Rail Industry Standard
RIS-4472-RST
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Engineering Requirements for Steam Locomotives and other Heritage Rail Vehicles

Synopsis

This document sets out the engineering requirements for heritage rail vehicles (including steam locomotives), using a combination of proven, historic design, compliance with specific standards where required for network compatibility and previously accepted rationale for deviations.

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Issue Record

Issue	Date	Comments
One	02/12/2017	Original document. This document sets out the engineering requirements for heritage rail vehicles (including steam locomotives).

This document will be updated when necessary by distribution of a complete replacement.

Superseded Documents

The following Railway Group Standard is superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GMRT2003 issue one Certification Requirements for Registration of Steam Locomotives	5.1.2, 5.1.5, 5.2.1, 5.2.2, 5.2.3	02/12/2017

Supply

The authoritative version of this document is available at www.rssb.co.uk/railway-group-standards. Enquiries on this document can be forwarded to enquirydesk@rssb.co.uk.

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Part 1 Purpose and Introduction

1.1 Purpose

1.1.1 The purpose of this document is to provide a set of engineering requirements and guidance for use by owners, restorers and builders of heritage rail vehicles.

1.1.2 Compliance with the requirements set out in this document are designed to be demonstrated through the use of associated document RIS-2003-RST. Consequently, RIS-4472-RST contains engineering requirements only; the process for scrutinising compliance with these requirements (including competency requirements for undertaking such scrutiny), leading to certification, is set out in RIS-2003-RST.

1.1.3 This document is part of a suite of documents which cover engineering and operational requirements to support the safe operation of heritage rail vehicles and heritage trains on the Great Britain (GB) mainline railway.

1.1.4 Where appropriate, references are made to other standards which contain requirements applicable to heritage rail vehicles.

1.1.5 Guidance under each requirement provides users with information on how the relevant requirement can be interpreted, examples of existing practice and the means by which the requirements can be complied with. In some cases, specific references are included to standards (such as Railway Group Standards) which provide a means to comply with the relevant requirements in this document by following a recognised industry approach.

1.2 Scope and application of RIS-4472-RST

1.2.1 This document applies to the following heritage rail vehicles:

a) Those vehicles already recognised* as ‘heritage’ that continue to operate on the GB mainline railway (*certificated as a ‘heritage’ vehicle and registered on the Rolling Stock Library, subject to periodic absences for planned overhaul activity).
b) Those that have operated over a heritage railway and are to be reintroduced for operation on the GB mainline railway, typically involving an element of upgrading / re-fitment.
c) Those that are to be reintroduced for operation over the GB mainline railway following rebuilding / reconstruction / refurbishment after a prolonged absence (including from scrapyard condition).
d) Replica heritage rail vehicles which have been constructed to former designs (without any significant upgrade to the design).

Note: Even though the new-build aspect removes a key risk consideration (that is, corrosion, wear and fatigue), the issues outlined in *2.2* remain.

1.2.2 For the avoidance of doubt:

a) The construction of a vehicle intended for heritage use but to a completely new design would only be partially covered by the scope of this document, as the design of the vehicle would require scrutiny from first principles as part of any certification work.

b) Any vehicles (including new-build vehicles) only intended for use on heritage lines are outside the scope of this document. However, the content of this document can be useful for a heritage line new-build project, particularly if there is an aspiration to subsequently operate on the GB mainline railway, as it may be difficult to demonstrate compliance retrospectively.

1.3 Application of this document

1.3.1 Compliance requirements and dates have not been specified since these will be the subject of internal procedures or contract conditions.

1.3.2 The Standards Manual and the Railway Group Standards (RGS) Code do not currently provide a formal process for deviating from a Rail Industry Standard (RIS). However, a member of RSSB, having adopted a RIS and wishing to deviate from its requirements, may request a Standards Committee to provide opinions and comments on their proposed alternative to the requirement in the RIS. Requests for opinions and comments should be submitted to RSSB by e-mail to proposals.deviation@rssb.co.uk. When formulating a request, consideration should be given to the advice set out in the 'Guidance to applicants and members of Standards Committee on deviation applications', available from RSSB's website.

1.4 Health and safety responsibilities

1.4.1 Users of documents published by RSSB are reminded of the need to consider their own responsibilities to ensure health and safety at work and their own duties under health and safety legislation. RSSB does not warrant that compliance with all or any documents published by RSSB is sufficient in itself to ensure safe systems of work or operation or to satisfy such responsibilities or duties.

1.5 Structure of this document

1.5.1 This document sets out a series of requirements that are sequentially numbered.

1.5.2 This document also sets out the rationale for the requirement. The rationale explains why the requirement is needed and its purpose. Rationale clauses are prefixed by the letter 'G'.

1.5.3 Where relevant, guidance supporting the requirement is also set out in this document by a series of sequentially numbered clauses and is identified by the letter 'G'.

1.6 Approval and Authorisation

1.6.1 The content of this document was approved by on 05 October 2017.

1.6.2 This document was authorised by RSSB on 03 November 2017.

Part 2 Introduction and Principles for Heritage Vehicles

2.1 Heritage rail vehicles operating on the GB mainline railway

Guidance

G 2.1.1 The following table puts heritage rail vehicles into context with other mainline vehicles.

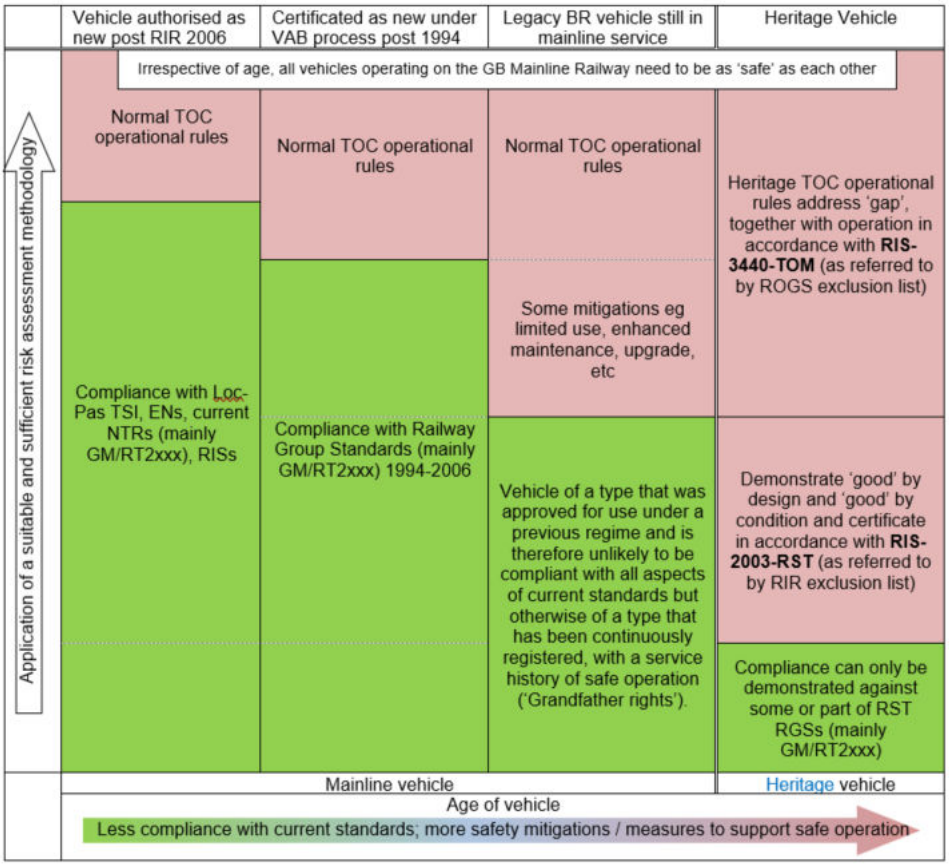

Figure 1: Diagram illustrating the progression towards heritage rail vehicle status

G 2.1.2 Figure *1* illustrates the gradual degradation with age of the degree of compliance with current standards and the corresponding increase in other controls (such as upgrade / rebuild, safety mitigations, and limitations) required in order to support continued safe operation.

2.2 Characteristics of heritage rail vehicles

2.2.1 No longer in mainline service

Guidance

G 2.2.1.1 Figure *1* illustrates the gradual degradation of compliance with current rolling stock standards arising from the continual process of updating or introducing new standards (in some cases aligned to changes in the regulatory environment). The

critical distinction for heritage is to define the moment at which a rail vehicle breaks the link with compliance with current standards, thus making it only suitable for heritage use (without major upgrade work).

G 2.2.1.2 GMRT2000 previously referred to vehicles remaining in mainline service for so long as the type had a continuous service history (the principle of 'Grandfather rights'). The logic behind this is that, for so long as the type remains in mainline service, then there is a collective body of knowledge and experience of the type held between the owner (typically a rolling stock operating company (ROSCO)), operator / maintainer, spare parts supplier, technical support consultancies and – possibly – the original manufacturer. Such a collective body of knowledge and experience supports safe operation in mainline service.

Note: The term 'mainline service' has a specific meaning for which a definition is provided in this document. This stems from the classification of heritage vehicles as non-mainline vehicles within the context of the Railway and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS).

G 2.2.1.3 It is recognised that there are vehicles of a type that can be owned by heritage groups or maintained at heritage locations that still retain their 'Legacy BR vehicle still in Mainline Service' status owing to their continuous registration. This means that they can be used for short-term hire on regular or occasional freight or passenger mainline services and they may be used for heritage services without compromising this status. These vehicles are not regarded as heritage vehicles for the purpose of this document and hence do not operate on the GB mainline railway under the same conditions as a heritage vehicle.

G 2.2.1.4 Once the last of the type has been withdrawn from mainline service, then there is no imperative for any of the above parties to maintain their knowledge of, and support for, the type and it can typically be the case that drawings, maintenance specifications, residual spare parts etc are disposed of, donated to a museum etc. Thereafter, if an entity wishes to operate a vehicle of the type on the GB mainline railway, then there is no collective body of knowledge and experience to support such operations.

G 2.2.1.5 For a type that has finished in mainline service to be subsequently operated as a heritage rail vehicle on the GB mainline railway, the collective body of knowledge and experience effectively transfers to the heritage sector and it is incumbent on the owning group for the vehicle concerned to maintain the knowledge, competence, drawings, maintenance manuals, spare parts etc for their vehicle, possibly liaising with other owners of vehicles of the same type (if they exist). Organisations such as Serco Raildata and the National Railway Museum have copies of old drawings and documentation, but this cannot be relied upon and such documentation may not in fact reflect the current configuration status of the heritage rail vehicle.

