



Strategy for regulation of health and safety risks - chapter 7: Rolling Stock Management

ORR strategy for Rolling Stock Management

How ORR will address this topic:

The industry, regulator, and other stakeholders have well-developed arrangements relating to the management of rolling stock risk. These include regulations, guidance, and standards. With the introduction of new technologies, material developments and changes in operating practices these arrangements continue to develop and evolve.

ORR will continue to use the range of its inspection, enforcement and permissioning powers to influence industry to address the many challenges it faces. The ORR views the following challenges as its main priorities.

ORR Risk Priorities

- increasing demand on rolling stock capacity;
- continued service operation of ageing rolling stock until such time as replacement fleets are available;
- repurposing of existing rolling stock with innovative technologies, which may include the reconciliation of vehicles with grandfather rights against current standards and novel requirements;
- managing and delivering legislative changes and requirements such as meeting the 31 December 2019 deadline for passenger rail vehicles to be accessible;
- delivery of new trains, with over 25 fleets being introduced. The new rolling stock introductions and major refurbishments in process between 2017 and 2022 represent over half of the pre-existing heavy rail passenger rolling stock in Great Britain.
- ensuring that harmonised international vehicle acceptance processes and standards achieve appropriate scrutiny of new designs for operation on the existing UK network;
- developing means of identifying and managing high impact/low frequency scenarios, particularly where these are not directly managed by standards;
- risks associated with introduction and operation of new multi-mode rolling stock or alternative energy sources (such as batteries and hydrogen).
- the introduction/modification of software.
- greater electrification of the network requiring compatible rolling stock; and
- supply chain management.

The introduction of technological improvements such as the European Rail Traffic Management System (ERTMS) and increasing reliance on software-based systems will provide a significant challenge to the industry in terms of modifying rolling stock to accommodate such equipment.

The Entities in Charge of Maintenance (ECM) Regulations are intended to reduce risks associated with the maintenance of vehicles, particularly in respect of freight wagons whose ECMs are required to comply with the criteria in the Regulation and be audited by an independent ECM Certification Body.

Specific to Heritage

The heritage sector continues to grow and by its very nature, the rolling stock is used well beyond its original design life. Maintaining expertise within the sector will be a challenge for the management of antiquated stock.

We will work with industry and regulatory bodies to encourage:

- safety by design, with identified risks being engineered out rather than exported into operational controls;
- focus on the risks that engineering change may adversely affect the integrity of train-borne safety critical systems;
- improved focus on introduction and modification of software and software systems;
- the development and implementation of TSIs so that they support continuous improvement in rolling stock design safety;
- consideration and use of emerging technologies where they can improve all aspects of rolling stock;
- the maintenance of critical design knowledge to ensure risks are managed throughout vehicles' operational lives;
- coherence between original design parameters and overhaul specifications to maintain or improve the safety integrity of components such as final drives;
- review and strengthening of ECM processes.

The class exemption for Mark 1 rolling stock to run without central door locking will not be renewed following expiration in 2023 without significant improvements being made. This has been made clear to the charter and heritage sectors and some operators are already making modifications.

Index of issues discussed

- Introduction
- The law
- Rolling stock issues common to railways:
 - General / Maintenance issues
 - Software
 - Running Gear (including axleboxes and axles)
 - Brakes / adhesion
 - Train doors
 - Freight Wagons
- Heritage

Introduction

1. This chapter is concerned with the actual rolling stock itself, including design issues. It does not consider operational aspects. Tramways issues are discussed in SRC 14.

2. The term rolling stock is used to cover self-propelling trains, traction units, passenger carriages, wagons, and mobile railway infrastructure construction and maintenance equipment. Road-rail vehicles and trams are not considered rolling stock under the interoperability regime.

