Energy storage systems interfere with other safety-critical onboard systems causing	Collision (worst case – catastrophic) immobilisation (minor)	Compliance with EN 50121-3-1:2017+A1:2019 and EN 50121-3-2:2016+A1:2019

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#	Causes	Hazardous event	Potential controls and safety measures
8	Energy storage systems interferes with other safety critical off-board systems causing mal-operation (compatibility with signalling systems)	Collision (worst case – catastrophic) immobilisation (marginal)	Compliance with EN 50121-3-1:2017+A1:2019 and EN 50121-3-2:2016+A1:2019 RIS-8270-RST Route Compatibility Assessment Design of current return paths and power circuits to prevent conducted currents in running rails
9	Other onboard systems interfere with the ESS causing abnormal operation including thermal runaway	Burns (catastrophic)	Energy storage systems compliance with EN 50121-3-2:2016+A1:2019
10	Multiple units simultaneously charging in the depot cause power overload	Immobilisation or loss of service because batteries are not sufficiently charged for service (marginal)	Depot assessment Design of charging infrastructure
11	Multiple units simultaneously charging in the depot cause the distribution network operator to shut down due to supply quality	Immobilisation or loss of service because batteries are not sufficiently charged for service (marginal)	Power supply system assessment Comply with BS EN 50121-5:2017+A1:2019 and ENA EREC G5/5
12	Increase in unit mass alters braking distances (for retrofit)	Collision (catastrophic)	Comply with GMRT2045

#	Causes	Hazardous event	Potential controls and safety measures
13	Battery electric multiple unit incompatible with its route	Immobilisation because batteries are not sufficiently charged for service (marginal) Service disruptions and delays result in immobilisation because batteries are not sufficiently charged for service (marginal)	Route assessment RIS-8270-RST Battery Driver Advisory System, (BDAS) Control informs driver of low capacity state of charge (SoC) information provided to driver Power changeover strategy RIS-2713-RST
14	Fire caused by debris penetrating battery	Burns (catastrophic)	Structural integrity of battery box GMRT2100 and RIS-2780-RST
15	Fire caused by depot equipment penetrating battery	Burns (catastrophic)	Depot procedures training, competence design of handling equipment
16	Electromagnetic fields from power converters	RF Burns (marginal)	Compliance with the electromagnetic field directive, maintenance procedures, GLGN1620
17	Low battery capacity – load shed of HVAC on a hot day	Passenger discomfort or immobilisation (marginal)	BDAS Control informs driver of low capacity
18	Batteries incorrectly stored – fire	Burns (catastrophic)	Depot storage risk assessment including input from emergency services

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#	Causes	Hazardous event	Potential controls and safety measures
19	Manual handling of LRUs	Crushing (critical), minor injuries (cuts etc)	Mechanical design remove hard edges and finger traps Provide handling jigs

Table 3: Risk assessment list example

Definitions

Battery management system (BMS)	A system associated with a battery pack which monitors and/or manages its state, disconnects or isolates the battery pack, calculates secondary data, communicates data outside of the battery system and/or controls its environment to influence the battery's safety, performance and/or service life
BTMS	A system associated with a battery pack which monitors and/or manages its thermal behaviour in order to maintain the temperature of the battery pack in the intended range for load profile agreed between the integrator and the battery system manufacturers
Combine Charge System (CCS2)	Automotive electric vehicle charging connector
Electromagnetic Compatibility Regulations 2016 (SI 2016/1091)	Delegated legislation used to fill out the details of primary legislation. It allows ministers to make changes to the law without a new Act of Parliament.
Enterprise network	IT infrastructure comprising hardware, software, and communication protocols, that connects users, devices, systems, and applications across a business to enable secure, reliable, and efficient data exchange and digital services
Fire defence strategy	component parts of design and operational processes that together form a strategy to reduce the likelihood and severity of a fire incident.
Human machine interface (HMI)	The graphical interface device which indicates information to the operator (user) and which is used by the operator for the purpose of operating the associated systems.
infrastructure manager (IM)	Has the meaning given to it in the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended), but is limited to those infrastructure managers who hold a safety authorisation issued in respect of the mainline railway.
Lithium cobalt oxide (LCO)	Specific active electrode materials used with a lithium-ion battery construction that influence a battery's characteristics
Lithium iron phosphate (LFP)	Specific active electrode materials used with a lithium-ion battery construction that influence a battery's characteristics
Lithium nickel manganese cobalt oxide (NMC)	Specific active electrode materials used with a lithium-ion battery construction that influence a battery's characteristics
National Technical Specification Notice (NTSN)	"NTSN" means a National Technical Specification Notice published by the Secretary of State pursuant to regulation 3B setting out the standards, technical specifications and technical rules in use in the United Kingdom as amended or varied from time to time. Source: RIR