G 2.2.1.6 As time moves on, it could be the case that rail vehicles equipped with more modern technology eventually transfer into the 'heritage' category, in which case the sector will need to be conversant with technology such as software integrity, availability of electronic components, modern structural arrangements (monocoque bodyshells), complex bogie suspension arrangements, alternative fuels / power sources etc.

G 2.2.1.7 The alternative to 'heritage only' operation for a type that has finished in mainline service and thus broken its continuous service history is for the vehicle type to be subject to an upgrade or renewal (in accordance with Railway Interoperability Regulations (RIR) Regulation 13) to make it suitable for a further period of mainline service. Such a project would typically involve new design drawings, technical manuals, spare parts and retraining of personnel – thus the collective body of knowledge and experience for the type is re-established. This is outside the scope of this Rail Industry Standard.

2.2.2 Basis of compliance to support safe operation

Guidance

G 2.2.2.1 Heritage rail vehicles are exempt from the RIR, which therefore means the requirements of the associated Technical Specifications for Interoperability (TSIs) do not apply. They are also exempt as vehicles from the ROGS, being categorised as 'non-mainline' vehicles for the purpose of these regulations.

G 2.2.2.2 Compliance with current standards for heritage rail vehicles can be difficult to demonstrate, due to the fact that a vehicle will be a type that was approved for service under the prevailing conditions of the time it was built. Each of the different heritage rail vehicle categories have different issues in this respect, as follows:

a) Steam locomotives were last in mainline service on the GB mainline railway in 1968 and are of a fundamentally different configuration compared to other vehicles - various aspects of compliance with current standards are impractical, because of the bulk and location of the locomotive boiler. Additionally, steam locomotive frames are typically heavily engineered, which makes them incompatible with crashworthiness requirements.
b) Heritage diesel and electric locomotives are of a similar design / configuration to equivalent rail vehicles in mainline service, and there is thus a greater likelihood that they may in fact be able to demonstrate compliance with all or part of prevailing standards. Such vehicles may even have been certificated as compliant prior to withdrawal from mainline service.
c) Heritage passenger vehicles, whilst similar in configuration to other equivalent vehicles in mainline service, can retain features which are not compliant with current standards. Specific issues include the poor crashworthiness of coach body shells and the use of manual door locks on exterior doors. Conversely, it is reasonable to require aspects of the vehicle interior, which are used by the general public, to be compatible with current standards.

G 2.2.2.3 Compliance with current standards may only therefore be necessary to address a specific aspect of technical compatibility to support safe operation (for example, interface with modern signalling systems such as the Train Protection & Warning System (TPWS) or compliance with braking curves to fit signalling distances) or where compliance with current standards is considered to be desirable and achievable. Current standards otherwise may not offer the most efficient basis for a set of engineering requirements for heritage rail vehicles, although they can provide a useful reference set of requirements against which to judge suitability for safe operation.

G 2.2.2.4 RSSB research project T1049 'Operating non-mainline vehicles on mainline infrastructure' provides useful guidance in this area. Clause 1.5 refers to the fact that to operate an existing non-mainline vehicle having a known safety record, it may be sufficient to demonstrate that the vehicle is 'good' in principle by referring to that safety record. This may need to take into account whether the changed infrastructure of the contemporary GB mainline railway invalidates such a principle (for example, new and upgraded electrification systems may have introduced technical incompatibility since the vehicles were in regular use). It also needs to consider any changes made that might affect the original or established design linked to the known safety record.

G 2.2.2.5 The prime consideration is whether a heritage rail vehicle is 'good' in practice; in other words, despite its vintage, whether it is in a condition such that levels of corrosion, wear and fatigue are contained such that it is in a suitable condition for continued mainline operation.

G 2.2.2.6 This document therefore seeks to recognise this situation and sets out an appropriate set of achievable technical criteria based around these principles, which can be summarised as follows:

a) Base design as per the type as previously operated on the GB mainline railway with a proven safety record (taking into account any service modifications).
b) Compliance with current standards (generally as stated in rolling stock Railway Group Standards) where required (typically for technical compatibility or to address a risk which is no longer tolerable on the modern railway) or readily achievable.
c) Demonstration that the vehicle integrity is in a suitable condition for mainline operation, including management of any design changes.

2.2.3 Consequence of heritage rail vehicles only demonstrating limited compliance with current standards

Guidance

G 2.2.3.1 As heritage rail vehicles can only demonstrate limited compliance (to varying degrees) with current standards, it is reasonable to consider what impact this might have when such vehicles are being operated on the GB mainline railway. Whilst the reference to a known safety record for the type can be a suitable basis for operation, there can still be undesirable issues from a point of view of operation on the GB mainline railway such as:

a) Incompatible braking and / or coupling systems (in terms of rescue and recovery).
b) Traction performance (slower acceleration rates, adhesion) that can lead to network disruption.
c) Lack of compatibility with new and upgraded electrification systems.
d) Steam and diesel locomotive emissions (carbon, particulate).
e) General health and safety issues such as cab air quality, noise, vibration dose etc.

Note: This list is not exhaustive.

G 2.2.3.2 Certain aspects in the list set out above can be mitigated with suitable requirements in this document (for example, use of rescue couplings for recovery); certain aspects are not directly addressed by this document but are covered by other legislation (particularly health and safety legislation). For the residual aspects, established practice has been to place limits on the operation of heritage rail vehicles on the GB mainline railway in order to contain the risk. The arrangements for this are addressed in RIS-2003-RST.

2.2.4 Categories of heritage rail vehicle

Guidance

G 2.2.4.1 Heritage rail vehicles are categorised according to the requirements set out in this document and in Table 1 below. Some categories are described by reference to several different parts of this document – for example, a Heritage Multiple Unit is covered by a combination of requirements for a diesel or electric locomotive (according to type) and a passenger-carrying vehicle.

Heritage Rail Vehicle Category	Part 3	Part 4	Part 5	Part 6
Steam Locomotive (TU)	X	X		
Diesel Locomotive (TU)	X		X	
Electric Locomotive (TU)	X		X	
Passenger Vehicle	X			X
Diesel Multiple Unit (TU)	X		X	X
Electric Multiple Unit (TU)	X		X	X
Steam Railmotor (TU)	X	X		X
Freight Wagon	X			
On-Track Machine (TU)	X		X	
Non-powered driving trailer (TU)	X			

Table 1: Categorisation of heritage rail vehicles

G 2.2.4.2 More unusual categories of heritage rail vehicle for operation as a heritage rail vehicle (such as a freight vehicle or an on-track machine) have been included for completeness.

G 2.2.4.3 The phrase 'Heritage Traction Unit' is used in this document to refer to a heritage rail vehicle capable of providing traction power for a heritage train and / or with a driving cab (denoted by 'TU' in Table *2*).

G 2.2.4.4 The following table shows where specific areas of vehicles are covered within this document.

Area of Vehicle	Includes (not exhaustive)	Section
Mainframes / underframe	Main frameplates, stretchers, dragboxes, hornguides, life guards	*3.1*
Bogies / trailing trucks	Bogie frame, pivot, centre casting, bolsters, swing links / centralising springs, side bearers, pony trucks	*3.1*
Suspension	Springs, dampers, friction links, torsion bars	*3.1*, *3.4*
Buffers and couplings	Automatic couplers, intermediate couplings; for example, loco-to-tender drawbar coupling for a steam locomotive	*3.1*
Lifting and jacking points		*3.1*
Underbody equipment	Battery boxes, gas boxes, fuel tanks, water tanks, control equipment boxes, lids / covers / doors / catches	*3.1*, *6.4*
Bodywork	Bodyside panels, structural members, cladding, doors, windows, gangways, tender tanks	*3.1*, *6.1*
Wheelsets	Axle load, wheel centres, axles, tyres, cranks and pins, eccentrics, gear wheels	*3.2*, *3.3*
Bearings	Axleboxes, pedestals	*3.3*
Brakes	Ejector, air pump, reservoirs, brake control valves, pipework, brake cylinders, brake linkage, brake blocks	*3.1*, *3.6*

Area of Vehicle	Includes (not exhaustive)	Section
Audibility and Visibility	Whistle / horn, headlight, marker / tail lights	*3.7*
Driving cabs and controls	Access doors, layout of controls, windscreens (inc. wipers, washers, heaters, and de-icers), power controllers, gauges	*3.1*, *3.8*
Safety systems	Automatic Warning System / Train Protection and Warning System (AWS/TPWS), On Train Monitoring Recorder (OTMR), Global system for Mobile Communications - Railway (GSM-R) and Radio Electronic Token Block (RETB)	*3.9*
Electrical safety	Bonding, Electromagnetic Compatibility (EMC), Overhead Line Equipment (OLE) protection	*3.10*
Boiler	Boiler barrel, firebox, smoke box, grate, ashpan, stays, tubes, superheater and elements, steam pipes, chimney and exhaust, injectors, fusible plugs, safety valves, pressure gauges, water gauges	*3.1*, *4.1*
Steam locomotives cylinders	Piston and valve liners	*3.1*, *4.2*
Motion and valve gear	Piston and valves, crosshead and slide bars, reverser	*3.1*, *4.2*
Diesel engine	Engine mountings, cooling systems, exhaust	*3.1*, *5.1*

Area of Vehicle	Includes (not exhaustive)	Section
Current collection	Pantographs, shoegear, current return brushes	*3.1*, *5.2*
Main generator / alternator		*3.1*, *5.3*
Electrical transformer		*3.1*, *5.3*
Traction motors	Electric motors, brush boxes, hydraulic motors	*3.1*, *5.4*
Transmissions and final drives	Drive shafts, gearboxes, fluid couplings	*3.1*, *5.4*
Vehicle interior (fittings)	Internal doors, seats, tables, toilets, catering equipment (cookers, boilers, water systems), fuel supplies (liquified petroleum gas (LPG))	*6.3*
Vehicle interior (systems)	Heating, lighting, passenger communication apparatus, alarms	*6.4*
Lubrication system	Wheelset bearings, steam locomotive motion and valve gear	*3.3*, *4.2.3*

Table 2: Areas of a heritage rail vehicle and where they are covered in this document

Part 3 Requirements for all Heritage Rail Vehicles

3.1 Overall vehicle condition

3.1.1 Introduction to overall vehicle condition

Guidance

G 3.1.1.1 This section generally applies to all areas of heritage rail vehicles, including main frames, bogies and body structure; detailed requirements for specific aspects are outlined in the subsequent sections. All build, re-build, restoration, overhaul and on-going maintenance work therefore needs to follow the requirements and guidance in this section.