3. Different parts of the railway system often have different rolling stock challenges and issues to manage. These challenges are heavily dependent on the underlying railway operating systems, which broadly fall into four types of operation depending on the extent of automation of the railway. These are:

- traditional rolling stock is designed and built to be used on railways under the operation of a driver responding to signals;
- traditional rolling stock being used on railways adapted to automatic control of the train, but where a train operator or driver is still in a driving position and manages the platform /train interface, initiates departure and may on occasion be required to drive the train in manual mode;
- 'automatic' rolling stock which has been purposely designed to operate wholly under the control of central control systems and does not normally have a person in the driving position on the train, but may be configured to allow such manual driving in a restricted mode;

- fully automatic systems, such as automated people movers used at airports, where the entire operation of the vehicles is conducted without any on-train staff.

4. The increasing use of automation for vehicle driving functions can result in changed duty cycles for vehicle components, arising from driving algorithms that seek to maximise network capacity. The vehicles used in these systems may therefore exhibit characteristics such as rapid transitions between traction and braking, and repetitive loading on the infrastructure due to each train performing in exactly the same way at any given location. Particular attention needs to be given to modifications to existing rolling stock for automatic operation. The impact of change on the operating dynamics need to be evaluated and understood, such as braking systems where brake wear profiles may change due to the accelerating / braking nature of automatic operations, as this may impact on the maintenance regime of the rolling stock.

5. The safety of rolling stock is managed by the fit for purpose design supported by a robust risk assessment and where required the use of standards. For the mainline GB railway, compliance with some requirements is compulsory through the obligations under the Railways (Interoperability) Regulations 2011 (RIR). The Regulations prescribe the use of European Technical Specifications for Interoperability (TSIs), GB Notified National Technical Rules (NNTRs) where applicable, and a demonstration of compatibility with the GB rail infrastructure.

6. It is important to recognise that if the designer's risk assessment processes are not sophisticated enough to identify gaps; a train that meets the TSI may not be fully safe to operate under operational or geographically driven local constraints/freedoms. The designer should identify and document residual risks that they are proposing to transfer and ensure that the operator/asset owner is fully aware and accepts those risks. Similarly, the train operator needs to conduct a risk assessment at a sufficiently early stage taking into account and if necessary, challenging any risks identified and documented by the designer that are proposed for transfer. This should take into account the conditions and restrictions which they are familiar with but the designer is not.

7. Interoperability legislation requires all new or significantly altered rolling stock in GB to be authorised by ORR before it is placed into service on the GB mainline railway. For rolling stock already authorised in another EU member state, an additional authorisation from ORR for placing into service in GB is not mandatory but may be sought voluntarily. The GB-specific requirements for safety and technical compatibility have to be met whether or not the duty-holder chooses to apply for an authorisation.

8. We have a team of Inspectors dedicated to the oversight of train operators and the rolling stock they operate. A specialist inspection team of professional

engineers supports the ORR Inspectors. The specialist team also provides guidance on the interoperability authorisation process for new, upgraded, and renewed rolling stock.

9. We review industry-monitoring information such as Rail Accident Investigation Branch (RAIB) reports; Urgent Safety Advice (USA) notifications; the national logs and National Incident Reports (NIRs).

10. Where significant issues have been identified, we undertake enquiries. We work with duty-holders to ensure that any shortcomings are addressed by identifying and implementing appropriate remedial actions.

11. We carry out inspections on all operators applying the Risk Management Maturity Model (RM3) principles to benchmark the management systems that underpin the safety assurance of rolling stock. This also allows us to benchmark each organisation against the ROGS criteria used in the assessment of their safety certification and informs our future inspection activities.

The Law

12. Health and Safety legislation relevant to the management of rolling stock assets includes, but is not limited to, the following:

- Health and Safety at Work etc. Act 1974 (HSWA)
- Railway Safety (Miscellaneous Provisions) Regulations 1997
- The Provision and Use of Work Equipment Regulations 1998 (PUWER)
- Management of Health and Safety at Work Regulations 1999
- Railway Safety Regulations 1999 (RSR)
- Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS)
- The Railways (Interoperability) Regulations 2011 (RIR)

13. This legislation places responsibilities on duty-holders to reduce risks to their employees, other workers and members of the public, so far as is reasonably practicable.