Office of Rail and Road (ORR)	The independent safety and economic regulator for Britain's railways.
overhead contact line (OCL)	Contact line placed above (or beside) the upper limit of the rail vehicle gauge and supplying vehicles with electric energy through roof-mounted current collection equipment. Sources: IEV 811-33-02, ENE NTSN
	Note: Where this includes, in addition to all current[1]collecting conductors, the following elements: reinforcing feeders; cross-track feeders; disconnectors; section insulators; overvoltage protection devices; supports that are not insulated from the conductors; insulators connected to live parts; along-track feeders; conductors connected permanently to the contact line for supply of other electrical equipment; earth wires and return conductors
railway undertaking (RU)	Has the meaning given to the term 'transport undertaking' in the Railways and Other Guided Transport Systems (Safety) Regulations 2006 as amended, but is limited to any private or public undertaking the principal business of which is to provide rail transport services for goods and/or passengers, with a requirement that the undertaking must ensure traction. Source: <i>ROGS</i>
register of infrastructure (RINF)	A register that shall be maintained in accordance with regulation 35 of the Railways (Interoperability) Regulations 2011 (as amended)
return circuit	All conductors which form the intended path for the traction return current. Note: Therefore, so far as this aspect is concerned, the return circuit is part of the energy subsystem and has an interface with the infrastructure subsystem. Source: <i>ENE NTSN</i>
RIR 2011	Railways (Interoperability) Regulations 2011 (as amended).
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006. Source: ORR
Rolling Stock Owning Company (ROSCO)	No definition.
State of charge (SoC)	Remaining capacity to be discharged, normally expressed as a percentage of full capacity by selected expression as defined in Annex A of BS EN 62864-1:2016
State of health (SoH)	State of health of a battery is a parameter used to describe the current overall performance of a battery compared to its original, as-new state

Thermal runaway (TR)	A condition where heat generated within a component or system exceeds its ability to dissipate heat, causing a self-accelerating temperature rise that can lead to failure or catastrophic breakdown.
Lithium manganese oxide (LMO)	Specific active electrode materials used with a lithium-ion battery construction that influence a battery's characteristics
Lithium nickel cobalt aluminium oxide (NCA)	Specific active electrode materials used with a lithium-ion battery construction that influence a battery's characteristics

References

The Standards catalogue gives the current issue number and status of documents published by RSSB: <http://www.rssb.co.uk/standards-catalogue>.

The governance arrangements for Railway Group Standards, Rail Industry Standards, National Operations Publications, and industry recommendations for revisions to National Technical Specification Notices are set out in the Railway Standards Code. Detailed management arrangements are in the complementary Standards Manual. Both documents are available on the RSSB website.

Rail Safety and Standards Board (2026), Railway Standards Code
Rail Safety and Standards Board (2026), Standards Manual

Documents referenced in the text

Railway Group Standards

GIRT7073	Requirements for the Position of Infrastructure and for Defining and Maintaining Clearances
GKRT0028	Infrastructure Based Train Detection Interface Requirements
GLRT1212	DC Conductor Rail Energy Subsystem and Interfaces to Rolling Stock Subsystem Synopsis
GMRT2045	Compatibility Requirements for Braking Systems of Rail Vehicles
GMRT2111	Rolling Stock Subsystem and Interfaces to AC Energy Subsystem
GMRT2113	Rolling Stock Subsystem and Interfaces to DC Conductor Rail Energy Subsystem
GMRT2130	Vehicle Fire Safety
GMRT2173	Size of Vehicles and Position of Equipment
GMRT2477	Compatibility Requirements for Track Circuit Assisters (TCAs) on Rail Vehicles
GMRT2100	Rail Vehicle Structures and Passive Safety
GMRT2132	On-board Energy Metering for Billing Purposes

RSSB documents

GEGN8646	Guidance on the Common Safety Method for Risk Evaluation and Assessment
GLGN1620	Guidance on the Application of the Control of Electromagnetic Fields at Work Regulations
GMGN2694	Rolling Stock Electromagnetic Compatibility with Trackside CCS Subsystems
GOGN3681	Operation of Vehicles with Traction Batteries