3.1.2 Historic design of the vehicle

3.1.2.1 The proven, historic design of the heritage rail vehicle shall be defined.

Rationale

G 3.1.2.2 This requirement reflects the principle outlined in *2.2.2*, being the basis of compliance to support safe operation, that is, whether it is of a configuration / type known to be 'good' by design. It provides the basis for certification under RIS-2003-RST.

G 3.1.2.3 In a similar manner to a ROSCO owning a fleet of mainline vehicles, it is incumbent on the owner of a heritage rail vehicle to understand the engineering design features and configuration of their vehicle(s); this is regarded as part of the collective body of knowledge and experience that is referred to in *2.2.1*.

Guidance

G 3.1.2.4 The proven, historic design of a heritage rail vehicle can typically be defined by reference to drawings, specifications, modification instructions, part numbers, performance characteristics, to a sufficient level of detail so as to avoid any uncertainty. In some cases, photographs may be sufficient to confirm aspects of the design.

G 3.1.2.5 The content of an Engineering Condition Report, as set out in RIS-2003-RST, contains examples of relevant historical information which can be used to define the proven, historic design.

G 3.1.2.6 The proven, historic design can include the fitment of additional equipment found necessary during the service life of the type. An example would be the fitment of train detection devices for multiple unit types that were otherwise unable to reliably operate track circuits. Continued fitment of such devices as a heritage rail vehicle is considered to be part of the proven, historic design (unless otherwise demonstrated that such equipment is no longer necessary).

3.1.3 Condition for continued mainline operation

3.1.3.1 Corrosion, wear and fatigue effects shall be controlled such that the heritage rail vehicle is in a suitable condition for continued mainline operation, taking into account the planned nature of the current and future operations.

Rationale

G 3.1.3.2 This requirement reflects the principle outlined in *2.2.2*, being the prime consideration as to whether the vehicle is 'good' in practice; in other words, despite its vintage, the effects of corrosion, wear and fatigue are contained such that they do not compromise the overall integrity of the vehicle.

Guidance

G 3.1.3.3 Heritage rail vehicles contain components and sub-assemblies which, by their very nature, are likely to have considerable corrosion, wear and fatigue history. Such components and sub-assemblies can already have reached the limit of their theoretical design life. Where such components are critical to the overall structural integrity of the vehicle then any malfunction, breakage or detachment as a result of excessive corrosion, wear and fatigue could lead to a significant incident such as derailment and / or collision. There may also be obsolescence issues to be addressed (for example, the use of asbestos gasket seals is no longer appropriate).

G 3.1.3.4 Repairs undertaken and replacement parts fitted during previous operation of the vehicle can contribute towards the overall structural integrity of the vehicle. In some cases, a replacement part fitted as new during its original service life can have removed the effects of corrosion, wear and fatigue hitherto built up for that particular component; conversely, a repair undertaken towards the end of a vehicle's service life may not have been to a standard that would support operation beyond the vehicle's expected design life.

G 3.1.3.5 Major overhaul / repairs, refurbishment and / or rebuild typically provide the most appropriate opportunity to inspect the condition of critical components and structures, including stripping down to enable thorough examination of main load-bearing structural components. Further requirements and guidance for the maintenance of heritage rail vehicles is given in *Part 7*.

G 3.1.3.6 Operating a heritage rail vehicle below its design capability (for example, at a slower speed, lighter trains) can be a valid approach to reducing the ongoing effects of corrosion, wear and fatigue.

G 3.1.3.7 By their very nature, new-build heritage rail vehicles, featuring all new structures and components are largely free from the effects of corrosion, wear and fatigue.

3.1.4 Repairs and replacement parts

3.1.4.1 Any repairs to the components and / or structure of a heritage rail vehicle or replacement parts fitted shall not compromise the integrity of the current vehicle condition.

Rationale

G 3.1.4.2 Where corrosion, wear or fatigue damage is excessive, undertaking a repair or fitting a replacement part is typically the most appropriate way to return the vehicle back to a suitable condition for continued mainline operation. However, if such a repair or replacement part is not in accord with the proven, historic design then it could inadvertently introduce an undesirable effect that compromises the integrity of the current vehicle condition (for example, fitting a stronger part than the original may move a 'weak point' to an undesirable area).

Guidance

G 3.1.4.3 Previously recognised / proven repair techniques, using original grades of materials (or their modern equivalent) and recognised methods of fixings or specifying a replacement part against the original design specification maintains the proven, historic design of the vehicle and therefore addresses the risk identified by this requirement. Any variation from this is considered to be a design change for which the requirements are outlined in clause *3.1.5*.

G 3.1.4.4 The fitment of any replacement parts manufactured from new is generally preferable to sourcing an already used part (for example, from a donor vehicle); however, the latter approach can typically be the most practical approach. A degree of examination / testing (for example, non-destructive testing (NDT)) may be necessary to confirm the structural integrity of replacement parts sourced as second hand and that they are not worn beyond recognised limits or suffering from excessive corrosion.

G 3.1.4.5 When procuring replacement materials, parts or services, the degree of assurance offered by the supplier of such products can be critical. Requirements for supplier assurance are set out in RIS-2750-RST.

3.1.5 Engineering change to a heritage rail vehicle

3.1.5.1 Where engineering change is undertaken to a heritage rail vehicle, the proven, historic design shall not be adversely affected in such a way as to compromise the overall integrity of the vehicle as fit for safe operation on the GB mainline railway.

Rationale

G 3.1.5.2 Engineering change has the potential to introduce a hazard, however inadvertently. There may be sound or unavoidable reasons for fitting additional equipment or modifying the existing vehicle (for example, replacement of obsolescent equipment or the reconfiguration of a vehicle's underframe structure to accept air-braking equipment, replacement of plain bearings with roller bearings); however, if the engineering change is not undertaken in accordance with recognised good practice, then it could lead to a risk that the vehicle is not in a suitable condition for continued mainline operation.

Guidance

G 3.1.5.3 Engineering change is considered to be any alteration made to critical components and structures that can adversely affect the overall integrity of vehicle condition and lead to an unsafe situation. This includes use of alternative components or grades /

types of material as well as actual modification to the configuration of the rail vehicle (for example, fitting of additional equipment for compatibility purposes).

G 3.1.5.4 It can be the case that seemingly trivial changes can nevertheless introduce significant risk (for example, changing the type of fasteners used for equipment suspended from the vehicle underframe).

G 3.1.5.5 Notwithstanding the risks addressed by this requirement, use of modern materials, components and manufacturing techniques can improve the overall integrity of a heritage rail vehicle (for example a welded assembly for a previous cast assembly, use of huck bolts instead of rivets etc). Use of prevailing standards when designing such changes can provide an opportunity to move a vehicle closer towards compliance with current standards.

G 3.1.5.6 Established methods and processes for scrutinising and certificating engineering changes to heritage rail vehicles are set out in RIS-2003-RST and are designed to be used in conjunction with this document.

3.1.6 Retention of heritage records

Guidance

G 3.1.6.1 Retention of relevant records associated with repairs, replacement parts and engineering change is recognised good practice and can assist with confirming the vehicle integrity whenever requested (for example, for subsequent certification or incident investigation).

G 3.1.6.2 Typical records supporting repair, replacement or engineering change can include but are not restricted to:

a) Material quality certificates.
b) Repair / welding procedures.
c) Heat treatment reports.
d) Test records (NDT and / or metallurgical).
e) Competency records for critical activities (for example, welding).
f) Final inspection / completion 'sign off' sheets.

3.2 Track interaction and gauging

3.2.1 Vehicle data for gauging compatibility

3.2.1.1 The gauging portfolio (or equivalent) for the heritage rail vehicle shall be available.

Rationale

G 3.2.1.2 Vehicle gauging information is required for route compatibility assessment before vehicles are put into use on the GB mainline railway.

Guidance

G 3.2.1.3 Requirements for vehicle gauging are set out in GMRT2173. This requires a gauging portfolio to be available to allow the dynamic swept envelope of the vehicle to be

determined. If a gauging portfolio for a heritage rail vehicle can be derived directly using the methods set out in GMRT2173, then this makes route compatibility assessment work in accordance with GERT8270 more straightforward.

G 3.2.1.4 Steam locomotives can contain features which require specific consideration when undertaking a gauging assessment. Appendix *C* of this document provides a methodology for undertaking a gauging assessment in such cases.

G 3.2.1.5 Where the heritage rail vehicle is equipped with pantographs or collector shoes, these form part of the gauging portfolio in both the operational and stowed position.

G 3.2.1.6 Standard vehicle reference gauges are set out in GEGN8573.

G 3.2.1.7 RIS-2773-RST provides a format for vehicle gauging data.

3.2.2 Static load characteristics for route availability

3.2.2.1 Principal dimensions and weights of a heritage rail vehicle

3.2.2.1.1 The principal dimensions and weights of a heritage rail vehicle(s) in working order shall be available in a recognised format.

Rationale

G 3.2.2.1.2 Vehicle weight and axle spacing dimensions are required in order to assess route availability as part of the assessment of compatibility with the infrastructure of the GB mainline railway at route level.

Guidance

G 3.2.2.1.3 Requirements for assessment of compatibility of rail vehicle weights are set out in GERT8006. This requires rail vehicle data to be established to allow assessment of compatibility to be determined.

G 3.2.2.1.4 RIS-2003-RST requires heritage rail vehicles to be subject to wheel weighing to either re-confirm or determine individual wheel loads in the following circumstances:

a) Following overhaul / rebuild.
b) Modifications affecting weight.

G 3.2.2.1.5 The following instances can also affect the weight distribution of a vehicle leading to a need to undertake wheel weighing (this is particularly the case for steam locomotives and other heritage rail vehicles using leaf springs):

a) Incident involving derailment.
b) Spring replacement.
c) Transport by low loader.

Note: This list is not exhaustive.

G 3.2.2.1.6 Any modification that significantly reduces the weight of a vehicle and / or weight distribution can increase the risk of derailment or roll-over in gales (as set out in GMRT2142). This has not traditionally been an area of concern for heavier vehicles such as steam locomotives.

3.2.2.2 Route Availability (RA) number for heritage rail vehicles

3.2.2.2.1 All heritage rail vehicles shall have a declared RA number.

Rationale

G 3.2.2.2.2 RA information is required as part of the train planning process, as described in RIS-3440-TOM.

Guidance

G 3.2.2.2.3 Requirements for determining RA are set out in GERT8006.

G 3.2.2.2.4 RIS-2003-RST includes the requirement to confirm vehicle data including RA number during certification work.