14. In addition to the management of health and safety, statutory provisions exist in respect of rail vehicle accessibility. They impose design and operational requirements to make rail vehicles broadly accessible to passengers with a wide range of reduced mobility:

- The Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010
- The Railways (Interoperability) Regulations 2011 (RIR)
- Persons with Reduced Mobility TSI

General / maintenance issues

15. The engineering design of rolling stock should address the majority of risks of using the rolling stock, minimising the need for operational risk controls. The standards framework forms a starting point for a design that is broadly fit for use on the GB network, but it must be accompanied by a clear understanding of the way in which the vehicles will be used. An effective design process will identify and control risks from the start. It has been found that failures in the process can result in risks being identified at a late stage, which can lead to increased cost, poor engineering risk control measures requiring operational procedures to achieve full control of risks, delays to the introduction of the rolling stock, operational restrictions, and possible withdrawal of the rolling stock from service.

16. Most maintenance of rolling stock is governed by the requirements of a vehicle maintenance plan specific to the type of rolling stock. This prescribes maintenance activities and frequencies for the vehicles, although there is potential for variation amongst fleets to reflect specific requirements arising from the service cycles to which the vehicles are subjected. Any revision of Vehicle Maintenance Instructions (VMI) content must be subject to change control processes. Generally, compliance with these maintenance plans has not been a cause for ORR concern.

17. Engineering change is the alteration of the function, performance, physical characteristics or maintenance of a vehicle. It can potentially introduce risks, especially if the wider impacts of the change are not effectively taken into account by the change management process. This can mean physical changes to vehicles (such as changing an on-board signalling system) as well as changes in applied methodology (for example, a shift from time to mileage-based maintenance). Industry should have robust change control processes in place to govern engineering change, to ensure that risk is not imported.

18. Some of the rolling stock in service on the mainline network is nearing the end of, or is beyond, its design life. General maintenance and life extension are areas that will continue to challenge the mainline industry. Whilst the correct maintenance regime can ensure on-going compliance with the vehicle's design standards, older vehicles do not meet current safety performance expectations such as the enhanced crashworthiness required of stock that is more modern. When considering overhaul and life extension work we encourage industry to take the opportunity to examine the practicability of making improvements to the vehicles, especially where concerns have been identified during service.

19. ROGS requires an identified Entity in Charge of Maintenance (ECM) to be responsible for managing the maintenance of railway vehicles and ensure they are in a safe state of running. The European Union Agency for Railways (ERA) proposed that the ECM process should be applied more widely to other types of rolling stock as part of the 4th Railway package. This has now been adopted, Commission

Regulation (EU) 2019/779 came into force on 16th June 2019 and applies from 16th June 2020.”

20. Adopting modern technology can also be a benefit, particularly in relation to proactive and predictive technologies that have the potential to identify and detect failing components well in advance of complete failure. This allows maintenance to be better planned and implemented, in order to reduce in-service failures. We encourage duty-holders to move beyond traditional maintenance practices and consider implementing such technologies.

21. Despite the industry processes for controlling the supply of components and services, a significant proportion of defects reported on rolling stock arise from issues with supplied components, whether from new or following overhaul. This is an area where we are increasingly encouraging duty holders to work more closely with the supply chain to address and formulate longer-term strategies to improve reliability.

Software

22. Modern railway systems are increasingly dependent on software and there have been instances where software changes or modifications have introduced problems to wider train systems. Change needs management at all stages, to identify potential risk and take actions to control the risk including design, installation, commissioning and configuration control of upgrades and patching.