RIS-0728-CCS	Infrastructure Based Train Detection Systems
RIS-0784-CCS	The Management of Packet 44 Applications
RIS-1853-ENE	AC Energy Subsystem and Interfaces to Rolling Stock Subsystem
RIS-2472-RST	Data Recorders on Trains
RIS-2700-RST	Verification of Conformity of Engineering Change to Rail Vehicles
RIS-2713-RST	System Requirements for the Introduction and Operation of Multi-Mode Rolling Stock
RIS-2715-RST	Rolling Stock Subsystem and Interfaces to AC Energy Subsystem
RIS-2730-RST	Vehicle Fire Safety and Evacuation
RIS-2777-RST	Functionality and Management of Track Circuit Assisters (TCAs) on Rail Vehicles
RIS-2795-RST	Track to Train RFID Compatibility
RIS-3437-TOM	Defective On-Train Equipment
RIS-8270-RST	Route Level Assessment of Technical Compatibility between Vehicles and Infrastructure
RIS-8273-RST	Assessment of Compatibility of Rolling Stock and Infrastructure - Gauging and Stepping Distances
TN2316 (2025)	Traction batteries in rolling stock depots
RIS-2780-RST	Rail Vehicle Structures
T1367 (2025)	Exploring the heat release rates of large lithium-ion batteries

Other references

ACC NTSN	Accessibility National Technical Specification Notice
BS EN 1363-2:1999	Fire resistance tests. Part 2: Alternative and additional procedures
BS EN 45545 (Series)	Railway applications. Fire protection on railway vehicles
BS EN 50121-2:2017	Railway applications. Electromagnetic compatibility. Emission of the whole railway system to the outside world
BS EN 50121-3-1:2017 +A1:2019	Railway applications. Electromagnetic compatibility. Rolling stock. Train and complete vehicle
BS EN 50121-3-2:2016 +A1:2019	Railway applications. Electromagnetic compatibility. Part 3-2: Rolling stock. Apparatus
BS EN 50121-5:2017+A1:2019	Railway applications. Electromagnetic compatibility. Emission and immunity of fixed power supply installations and apparatus
BS EN 50126-1:2017+A1:2024	Railway Applications. The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS). Part 1: Generic RAMS Process

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BS EN 50128:2011 +A2020	Railway application. Communication, signalling and processing systems. Software for railway control and protection systems
BS EN 50153:2014	Railway applications. Rolling stock - Protective provisions relating to electrical hazards
BS EN 50343:2024	Railway applications. Rolling stock. Rules for installation of cabling
BS EN 50546:2024	Railway applications. Rolling stock. Three-phase shore (external) supply system for rail vehicles and its connectors
BS EN 50553:2012	Railway applications. Requirements for running capability in case of fire on board of rolling stock
BS EN 61287-1:2014	Railway applications. Power converters installed on board rolling stock. Part 1: Characteristics and test methods
BS EN 62625-1:2013+A11:2017	Electronic railway equipment. On board driving data recording system. Part 1: System specification
BS EN IEC 60038:2011	Standard voltages
BS EN IEC 61851-1:2019	Electric vehicle conductive charging system. Part 1: General requirements
BS EN IEC 62196-1:2022	Plugs, socket-outlets, vehicle connectors and vehicle inlets. Conductive charging of electric vehicles
BS EN IEC 62236 series	Railway Applications. Electromagnetic Compatibility
BS EN IEC 62443 series	Security for industrial automation and control systems
BS EN IEC 62864-1:2016	Railway applications. Energy recovery systems for rolling stock
BS EN IEC 62928:2018	Railway applications. Rolling stock. Onboard lithium-ion traction batteries
BS EN ISO 13850:2015	Safety of machinery. Emergency stop function. Principles for design
BS EN ISO 27001:2023+A1:2024	Information Security, Cybersecurity and Privacy Protection. Information Security Management Systems
BS ISO 834-1:2025	Fire resistance tests. Elements of building construction
CLC/TS 50729:2025	Railway applications. Fixed installations and rolling stock. Interface requirements between charging infrastructure with dedicated contact line sections and electric traction units with onboard electric traction energy storages and current collectors
DSEAR L138	Dangerous Substances and Explosive Atmospheres Regulations 2002: Approved Code of Practice and Guidance (L138)
ENA EREC G5/5	Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom
ENE NTSN	Energy National Technical Specification Notice
LOC&PAS NTSN	Locomotives and Passenger Rolling Stock National Technical Specification Notice

PD CLC/TS 50701:2023	Railway applications – Cybersecurity
RDG-OPS-GN-007	Depot Good Practice
SRT NTSN	Safety in Rail Tunnels National Technical Specification Notice
T1375 (2026) [Proposed]	Exploring methods to monitor and model the safety risk of battery trains as they are introduced to the network
TAF NTSN	Telematics Applications for Freight National Technical Specification Notice
TAP NTSN	Telematics Applications for Passenger Services National Technical Specification Notice
The National Cyber Security Centre (NCSC) Cyber Assessment Framework (CAF)	Developed by the National Institute of Standards and Technology (NIST)
The National institute of standards and technology (NIST) framework	Developed by the UK's National Cyber Security Centre (NCSC)
WAG NTSN	Wagons National Technical Specification Notice
UNECE Regulation No. 100	Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train.
Other relevant documents	
BS EN ISO 7010:2020	Graphical Symbols. Safety colours and safety signs