G 3.2.2.2.5 The historic RA number for the heritage rail vehicle is not always the same as that calculated in accordance with GERT8006.

G 3.2.2.2.6 Modifications which alter the weight of the heritage rail vehicle can affect its RA number.

3.2.3 Train detection and monitoring systems

Guidance

G 3.2.3.1 Reliable train detection is required in order for the signalling systems to function safely. Traditionally, heritage rail vehicles (especially locomotives) are characterised by higher axle loads and / or a larger number of wheels in contact with the running rails, as well as use of tread brakes; as a result, train detection has never been an issue. Fitment of devices such as track circuit actuators has been typically required for low axle load multiple units fitted with disc brakes.

G 3.2.3.2 Requirements for compatibility with train detection systems in terms of vehicle size and position of axles are set out in GMRT2173 section 3.3. GMRT2461 Part 2, sets out requirements for sanding and train detection.

Note: The requirements as stated regarding minimum axle spacing for non-bogie vehicles were intended for On-Track Machines (OTMs) and are not compatible with steam locomotives.

Note: Requirements for interaction with signalling systems, such as AWS/TPWS, are set out in 3.8.

3.3 Wheelsets and bearings

3.3.1 Construction and integrity of heritage wheelsets and bearings

3.3.1.1 Overall construction and integrity of heritage rail vehicle wheels, axles and bearings shall be in accordance with recognised industry standards.

Rationale

G 3.3.1.2 Wheelsets and associated equipment are one of the principal safety-critical features of a rail vehicle, with the risk of a significant incident arising from failure of such components, such as derailment or damage to the vehicle or infrastructure. Compliance with recognised standards is therefore critical to support safe operation.

Guidance

G 3.3.1.3 Requirements for rail vehicle wheelsets are set out in GMRT2466, from which other related standards are referenced.

G 3.3.1.4 Steam locomotives are characterised by wheelsets consisting of a variety of diameters, usually of spoked construction, with tyres fitted. Aspects of these arrangements are either at variance with or not covered by GMRT2466. Common domain document MT276 contains the established requirements for steam locomotive wheels.

G 3.3.1.5 There can be instances where aspects of recognised industry standard cannot be complied with or are not desirable. For example, being a common domain document (last updated in 1990), MT276 is known to contain errors and inconsistencies. In such cases, established practice is for alternative approaches to be supported by a suitable and sufficient risk assessment; the requirements of *3.1.4* may also provide a solution.

G 3.3.1.6 Being heritage rail vehicles, wheelset components and sub-assemblies are likely to have considerable fatigue and/or corrosion history. As indicated in Table *2*, the requirements of section *3.1* are also applicable to wheelsets in terms of the management of existing designs and ongoing integrity of components.

G 3.3.1.7 Certain designs of steam locomotive feature intermediate driving wheels without a flange. Due to the risk from contact with raised checkrails introduced since the end of steam traction in mainline service on the GB mainline railway, the use of such locomotives on the GB mainline railway would require a specific risk-based justification to support their operation as part of the certification process, as set out in RIS-2003-RST.

G 3.3.1.8 Wheels were typically stamped by the original manufacturer which can give an indication as to their provenance.

G 3.3.1.9 The industry standard for suppliers of wheelset components and wheelset assembly for use on rail vehicles operating on the GB mainline railway is to be RISAS-approved (formerly GMRT2470).

3.3.2 Crank pins and crank axle assembly

Guidance

G 3.3.2.1 Where power is transmitted to the wheels via crank pin connections, these critical components are subject to high cyclical forces which can result in excessive wear. Any defect arising can lead to catastrophic failure of associated components (such as connecting rods), leading to risk of derailment.

G 3.3.2.2 Steam locomotives equipped with inside cylinders (located between the mainframes) transmit the drive through a crank arrangement (typically a forging or a built-up assembly) that is integral to the axle of the wheelset concerned.

G 3.3.2.3 Major overhaul / repairs, refurbishment and / or rebuild provides an opportunity for all crank pins and crank axle assemblies to be subject to thorough examination of interference and keyed fits. Use of NDT can confirm continued integrity where this cannot otherwise readily be determined.

3.3.3 Wheel tread profiles for heritage rail vehicles

Guidance

G 3.3.3.1 The interaction of the wheel tread on the rail head is the key interface that prevents derailment. Recognised wheel tread profiles that provide stable ride and robust derailment resistance have been established through many years of service experience.

G 3.3.3.2 Recognised wheel tread profiles are set out in Appendix A of GMRT2466. This includes the reference to Common Domain document MT276 for steam locomotives.

G 3.3.3.3 Any change of use to an unproven wheel tread profile is an issue for novelty and proving dynamics. Although this is considered unlikely for a heritage application, section *3.4* provides methods and guidance.

3.3.4 Bearings and lubrication for heritage rail vehicles

Guidance

G 3.3.4.1 A satisfactorily functioning lubrication system is vital to the safe operation of wheelsets and bearings. Any failure can lead to degradation of axle condition and ultimately derailment risk.

G 3.3.4.2 Operation over new and upgraded electrification systems can include the electric current flow in bearings, which can give rise to increased bearing degradation, even on non-electric vehicles.

G 3.3.4.3 Requirements for hot axlebox detection are set out in GERT8014. Due to their typical configuration (for example, inside axleboxes and other external heat sources, for example, ashpan and cylinders) steam locomotives are regarded as exempt from the requirements of GERT8014 as it is impractical to shield such sources of heat without impairing the locomotive operation or causing gauge infringements.

3.4 Vehicle ride

3.4.1 Any modification to parameters affecting the ride of an existing heritage rail vehicle shall be subject to one or more of the validation methods set out in *3.4.7* to *3.4.13*.

Rationale

G 3.4.2 Suspension arrangements and other related factors can contribute to vehicle ride and derailment resistance, including:

a) Removal or addition of equipment affecting the centre of gravity of the vehicle.
b) Replacement or adjustment of suspension components and suspension arrangements.
c) Wheel balancing.

G 3.4.3 Any such changes have the potential to adversely affect the established ride performance of the heritage rail vehicle, leading to possible derailment risk.

Guidance

G 3.4.4 Requirements relevant to vehicle ride are set out in the following documents:

a) GMTT0088 Permissible Track Forces for Railway Vehicles.
b) GMRT2141 Resistance of Railway Vehicles to Derailment and Roll-Over.

G 3.4.5 Steam locomotives have relatively low un-sprung mass and Q/D ratio, when compared with diesel locomotives fitted with axle hung traction motors, but give rise to 'Hammer-blow' effects due to the combined effects of the rotating masses (side rods and reciprocating motion) and the reciprocating masses (piston rods and little end of connecting rods). Hammer-blow is typically mitigated by adjusting the degree of balancing fitted to or within the wheels, but there can be a trade-off between this effect and an undesirable yawing motion. Adoption of a front bogie arrangement for higher-speed locomotives to aid steering into curves was generally sufficient to deliver a stable ride.

G 3.4.6 Validation of vehicle ride is a complex subject and Appendix *A* outlines typical topics for consideration. For this reason, engagement of a recognised industry expert in the subject is strongly recommended for all but very routine changes.

Compliance method

3.4.7 Certain modifications may be proven by calculation in accordance with recognised standards. Confirmation of compliance with requirements shall be demonstrated by provision of validated calculations.

3.4.8 The recognised standards set out in *G 3.4.4* are generally aligned to the ride characteristics of modern rolling stock and therefore may be of limited assistance to heritage rail vehicles, especially steam locomotives.

Comparison method

3.4.9 A modification may be justified by comparison with a similar modification in a different application (for example, to a similar rail vehicle of a different class). Confirmation of suitability shall be demonstrated by provision of a documented and risk-based justification, using proven arguments and rationale.

3.4.10 Comparison arguments can be subjective, and factors that affect vehicle ride in terms of both similarities and differences can easily be overlooked or over-simplified.

Modelling method

3.4.11 Computer modelling programs (such as Vampire®) may be used to investigate and validate the ride performance of a modified heritage rail vehicle. Confirmation of

suitability shall be demonstrated by provision of a report in industry-recognised format.

Testing method

3.4.12 On-track testing may be used to validate the ride performance of a new, reintroduced or modified heritage rail vehicle. Typically, this would be on the GB mainline railway. Confirmation of suitable ride performance shall be demonstrated by provision of a testing report in industry-recognised format.

3.4.13 Recognised practice is for any proposed testing to be supported by the output from one of the methods set out above (so as to provide confidence for the operation of the vehicle under test); alternatively, testing at a heritage line may provide sufficient initial confidence to support subsequent mainline testing as part of a staged process.

3.5 Heritage rail vehicle speed

3.5.1 Maximum speed for the type

3.5.1.1 The maximum speed for a type of heritage rail vehicle shall be based on the established maximum speed for the class / type where this is known (see *3.5.3*). For steam locomotives, the maximum speed limits for each type currently, recently or likely to operate over the GB mainline railway are set out in Appendix *D*.

Rationale

G 3.5.1.2 The speed at which a rail vehicle is operated at is the primary control whereby dynamic behaviour can be contained to an acceptable level. For electric traction units this includes consideration of the dynamic behaviour of the current collector to the contact line.

Guidance

G 3.5.1.3 The maximum speed for the type is regarded as the theoretical safe maximum speed of operation. This does not imply that any heritage rail vehicles of that type have to be operated at that speed.

G 3.5.1.4 In the case of steam locomotives, the speeds quoted are generally lower than the historical maximum recorded speed to allow for a safe engineering margin. A further allowance is made in Appendix *D* for tender-first operation.

G 3.5.1.5 Locomotives running 'light engine' are required to run at a reduced speed due to inadequate braking capability (explained in *3.6*), but this does not affect the maximum speed for the type as it is an operational requirement.

G 3.5.1.6 In the case of steam locomotives, some of the speeds quoted in Appendix *D* differ (by either 5 mph or 10 mph) from the speeds previously quoted in RIS-3440-TOM. This is due to the original version of that document (GORT3440) being introduced as a ‘rapid response’ standard at the time and the speed limits have never been subject to subsequent refinement prior to the introduction of this document.

3.5.2 Maximum speed limit for an individual heritage rail vehicle

3.5.2.1 The maximum speed limit for an individual heritage rail vehicle shall be any speed lower than or equal to the maximum speed for the type, as determined through the independent process of certification set out in RIS-2003-RST.