23. Given the experiences and the number of failures recently seen, ORR seeks to ensure the industry builds upon the work carried out by the RSSB High Integrity Systems Group (HISG) and examine the relevant standards. ORR acknowledges this is a complex and dynamic area of technology change. The management of which needs to be improved with skills and competencies in the sector

24. Software interacts with multiple subsystems within and beyond the train itself, interfacing with mechanical and electrical systems. It should therefore be considered in conjunction with the following systems.

Running gear

25. Wheel set systems (axles, axleboxes, bearings and wheels) are a safety-critical part of a rail vehicle: component failure can result in derailment and a high consequence event.

26. Failures of wheel set systems and final drives can arise for a number of reasons including insufficient lubrication, excessive loading, corrosion and poor component assembly. Failure to appreciate the implications of any modifications to original designs can compromise the integrity of the system, which can be challenging when no details of the original design parameters are available.

27. A number of factors can result in overheating of axlebox bearings. This can be a precursor to an axle failure in turn leading to a high consequence event. In order to identify axleboxes that are beginning to overheat, there are on-board hot axle detection systems as well as lineside “hot box” detectors mounted on the railway infrastructure. These systems monitor axlebox temperatures or noise signatures. Work is ongoing in the industry to increase and improve the levels of detection, which will further reduce risk.

28. Train axles are subject to periodic examination to detect potential flaws. Although not seen as a significant problem, our operational intelligence suggests that there may be a shortage of Non Destructive Testing (NDT) axle inspectors available nationally. We are pursuing the industry to ensure that sufficient competent axle inspectors are available if this is the case.

29. Work is also taking place, within Europe and the industry, to consider the human factors associated with axle inspection to ensure competent inspectors are following well-designed practices and processes.¹ There may be arguments for revising design codes such that the safety factors in the axle design do away with the need for in-service inspection, as this has an associated risk of introducing faults to the running gear.

Brakes / adhesion

30. The performance of rolling stock braking systems is critical to the safe operation of the railway. As rolling stock evolves, potential risks need to be identified, understood, and managed.

31. Incidents due to brake equipment/component failure have become uncommon in recent years, although there have been a number of precursor events which have been mainly caused by issues relating to safety critical brake components.

32. Reliable braking performance is likely to become even more important in the move towards the introduction of the European Train Control System (ETCS)². It is essential that there is predictable braking performance to enable the on-train computer to determine safe speeds and thus deliver full automatic train protection (ATP). There is further work to be done to optimise algorithms and ensure that the duty holders apply the system intelligently to maximise benefits.

33. In response to the need to improve adhesion in both traction and braking, the GB rail industry has elected to install on-board sanding systems to mitigate the effects of low adhesion. The desire to increase throughput on some routes and the need for automatic train operation bring challenges to achieve dependable braking.

34. To meet these challenges the industry will need to innovate and understand the impacts of new technologies and systems. Electro-magnetic track brakes and

¹ RSSB - Axle Bearing NIR Investigation, 2014

² <http://www.rail-reg.gov.uk/server/show/nav.2497>

eddy current brakes are alternative braking technologies that are now in use in other European countries.

35. As these technologies develop and more return on experience is gathered from successful implementation, the industry should continue to assess the suitability and viability of these and other approaches to address low adhesion conditions in line with the Rail Technical Strategy. The wider implications of low adhesion is discussed in detail in the interface system safety chapter.

Train doors

36. The two main issues with external train doors are:

- trap and drag incidents where the detection system has failed to detect the presence of an obstruction in the doors and allows the train to move; and
- passengers stepping/falling from incorrectly opened doors.

37. Trap and drag incidents result in injury to and death of passengers. There have been issues with obstacle detection systems on some passenger stock, which have required modifications to door systems. However, a counterpoint to the increasing reliability of door systems is the risk of decreased vigilance on the part of staff responsible for despatching the train, driving the need for further improvements in the engineering controls. ORR will press the industry to look at improvements to door systems where it is reasonably practicable to do so.