3.5.2.2 Where no pre-determined maximum speed can be identified to a type of heritage rail vehicle, then the maximum speed for the type shall be determined as follows:

a) For a steam locomotive, a submission shall be provided to the RSSB RST SC for inclusion in Appendix *D*.
b) For all other types of heritage rail vehicles, an appropriate combination of the various methods outlined in *3.4* shall be used, together with an assessment of braking capability, overseen by an independent certification body in accordance with RIS-2003-RST.

Rationale

G 3.5.2.3 This requirement is designed to take into account the condition / integrity of an individual heritage rail vehicle, which can be different to other vehicles of the type.

Guidance

G 3.5.2.4 Reasons why a maximum speed for a heritage rail vehicle can be lower than the maximum speed for the type might include:

a) Vehicle of an increasing vintage such that operation at the maximum speed for the type would not be appropriate.
b) Vehicle in a degraded state (which may be temporary) but otherwise in a suitable condition to operate over the GB mainline railway at a reduced speed.
c) Voluntary lower speed in order to protect the condition of the vehicle.

G 3.5.2.5 In the case of steam locomotives, with the introduction of this document, the maximum speed for some types has been increased by either 5 mph or 10 mph. This does not imply automatic alteration of the currently certificated maximum speed of operation of any particular steam locomotive so affected; the requirements for altering the maximum speed in this case are set out in *3.5.3.1*.

G 3.5.2.6 The maximum speed does not necessarily reflect maximum speeds for train timing, which are generally lower for recovery purposes. This is set out in RIS-3440-TOM.

3.5.3 Increased speed limits

3.5.3.1 Increase up to maximum speed for the type

3.5.3.1.1 Any increase to the current speed limit of a heritage rail vehicle up to the maximum speed for the type shall be overseen by an independent certification body in accordance with RIS-2003-RST.

Rationale

G 3.5.3.1.2 The maximum speed of operation is part of the vehicle data kept in R2, and its alteration may only be undertaken following the application of an appropriate

certification process. For heritage rail vehicles, the appropriate certification process is set out in RIS-2003-RST.

Guidance

G 3.5.3.1.3 It can be the case that the existing maximum speed for the heritage rail vehicle is lower than the maximum for the type, due to previous concerns of the condition of the vehicle which have since been addressed. Alternatively, the maximum speed for the type might have been amended (for example upon first publication of this document, where the maximum speed for some types of steam locomotives has been amended compared to the previous version in RIS-3440-TOM).

G 3.5.3.1.4 Typical rationale for considering an increase in operational speed up to and including the maximum speed for the type include the current physical condition / integrity of the heritage rail vehicle under consideration. Whilst the more rigorous methodology in *3.5.3.2* is generally not necessary for this requirement, an element of testing might be undertaken to support such an increase in speed. Also, some of the considerations identified in *G 3.5.3.2.4* can be relevant.

3.5.3.2 Increase above the maximum speed for the type

3.5.3.2.1 Any increase to the current speed limit of a heritage rail vehicle above the maximum speed for the type shall the undertaken in accordance with Appendix *B*, supported by the output from the application of an appropriate combination of the various methods outlined in *3.4*. This shall be overseen by an independent certification body in accordance with RIS-2003-RST.

Rationale

G 3.5.3.2.2 Operation of a heritage rail vehicle above the maximum speed for the type is considered to take the vehicle outside the principles outlined in *2.2.2*. Hence it is considered reasonable that the requirement is for the use of contemporary industry methods.

Guidance

G 3.5.3.2.3 There can be examples where the operation of a heritage rail vehicle at a greater speed is justified. This might include:

a) Vehicle of wholly or substantially new build, thus eliminating some of the typical risks associated with the operation of heritage rail vehicles (for example, fatigue, corrosion etc).
b) The established maximum speed of operation of a heritage rail vehicle can be readily demonstrated as unnecessarily restrictive.

G 3.5.3.2.4 Operation at a speed greater than the maximum speed for the type will logically rely on additional mitigations, commensurate with the degree of speed increase being contemplated. Examples can include:

a) Fixed rather than portable headlamp (see *3.7.1*).
b) Temperature monitoring for axle bearings (dynamic for a higher degree of speed increase).

c) Effects of out-of-balance forces (especially steam locomotives) at higher speeds.
d) Lower shelf bracket for buckeye fitted vehicles where not already fitted.
e) Upgraded current collection equipment.
f) Additional data channels for data recorders.
g) NDT examination of steam locomotive motion and valve gear parts to demonstrate their suitability to withstand additional loads.
h) Audibility of horn / whistle.
i) Effectiveness of the brake control system.
j) Forward-facing windscreens compliant with current standards.

Note: This list is not exhaustive.

3.5.4 Indication of maximum speed in the cabs of heritage traction units

3.5.4.1 The maximum permitted speed of operation of a heritage traction unit shall be clearly indicated in the driving cab(s) and be readily visible from the normal driving position. For steam locomotives of engine-tender configuration, the maximum permitted speed of operation when running tender first shall also be indicated.

Rationale

G 3.5.4.2 This is a standard arrangement in the cabs of all mainline traction units. In the case of heritage traction units, which may not have features such as automatic power shut off above maximum permitted speed, this requirement is considered to be a key mitigation to the risks arising from operation at excessive speed.

Guidance

G 3.5.4.3 There is no guidance associated with this requirement.

3.6 Braking

3.6.1 Power brake

3.6.1.1 All heritage rail vehicles shall be equipped with a power brake capable of continuous and automatic operation when coupled to other vehicles in a train formation.

Rationale

G 3.6.1.2 Braking is an area where there are limited opportunities for deviation against the applicable standards as a heritage train operating over the GB mainline railway must be capable of complying with the relevant braking curve(s) in relation to signal spacing and operational speed.

Guidance

G 3.6.1.3 Requirements for rail vehicle braking systems are set out in GMRT2045.

G 3.6.1.4 The braking performance required for heritage passenger trains is as set out in GMRT2045 at 2.3.3.5 a). GMRT2045, Figure 2, shows the appropriate stopping

distances for passenger trains. GMRT2045, Figure 1, applies on mixed traffic routes, and hence takes into account the reduced braking performance for freight trains.

G 3.6.1.5 It is important to recognise that the braking performance of a train is determined by the combined effect of all the vehicles in the train. A locomotive on its own is generally not capable of braking its own weight from line speed; hence, a train consisting of a locomotive hauling a rake of coaches requires proportionally greater braking performance from the coaches being hauled. The primary role of the locomotive is to send an efficient brake signal down the train.

G 3.6.1.6 Short locomotive-hauled formations need to have lower speed limits due to reduced braking performance. This is set out in GMRT2045.

G 3.6.1.7 Steam locomotives of engine-tender configuration are considered to be two separate vehicles in the context of this requirement.

3.6.2 Types of brake system

3.6.2.1 Brake systems in use and the control of them on heritage rail vehicles shall be those that have proved to be safe and reliable in operation on the GB mainline railway and for which driver familiarisation and continuity of product support does not constitute an unacceptable risk.

Rationale

G 3.6.2.2 This requirement reflects the principles outlined in *2.2.1* and *2.2.2*; in other words, a combination of a brake system known to be 'good' by design and capable of being supported by the heritage sector if otherwise no longer in use on the GB mainline railway. If either of these conditions are not fulfilled, then there is a risk of inadequate braking performance leading to a collision scenario.

Guidance

G 3.6.2.3 The principles of operation of the current friction braking systems in use on the GB mainline railway are set out in Appendix J of GMRT2045. This does not include the vacuum brake system.

G 3.6.2.4 The vacuum brake system is now recognised as only being actively used on the GB mainline railway by the heritage sector. The principles of its operation are explained in GMRT2045 issue four, Appendix C.6 – although a withdrawn document, this version of GMRT2045 remains available for reference. It is therefore incumbent on the heritage sector to maintain the collective body of knowledge and experience of the vacuum brake system, including maintenance / operational training and supply of the component parts.

G 3.6.2.5 Notwithstanding the fact that the vacuum brake system is now only actively used by the heritage sector, tread-braked passenger vehicles were designed to meet a common standard, and the current stopping curves shown in GMRT2045 Figure 2 were derived from full size tests carried out with a vacuum-braked train in the 1970's (in conjunction with widespread introduction of multiple aspect signalling). Hence, a vacuum-braked passenger train is expected to give the same performance as an equivalent air-braked train as set out in GMRT2045 2.3.3.5 a) and Figure 2.

G 3.6.2.6 Some steam locomotives are fitted with steam driven air pumps to generate a supply of compressed air to enable use with air-braked passenger vehicles. A risk arising from this is the contamination of associated brake equipment, air piping and hoses leading to a loss of efficiency in the braking system. Such systems typically include oil and water separating devices to mitigate this risk; a reference is included in the guidance to *7.1* as a specific item to consider within the maintenance arrangements.

G 3.6.2.7 The Rail Accident Investigation Branch (RAIB) investigation into the incident at Wootton Bassett on 07 March 2015 (Report reference 08/2016) recommended that current standards specifically consider the likelihood or magnitude of overruns caused by braking systems not designed to meet modern standards of performance. The content of this section 3.6.2 are intended to address this recommendation.

3.6.3 Brake control system interlock with traction

3.6.3.1 Where the operation of a heritage rail vehicle is intended for one person in the cab only then a traction interlock feature shall be provided.

Rationale

G 3.6.3.2 On certain types of heritage traction units (particularly steam locomotives), brake applications do not interrupt traction power. It is accepted that generic mitigations for the operation of heritage traction units (for example, more than one person in the cab) provide adequate protection against this risk.

Guidance

G 3.6.3.3 BR legacy diesel or electric traction units were typically fitted with an automatic air brake pipe (AABP) governor interlock to the traction power system; newer vehicle types typically have a contact in the relay that confirms continuity of the 'round train circuit' on an electrically coded emergency brake system. Both of these systems (and variants of them) enable compliance with this requirement.

G 3.6.3.4 For steam locomotives, the power control of the locomotive is operated by a mechanical lever, (regulator handle) which regulates the steam supply from the boiler. It is fundamentally different to the relatively simply arranged interlock arrangements described in *G 3.6.3.3*. To achieve brake control system interlock with traction, a novel system would have to be designed, tested, and provide the required levels of safety and reliability.

G 3.6.3.5 The proportion of tractive effort to brake force is significantly weaker on a steam locomotive compared to diesel or electric traction units; hence, a brake demand can be relatively effective even if traction power (initially) remains applied.

3.6.4 Emergency brake command

3.6.4.1 Heritage traction units shall be configured such that it is possible for an authorised person other than the driver to activate an emergency brake application.

Rationale

G 3.6.4.2 This requirement is intended for heritage traction units where operation is covered by the mitigation of more than one person in the cab. In such circumstances, persons other than the driver need to be capable of bringing the train to a safe stand in the event of an incident or emergency (as set out in RIS-3440-TOM).

Guidance

G 3.6.4.3 GMRT2045 F.5 gives guidance on the emergency brake command. In addition to the example quoted of an emergency brake command feature in a non-active cab (diesel or electric traction unit), a separate emergency brake valve (or equivalent) in the cab of a steam locomotive would meet the intent of this requirement.

3.6.5 Parking brake

3.6.5.1 A parking (hand) brake shall be fitted and operational where this was a feature of the original design.

Rationale

G 3.6.5.2 A parking brake feature is required so that a heritage train or rake of heritage rail vehicles can safely be stabled temporarily on a running line during the normal course of operations.

Guidance

G 3.6.5.3 Typically, all heritage traction units and vehicles incorporating a guard's area are fitted with a parking (hand) brake.

G 3.6.5.4 *3.11* includes the requirement for recognised emergency and recovery equipment to be provided (for example, wheel scotches) for degraded situations where a parking (hand) brake may not be available or sufficient / adequate.

3.7 External lights and other visible / audible warning devices

3.7.1 External lights

3.7.1.1 All heritage traction units shall be fitted with a fixed headlamp capable of displaying 'Day time' ('Full beam') and 'Night time' ('Dimmed') settings; as an alternative, a lamp bracket capable of mounting a portable headlamp shall be fitted. In the latter case, speed of operation is limited to 75 mph.

3.7.1.2 Heritage traction units (other than steam locomotives) shall be fitted with marker and tail lamps capable of display appropriate to their direction of operation and position in a train formation.

3.7.1.3 Where fitted, all external fixed lamps fitted to heritage diesel and electric traction units and to steam locomotives for operation in excess of 75 mph shall be capable of being operated from the cab of the heritage traction unit, with a visual indication of the setting of each lamp.

Rationale

G 3.7.1.4 Visibility and audibility is an area where there are limited opportunities for deviation against the applicable standards, as a heritage train operating over the GB mainline railway needs to be clearly visible / audible and recognisable as a train to members of the public and trackside staff, particularly during the hours of darkness and in reduced visibility.

Guidance

G 3.7.1.5 Requirements for visibility are set out in GMRT2131. GMRT2131 section 3.7 sets out the requirements for steam locomotives based on existing operating practice at the time of publication of that document (December 2015). At that time, the maximum permitted speed of operation of steam locomotives on the GB mainline railway was 75 mph. The requirements in this section 3.7.1 take into account that this RIS includes a process whereby steam locomotives can be operated in excess of 75 mph. GMRT2131 section 3.8 sets out the requirements for portable headlamps.

G 3.7.1.6 In the case of steam locomotives, the lamp bracket required by GMRT2131 section 3.7 is intended to be fitted at both ends of the locomotive such that a portable tail lamp can be attached when running light engine.

3.7.2 Front end colour

3.7.2.1 Heritage traction units (other than steam locomotives) shall comply with GMRT2131 section 3.9.

Rationale

G 3.7.2.2 Visibility and audibility is an area where there are limited opportunities for deviation against the applicable standards, as a heritage train operating over the GB mainline railway needs to be clearly visible / audible and recognisable as a train to members of the public and trackside staff, particularly during the hours of darkness and in reduced visibility.

Guidance

G 3.7.2.3 The exemption from front end colour is a long-standing exemption for steam locomotives. Of specific note, is the generally lower operating speed, and the presence of the smoke and steam emissions from the locomotive chimney, which are an alternative aid to visibility.

3.7.3 Horn or whistle (audible warning device)

3.7.3.1 All heritage traction units shall have a whistle or horn fitted – as a minimum this shall be in accordance with the original design.

Rationale

G 3.7.3.2 Visibility and audibility is an area where there are limited opportunities for deviation against the applicable standards, as a heritage train operating over the GB mainline railway needs to be clearly visible / audible and recognisable as a train to members of

the public and trackside staff, particularly during the hours of darkness and in reduced visibility.

Guidance

G 3.7.3.3 Full compliance with the requirements of GMRT2131 is otherwise not mandatory.

3.8 Driver's cab and controls

3.8.1 Audibility within and visibility from driver's cab

3.8.1.1 New or modified equipment affecting visibility and audibility

3.8.1.1.1 Any new or modified cab equipment for a heritage traction unit shall be situated within the cab such that forward visibility and in-cab audibility is not adversely affected compared to the proven, historic design.

Rationale

G 3.8.1.1.2 Audibility within and visibility from drivers' cabs is a key requirement for safe operation of rail vehicles. It is acknowledged that forward sighting from the cabs of heritage traction units can be sub-optimal (particularly for steam locomotives, because of the bulk and location of the boiler), so the intention of this requirement is that any changes do not make the situation appreciably worse.

Guidance

G 3.8.1.1.3 Requirements for audibility / visibility in drivers' cabs are set out in the following documents:

a) GMRT2160 Environment Inside Railway Vehicles (Audibility of detonators).
b) GMRT2161 Requirements for Driving Cabs of Railway Vehicles.

G 3.8.1.1.4 The requirement for a minimum of two persons in the cab of a steam locomotive who are rules-trained to driving standard is an established mitigation for risks arising from restricted audibility / visibility.

G 3.8.1.1.5 Assistance with audibility and visibility may be provided using suitable indicators (for example, AWS flashing light).

3.8.1.2 Driver's cab windscreen

3.8.1.2.1 Any predominantly forward-facing window shall be regarded as a windscreen.

Rationale

G 3.8.1.2.2 Protection for traincrew against the consequences of projectile impact on forward-facing windows is considered to be an area where the requirements are equivalent to those for traincrew on mainline services.

Guidance

G 3.8.1.2.3 Requirements for windscreens are set out in GMRT2100 (Part 5).

G 3.8.1.2.4 The consequence of projectile impact on forward-facing windows increases according to the speed of operation. A lower speed of operation can therefore be a suitable mitigation for older designs of windscreen that cannot demonstrate compliance with current requirements.

3.8.2 Cab ergonomics, controls and instruments

3.8.2.1 Controls and instruments for heritage traction units

3.8.2.1.1 All heritage traction units shall have appropriate controls and instruments fitted to enable safe operation – as a minimum these controls and instruments shall be in accordance with the proven, historic design (except where any such controls are now obsolete).

Rationale

G 3.8.2.1.2 Appropriate controls and instruments are required to enable drivers of heritage traction units to perform their duties safely and effectively, as defined by the Rule Book and other working instructions.

Guidance

G 3.8.2.1.3 Requirements for cab ergonomics, controls and indicators are set out in the following documents:

a) GMRT2161 Requirements for Driving Cabs of Railway Vehicles (Part 7).
b) GMRT2162 Traincrew Access to and Egress from Railway Vehicles.
c) GMRT2176 Air Quality and Lighting Environment for Traincrew Inside Railway Vehicles.

G 3.8.2.1.4 GMRT2161 defines ‘Appropriate controls and instruments’ as being arranged and operated in a logical and functional manner, to maximise driver effectiveness and minimise errors.

G 3.8.2.1.5 Not all steam locomotives were originally fitted with a speedometer. It is now considered reasonable for these devices to be fitted in all normal situations. An exception might be the one-off use of a heritage rail vehicle on the GB mainline railway where other mitigations are in place.

G 3.8.2.1.6 In the case of steam locomotives it is acknowledged that the nature of coal firing creates an inherently dirty and contaminated environment, although the open nature of the cab provides a significant amount of fresh ventilation. Steam locomotives are typically fitted with a ‘slaker’ pipe (or equivalent) to minimise the amount of coal dust.

G 3.8.2.1.7 It is good practice for controls and instruments to be clearly marked with unambiguous descriptions where their function might otherwise be unclear or could be confused with other controls and instruments.

3.8.2.2 Driver alertness equipment for heritage traction units

3.8.2.2.1 Where the operation of a heritage traction unit is intended for one person in the cab only, then systems shall be fitted to monitor the alertness of the driver and initiate an emergency brake application if the driver becomes incapacitated.

Rationale

G 3.8.2.2.2 This is an established requirement for mainline traction units, which typically feature only one person in the cab and is designed to automatically bring the train to a stand if the driver becomes incapacitated. Given the typical speed of operation of heritage trains on the GB mainline railway it is considered reasonable for this requirement to apply to heritage traction units if they are intended for operation by one person only.

Guidance

G 3.8.2.2.3 Requirements for train safety systems for monitoring the alertness of the driver are set out in GMRT2185.

G 3.8.2.2.4 The presence of more than one rules-trained person in the cab of a heritage traction unit is an established mitigation for heritage traction units not fitted with systems for monitoring the alertness of the driver.

3.8.3 Internal lighting

3.8.3.1 Cab lighting, suitable to illuminate critical controls and gauges, shall be provided for use at night-time and other low ambient lighting conditions (for example, tunnels).

Rationale

G 3.8.3.2 Illumination of critical controls and gauges such as speedometers, boiler water level and brake pressures is essential to ensure safe operation of heritage traction units.

Guidance

G 3.8.3.3 This requirement may be satisfied by provision of a suitable portable lighting device with at least eight hours lighting performance (on charged or new batteries). Alternatively, or in addition, certain types of cab controls and instruments may be provided with built-in illumination or adjacent, directed illumination.

3.8.4 Vehicle number and other operational data

3.8.4.1 Heritage rail vehicles shall display their identification number on the exterior to each side of the vehicle. Additional operational data shall be displayed or alternative means used to provide access to this information.

Rationale

G 3.8.4.2 Data displayed on rail vehicles enables authorised personnel to ensure safe rail operations when national operating systems such as Total Operations Processing System / Train Running Under System Tops (TOPS / TRUST) are unavailable.

Guidance

G 3.8.4.3 Requirements for data to be displayed on vehicles are set out in GMRT2453.

G 3.8.4.4 Steam locomotives typically display their historic number on the exterior of the cab, together with basic data information for the locomotive indicated in the cab, including TOPS number, together with the locomotive's maximum speed.

G 3.8.4.5 Heritage rail vehicle support crew members will typically be able to provide any relevant vehicle data in the event of an incident. Alternatively, or in addition, it can be helpful to have copies of current certification and registration documentation (as generated through the processes set out in RIS-2003-RST) available for reference.

G 3.8.4.6 As heritage rail vehicles are exempt from the requirements of the RIR, then there is no requirement to display a 12-digit European Vehicle Number.

3.9 Train safety systems

3.9.1 Train safety systems for heritage traction units

3.9.1.1 The following train safety systems shall be provided on heritage traction units:

a) TPWS and AWS.
b) GSM-R voice radio.
c) Data recorder.