38. There have been few reported instances of passengers falling from train doors since the coming into force of the Railway Safety Regulations 1999. These resulted in the introduction of central door locking on slam doors, and the withdrawal of older Mark-1 slam door rolling stock. However, some trains with slam doors may still require a dispatcher to check that doors are fully closed before the train leaves a station, as the on-train systems do not detect the deployment of the door locks.

39. Recently, fatal injuries to passengers who have leaned out of door droplight windows on older rolling stock have occurred. Signs alone are unlikely to be a sufficient mitigation measure given the potential consequences of passengers leaning out of the windows of moving trains. The ORR has written to industry stating that for mainline operators after 31st December 2019 it is considered reasonably practicable to design and install some form of engineering control, such as internal door handles which allow windows to be locked out of passenger use, but to be capable of being unlocked by a guard for dispatch purposes.

40. Passengers may fall from more modern passenger trains if the doors are inadvertently opened on the wrong side at stations. We are pursuing the industry to develop correct side door enable systems.

Freight Wagons

41. The maintenance of wagons, including private wagons, is the responsibility of the ECM. The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) require every wagon in operation on the national network to be registered on the National Vehicle Register (NVR) and have an ECM assigned to it.

42. ECMs of freight wagons (who may be wagon owners and/or keepers) are required to hold a certificate to demonstrate that they are competent to manage and maintain wagons.

43. There has been a slight increase in the number of freight wagon derailments and one of the causal factors has been offset loads within container & hopper wagons that increases the propensity to derail on twisted track.

44. Trackside equipment to identify unequal wheel loading across axles, which can be a precursor to derailment, is being optimised to improve detection of vehicles with potential for offset loading.

45. A pan-industry working group initiated by ORR has been formed to examine this system issue, governing the interaction between wagons, permanent way and wagon loading configuration. We will continue to press for improvements in wagon loading and trackside monitoring equipment to detect and prevent unequally loaded vehicles from importing risk onto the mainline railway.

Heritage

Summary

Many of the mainline issues also apply to the non-mainline heritage sector, although adapted to reflect the largely historical nature of the traction and rolling stock.

Heritage organisations need to be aware of their rolling stock asset condition and have in place an effective health and safety management system to identify and control risk, so far as is reasonably practicable.

Heritage railways generally operate using former main line rolling stock vehicles that require more maintenance than modern rolling stock along with challenges of finding replacement parts.

Maintaining expertise within the sector is an increasing challenge. Whilst the management requirements to ensure safe use of steam and diesel locomotives is generally well understood, the sector's capability to manage the risks associated with the ageing carriage stock is less clear, particularly regarding inspection and maintenance of structural integrity.

Asbestos: All traction and rolling stock from the period up until 1980s contained asbestos. Most locomotives have had it removed but some may still contain it in small areas. The rail sector has a legal duty to ensure it has systems in place to manage the risk asbestos poses to the health of workers and the public.

46. Many of the mainline issues also apply to the non-mainline heritage sector, although adapted to reflect the largely historical nature of the traction and rolling stock.

47. Heritage railways use steam and diesel locomotives, and a small number of battery-powered locomotives. Other than a few replica builds, the newest steam locomotives date from 1964 (standard gauge) and 1971 (narrow gauge, and pre-date current standards). The vast majority built from the 1920's to the 1950's. Diesel multiple units are also popular as a low-cost and convenient way of providing services on heritage lines at quieter times. Some electric rolling stock is also in preservation but its operation is limited to the main line network where the overhead line or conductor rail, as required, is available.

48. In addition to the safety critical parts, such as wheels and brakes etc, steam trains have a boiler, which, as time goes by, requires greater and more expensive maintenance. Heritage railways are required to comply with specific regulations, such as the Pressure Systems Safety Regulations 2000 (PSSR 2000).

49. Diesel traction has become more popular with the withdrawal of main line classes, primarily from the 1960's. Diesel-electric locomotives pose significant electrical hazards, which require staff to be suitably competent – in addition to usual maintenance and operating risks.