Rationale

G 3.9.1.2 Train safety systems is an area where there are limited opportunities for deviation against the applicable standards, as a heritage train operating over the GB mainline railway requires to be compatible with the safety systems fitted to the network to ensure safe operation.

Guidance

G 3.9.1.3 Requirements for train safety systems are set out in the following documents:

a) GERT8075 AWS and TPWS Interface Requirements.
b) RIS-0794-CCS GSM-R Train Voice Radios.
c) GMRT2472 Requirements for Data Recorders on Trains.

G 3.9.1.4 Use of a portable radio can provide a solution to the requirement for a GSM-R train voice radio. However, it is less desirable than fixed equipment as it cannot be registered and requires the capability to send and receive railway emergency calls (RECs) if it is to be adopted as a permanent solution for a particular heritage traction unit.

G 3.9.1.5 In the case of steam locomotives, which are of a fundamentally different configuration to diesel / electric traction units, equivalent arrangements can meet the intent of the requirements for data recorders (for example, recording of steam chest pressure can give a good indication of traction power applied).

3.9.2 Isolation devices

3.9.2.1 Isolation devices associated with train safety systems shall be locked such that they cannot be activated whilst a heritage train is in motion.

Rationale

G 3.9.2.2 Train safety systems are provided as a key protection to ensure safe operation of trains. Overriding of such systems by activation of an isolation device is only intended once the train is safely at a stand and the circumstances that has caused the train safety system to intervene have been appropriately investigated.

Guidance

G 3.9.2.3 This requirement refers to the principal isolation device for the train safety system concerned. Fitment of tamper-proof seals to other associated devices is established good practice.

G 3.9.2.4 GERT8075 sets out requirements that can be used to control the risk arising from incorrect driver response to a TPWS activation.

G 3.9.2.5 The RAIB investigation into the incident at Wootton Bassett on 07 March 2015 (Report reference 08/2016) identified that inappropriate use of the AWS isolation device was a causal factor of the incident.

3.9.3 Other train safety systems

Guidance

G 3.9.3.1 Requirements for in-cab signalling ETCS for heritage traction units are to be included in the National Operating Systems Specification (NOSS) with the intention being that, when the national fitment programme is undertaken, the requirements for heritage traction units will be in the NOSS. GERT8402 sets out requirements for displaying mph on the ETCS Driver Machine Interface (DMI) and also for using alphanumeric train reporting numbers. Future fitment of ETCS to heritage traction units will be on the basis of maintaining technical compatibility with the GB mainline railway only, due to the fact that heritage rail vehicles are exempt from RIR and the associated TSIs.

G 3.9.3.2 When heritage traction units are scheduled to run on lines where trip cocks are required, this is typically controlled by special arrangements with the infrastructure manager (IM) concerned (for example, London Underground).

G 3.9.3.3 GKGN0554 Guidance on Radio Electronic Token Block (RETB) describes the features of the RETB systems for those routes on the GB mainline railway so fitted. Use of portable devices, as described in GKGN0554, is an established method for heritage trains operating on these routes.

Note: At the time of publication of this document, GKGN0554 requires updating to reflect the upgraded systems currently being implemented in Scotland.

G 3.9.3.4 The use of mobile telephones or hand-held radios enables direct communication between the vehicle cab and the on-train operational staff. Unless originally fitted,

there is otherwise no requirement for a permanent 'On Board' communication system between the driver and guard.

3.10 Electrical safety

3.10.1 Safe integration of all heritage rail vehicles with electrification systems

3.10.1.1 Heritage rail vehicles shall provide precautions of sufficient strength and current-carrying capability to discharge electrical energy to prevent danger arising from electrification fault current.

Rationale

G 3.10.1.2 Safe integration with electrification systems is an area where there are limited opportunities for deviation against the applicable standards as all rail vehicles operating over the GB mainline railway must provide adequate protection against electrification fault currents. The only alternative to support an operation if the requirements cannot be met would be to arrange for the electrification to be de-energised whilst transiting an electrified section of route; this is only considered practical for limited, one off situations.

G 3.10.1.3 Modern electrification systems contain greater power compared to previous eras when heritage rail vehicles would have originally been in service. For this reason, the electrical safety arrangements of the proven, historic design might not be sufficient without modification to increase capacity to protect against fault currents.

Guidance

G 3.10.1.4 Requirements for electrical safety precautions of rail vehicles operating under or over modern electrification systems are set out in:

a) GMRT2111 Part 2 and Appendix D, which set out the requirements for OLE warning lines, previously set out in GMRT2181.
b) GMRT2111 Part 2 and GMRT2113 Part 2, which set out the requirements for equipotential bonding, previously set out in GMRT2304.

Note: Compliance with GMRT2111 and GMRT2113 does not necessarily fully address the requirements of the Electricity at Work Regulations 1989. Health & Safety Executive HSR25 provides assistance to comply with the Electricity at Work Regulations 1989.

G 3.10.1.5 Historic designs of steam locomotives have not traditionally featured fitment of bonding between frames and wheelsets of a steam locomotive (which would otherwise provide a fault current path back to the running rails). This can expose axle bearings to fault currents which could result in bearing damage. However, the presence of multiple current paths and limited exposure to the network could be used for justification for not fitting earth bonds, providing the electrical requirements are achieved.

G 3.10.1.6 Proven modifications to address the risk associated with operation of steam locomotives whilst under OLE include fitment of ground level filler pipes and step guards on the rear of the tender (watering of tenders), mesh screens over cab roof ventilators and guards to prevent access to tender coal space.

G 3.10.1.7 GMRT2111 exempts steam locomotives from the need to fit an OLE Warning Line; however the requirement to fit warning signs relating to the overhead electrification system, as stated in the document, is considered to be relevant to all steam locomotives.

G 3.10.1.8 DC overhead contact line operating at 750 V or 1500 V exists on some parts of the GB mainline railway and more may be installed in the future.

3.10.2 Vehicle electrical systems

Note: The requirements for compatibility between an electric traction unit and the electrification supply systems are set out in *5.3*.

3.10.2.1 Heritage rail vehicles shall provide adequate protection from the risk of shock from interior electrical systems.

Rationale

G 3.10.2.2 Protection of traincrew and passengers from electrical shock is considered to be an area where the requirements are equivalent for vehicles used on mainline services.

Guidance

G 3.10.2.3 Requirements for electrical protection within rail vehicles are set out in GMRT2130 Part 6 (this gives the references for safety signs, which includes electrical safety signage).

G 3.10.2.4 Electrical systems on a rail vehicle can give rise to risk from electric shock if not suitably protected. Protection arrangements will be defined as part of the proven historic design; however, applicable legislation such as the Electricity at Work Regulations can require additional arrangements over and above the proven, historic design. An additional risk arises from the degradation of electrical cabling insulation due to advanced vintage.

G 3.10.2.5 A steam locomotive is fundamentally a mechanically-based machine; what electrical systems exist are of a safe low voltage design and / or battery powered systems (for example, AWS/TPWS) and hence do not pose any risk in terms of electric shocks.

3.10.3 Electromagnetic compatibility

3.10.3.1 The electromagnetic emissions from heritage rail vehicles shall be limited to levels which do not create a hazard to the safe operation of infrastructure systems and equipment.

Rationale

G 3.10.3.2 The electromagnetic emissions from a heritage rail vehicle will be defined as part of its proven historic design. However, risks can arise from any changes in infrastructure systems and equipment (including signalling and telecommunications equipment). These effects can be incremental as such systems are developed.

G 3.10.3.3 Risks can arise if an engineering change is undertaken to a heritage rail vehicle which affects its existing emission levels.

Guidance

G 3.10.3.4 Requirements for electromagnetic compatibility between trains and railway infrastructure are set out in GERT8015 Electromagnetic Compatibility.

3.11 Other requirements affecting all heritage rail vehicles

3.11.1 Environmental conditions

3.11.1.1 Where originally designed, the following features shall be fitted and operational:

a) Sanding systems to assist traction and braking in low adhesion conditions.
b) Cold weather prevention measures (winterisation) to ensure essential systems continue to function in periods of snow and ice.

Rationale

G 3.11.1.2 Adverse environmental conditions can cause operational difficulties; in extreme situations these have caused wrong-side failures of critical systems such as brakes.

Guidance

G 3.11.1.3 There is no guidance associated with this requirement.

3.11.2 Emergency and recovery equipment

3.11.2.1 Heritage rail vehicles shall carry recognised equipment and appropriate supporting information used to assist emergency and recovery operations.

Rationale

G 3.11.2.2 Emergency and recovery is an area where there are limited opportunities for deviation against the applicable standards, as a heritage train operating over the GB mainline railway can potentially be involved in an operational incident in a similar way to a mainline service train.

Guidance

G 3.11.2.3 Requirements for emergency and recovery are set out in the following documents:

a) GMRT2100 Lifting, Jacking, Recovery and Emergency Movement of Rail Vehicles (Part 9).
b) GMRT2130 Requirements for Emergency and Safety Equipment (Part 5), supported by GMRC2532.

G 3.11.2.4 GMRT2130, Part 5, sets out the requirement for (six) wheel scotches to be provided for air-braked locomotive-hauled trains. This requirement is considered to be equally valid for vacuum-braked locomotive-hauled heritage trains.

G 3.11.2.5 GMRC2352 sets out a list of emergency and recovery equipment mandated by GMRT2130 (such as detonators), together with other equipment (such as first aid equipment). The determination of what equipment is required to be carried and where may be determined in consultation with the heritage train operator. This can

include the requirement to carry any equipment required to assist with the timely recovery/rescue of vacuum-braked locomotives and rolling stock in the event of an incident.

G 3.11.2.6 Aspects of this requirement can be met by the carrying of recognised equipment in the guard's or brake compartment of a vehicle within a heritage train. Some heritage traction units regularly operate with a support vehicle which includes such equipment.

G 3.11.2.7 Recovery techniques are subject to the breakdown and recovery procedures for the Network Rail-nominated recovery agent (currently DB Cargo Ltd). Heritage rail vehicles can contain unique or unusual features which may require specialist equipment / information to assist efficient recovery from the GB mainline railway. Information can be made readily available through consultation with the owner's representative on site.

G 3.11.2.8 Large diameter wheels of steam locomotives are not compatible with wheel skates. Steam locomotives are not prone to 'seized axle' type of incidents (requiring the use of a wheel skate), compared to diesel / electric locomotives fitted with traction motors. Dis-assembly of steam locomotive coupling / connecting rods to aid out-of-service movement is a routine procedure. It can also be possible to relieve the spring loads and pack under the axleboxes of the axle concerned to lift the wheels just clear of the rails to facilitate a recovery move.