50. The heritage sector is supervised using the same principles as other duty holders operating rolling stock and we have an inspection team to perform this work. We use this team to carry out inspections including specific assessments of duty holders' capability to manage rolling stock.

51. **Rolling stock:** The increasing age of the heritage fleet inevitably means that corrosion, wear and fatigue will impact on the ability to maintain vehicles in service without significant repair or replacement of components. Improving detection techniques also help with identifying latent defects existing from manufacture. The introduction of more modern traction & rolling stock, such as Mk 3 coaching stock and Electric Train Supply (ETS) equipped locomotives introduces new risks to the heritage sector, such as high voltage electricity.

52. Maintaining expertise within the sector is an increasing challenge. Whilst the management requirements to ensure safe use of steam and diesel locomotives is generally well understood, the sector's capability to manage the risks associated with the ageing carriage stock is less clear, particularly regarding inspection and maintenance of structural integrity. ORR has raised its concerns with the Heritage Rail Association (HRA), who have accepted this as a high-risk area. We are

supporting the HRA in the creation of a carriage working group, tasked with creating guidance to support the sector manage ageing carriages.

53. The difficulty of obtaining spare parts and the changes to, and availability of, suitable replacement material(s) complicates the situation further. ORR will encourage and work with the heritage industry to develop robust engineering change approaches to managing these issues, particularly in relation to identifying risks from the changes introduced, to ensure that the resulting repair, modification or replacement are effectively controlled.

54. **Asbestos:** All traction and rolling stock from the period up until 1980s contained asbestos. Most locomotives have had it removed but some may still contain it in small areas such as the gland packings, steam brake cylinders, and cubicle arc chutes. Mk1 coaching stock may contain residual 'millboard' next to radiators in compartment stock or asbestos tape / rope around calorifier pipework. Few vehicles contain external / internal insulation between the skins and most steam heat pipework insulation has 'disappeared' over the years.

55. The sector benefits from an exemption to the EU REACH³ regulations allowing them to transfer rolling stock that contains asbestos. However, anyone intending to place an asbestos containing component for use in a railway vehicle or a vehicle containing asbestos onto the market under the REACH exemption must comply with a number of detailed conditions. ORR has a specific web page on Asbestos that links to the REACH exemption.

56. There is a growing trend to build new heritage-style vehicles. These include new builds and the assembly of parts from existing vehicles to form another vehicle. The vehicle must be demonstrated to be safe to use before it enters service. Depending on the intended use of the vehicle, there are a number of approaches to determining the appropriate level of assessment. They include compliance with original standards, comparative assessment and evaluation from first principles.

57. Whilst ORR has no formal role in approving new build vehicles for operation on the heritage networks, we will maintain oversight of them and engage with heritage railways to encourage a level of assessment commensurate with the intended operation. We expect that projects can demonstrate use of approved designs and that change from the original designs are effectively considered and assessed.

³ Registration, Evaluation, Authorisation and Restriction of Chemicals

Glossary of terms	
Acronym	Definition
AsBo	Assessment Body
ATP	Automatic Train Protection
ECM	Entity in Charge of Maintenance
ERA	European Union Agency for Railways
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FOC	Freight Operating Company
HISG	High Integrity Systems Group
HSW	Health and Safety at Work etc. Act 1974
NDT	Non Destructive Testing
NIR	National Incident Report
NNTR	National Notified Technical Rule
NSA	National Safety Authority
ORR	Office of Rail and Road
PUWER	The Provision and Use of Work Equipment Regulations 1998
RIR	The Railways (Interoperability) Regulations 2011
ROGS	The Railways and Other Guided Transport Systems (Safety) Regulations 2006
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RM3	Railway Management Maturity Model
ROSCO	Rolling Stock Leasing Company
RSR	Railway Safety Regulations 1999
TOC	Train Operating Company
TSI	Technical Specification for Interoperability
USA	Urgent Safety Advice
VMI	Vehicle Maintenance Instruction