Part 4 Specific Requirements for Steam Locomotives

4.1 Steam locomotive boilers

4.1.1 Introduction to steam locomotive boilers

Guidance

G 4.1.1.1 A steam locomotive's principal source of power is the boiler, typically operating at pressures between 180 and 250 psi depending upon the design of the locomotive. Typically, these are coal fired, although oil firing has occasionally been used historically. The principal critical risk is that of boiler explosion.

4.1.2 Existing Boilers

4.1.2.1 Existing boilers and associated equipment shall be subject to an agreed written scheme of examinations and inspection.

Rationale

G 4.1.2.2 As an item of pressure equipment identified under the Pressure Systems Safety Regulations (PSSR) 2000, a steam locomotive boiler is required to be managed in a safe manner and inspected periodically by a Competent Person.

Guidance

G 4.1.2.3 The safe management of steam boilers is governed by a 'Written Scheme of Examination', as required by PSSR.

G 4.1.2.4 Typically, the Competent Person referred to in the rationale statement works on behalf of an engineering inspection body, recognised by a boiler insurance company.

G 4.1.2.5 The safe operation of a steam locomotive boiler depends on associated equipment such as safety valves, injectors, pressure gauges and water level indicators.

G 4.1.2.6 It is good practice for boilers to employ a recognised boiler feed water treatment system to reduce the effects of corrosion and other internal damage and hence prolong boiler life.

G 4.1.2.7 RIS-2003-RST Appendix B contains details of independent examination of boilers to support periodic re-certification of steam locomotives for operation on the GB mainline railway.

G 4.1.2.8 *8.1.2* outlines competence requirements for the on-going maintenance and repair of steam locomotive boilers and highlights the role of an appointed person within, or affiliated to, the locomotive owning group to co-ordinate the work necessary. This includes the maintenance of suitable records including: steaming dates, washouts, examinations, details of repairs and the extent of maintenance carried out.

G 4.1.2.9 All boiler components and associated equipment are considered to be safety critical and, as such, the requirements set out in section *3.1.3* to *3.1.5* of this document apply when undertaking repairs, replacement and modifications. Any significant repairs

that materially affect the proven, historic design of a boiler can fall under the scope of the Pressure Equipment Regulations 1999.

G 4.1.2.10 Further information on the management, maintenance and repairs of steam locomotive boilers is available from the following sources:

a) Heritage Railway Association (HRA) Guidance Documents.
b) ORR guidance RSP6 – Management of Steam Locomotive Boilers.
c) MT276 Examination Schedule for Preserved Steam Locomotives (Common Domain document).

4.1.3 New boilers

4.1.3.1 The design and construction of any new steam locomotive boiler (including any associated safety accessories) shall be subject to Notified Body (NoBo) certification under the Pressure Equipment Regulations 1999.

Rationale

G 4.1.3.2 The Pressure Equipment Regulations 1999, require a NoBo to certificate new items of pressure equipment above certain volumetric and pressure criteria; boilers for mainline steam locomotives fall into this category.

Guidance

G 4.1.3.3 New boilers can be constructed based on historic designs. However, there may be sound reasons for revising the design in order to use modern materials and assembly methods which better align with prevailing regulations.

G 4.1.3.4 The Pressure Equipment Regulations define safety accessories as devices designed to protect pressure equipment, including devices for direct pressure limitation. In the case of a steam locomotive boiler, this includes safety valves and fusible plugs.

4.2 Steam locomotive cylinders, motion and valve gear

4.2.1 Introduction to steam locomotive cylinders, motion and valve gear

Guidance

G 4.2.1.1 Steam locomotives are characterised by various moving motion parts which transmit traction forces and control valve gear events. These are subject to high inertia and cyclical loads whilst typically containing plain (white metal) bearing surfaces. There is therefore a risk of a significant incident arising from violent breakage or detachment of such components leading to risk of derailment or damage to the vehicle or infrastructure or injury to adjacent persons.

G 4.2.1.2 Generally, heritage steam locomotives in the UK are fitted with either Stephenson's or Walschaert's valve gear, the risks of which are well known and understood. The greater risk therefore lies with less common types of valve (for example, poppet valves or chain driven valve gear), for which the challenge of maintaining the

collective body of knowledge and experience (as set out in *2.2.1*) is correspondingly greater.

4.2.2 Repairs, replacement and modification

Guidance

G 4.2.2.1 Cylinders, motion and valve gear are considered to be safety-critical equipment and, as such, the requirements set out in section *3.1.3* and *3.1.5* of this document apply when undertaking repairs, replacement and modifications.

G 4.2.2.2 The incident at Winchfield on 23.11.13 (RAIB report reference 13/2014, June 2014) highlighted the inherent risks associated with the modification of the design of existing steam locomotive motion and valve gear components.

G 4.2.2.3 Notwithstanding the risks involved, there may be sound reasons for modifying the existing design in order to use modern materials and assembly methods, for example, fabricated rather than cast cylinders.

4.2.3 Lubrication system

Guidance

G 4.2.3.1 A satisfactorily functioning lubrication system is vital to the safe operation of steam locomotive cylinders, motion and valve gear. Many valve gear components traditionally use cork stoppers (with a cane breather) to retain the bearing oil in the reservoir.

G 4.2.3.2 There can be sound or justifiable reasons for modifying the lubrication system or changing the type of lubricant (for example 'rape oil' no longer has its previous high-grade boundary lubrication properties). *3.1.5* sets out the need to consider consequential effects of such modifications.

4.3 Fire safety performance for steam

4.3.1 Steam locomotive shall be fitted with suitable spark arrestor devices to control cinder and ash emissions from both the chimney and the ash-pan.

Rationale

G 4.3.2 A steam locomotive’s source of power is a fire, typically using coal as its fuel, stored in an open tender. There are therefore inherent risks associated with fire, including uncontrolled emissions which can lead to lineside fires (when conditions are dry), which can cause damage to the infrastructure.

Guidance

G 4.3.3 The condition of related features such as ash-pan, hopper doors and smokebox can contribute to the effectiveness of spark arrestor devices.

G 4.3.4 Steam locomotives are generally regarded as only able to demonstrate limited compliance with GMRT2130 (Part 2) due to their fundamentally different configuration.

Part 5 Specific Requirements for Heritage Diesel and Electric Locomotives / Multiple Units

5.1 Compliance with Standards

5.1.1 Heritage diesel and electric traction units shall comply with relevant industry standards where required for compatibility purposes and otherwise where reasonably practical.

Rationale

G 5.1.2 The overall configuration of heritage diesel and electric traction units can be similar to other diesel and electric traction units currently in mainline service whose continued operation is supported by the relevant industry standards. Hence, the proven, historic design of a heritage diesel or electric traction unit can contain features that are either compliant with current industry standards or, with little additional work, could be made compliant without adversely affecting the proven, historic design. Where compliance is required for compatibility purposes, this is set out in *Part 5*.

Guidance

G 5.1.3 The following sections *5.2* to *5.6* identify the relevant industry standards for the specific safety-critical areas of heritage diesel and electric traction units not already covered in *Part 3*.

G 5.1.4 Repairs, replacement and modification to safety-critical equipment of heritage diesel and electric traction units introduces risk and, as such, the requirements outlined in sections *3.1.3* to *3.1.5* apply.

5.2 Diesel engines

Guidance

G 5.2.1 A diesel locomotive or multiple unit's principal source of power is the diesel engine. The principal critical risk is that of catastrophic engine failure resulting in crankcase explosion / fire or a connecting rod puncturing the engine casing.

G 5.2.2 Requirements applicable to diesel engines are set out in GMRT2130, specifically Part 2 (fuel systems, emergency stop devices) and Part 3 (engine exhaust).

G 5.2.3 The safe operation of a diesel engine depends on associated equipment such as cooling and lubrication systems, governors and engine protection devices.

G 5.2.4 It is not expected that existing diesel engines fitted to heritage traction units will meet modern emissions regulations. The limit on operation is considered to be an adequate mitigation (see principle of non-compliance in *2.2.2*); however, any reasonable opportunity to improve emissions performance will lessen the degree of non-compliance.

5.3 Electric power supply

5.3.1 Heritage electric traction units shall be compatible with the electrical power supply system for the intended routes of operation.

Rationale

G 5.3.2 An electric locomotive or multiple unit's principal source of power is from an external supply, either by pantograph(s) in contact with the overhead lines at 25 kV AC or shoegear in contact with a third rail at 750 V DC. The principal critical risks are de-wirement of the pantograph or flashover, overload or insulation failure incidents leading to fire; the latter risk can arise if the vehicle's bonding, circuit breakers and electrical traction equipment are incompatible with the power supply system.

G 5.3.3 The capability of the electrical power supply system may have increased since the heritage rail vehicle was previously in service on the GB mainline railway. Issues for consideration include:

a) System voltage operating range.
b) Fault current levels and clearance times.
c) Circuit breaker rating.
d) Pantograph or collector shoe type (including number in use and spacing).
e) Electrical clearance.
f) Changes in neutral section design.
g) Vehicle bonding and fault current carrying capacity.
h) Effective touch potentials.
i) Electrical damage to bearings.

Guidance

G 5.3.4 Requirements for compatibility with GB electrification systems are set out in:

a) GMRT2111 and associated guidance document GMGN2611, which cover interfaces with AC overhead lines.
b) GMRT2113 and associated guidance document GMGN2613, which cover interfaces with DC conductor rails.

Note: Compliance with GMRT2111 and GMRT2113 does not necessarily fully address the requirements of the Electricity at Work Regulations 1989.

5.4 Transformers and generators

Guidance

G 5.4.1 Diesel or electric traction units can use electrical machines such as generators and transformers (including contactors) to create traction power. The principal critical risk is that of severe flashover or overheating leading to fire.

G 5.4.2 Requirements applicable to electrical power generation (transformers and generators) are set out in GMRT2130, specifically Part 2 (Fire Safety).

G 5.4.3 For electric traction units, this section 5.4 is intended to apply to equipment downstream of the main circuit breakers protecting the vehicle from the electrical power supply system.

5.5 Traction motors, transmissions and final drives

Guidance

G 5.5.1 Diesel or electric traction units can use traction motors or gearboxes, fluid couplings, cardan shafts and final drives to apply traction power. The principal critical risk is that of severe flashover or detachment or bearing failure leading to fire or derailment. This includes the integrity of gear wheels and the assembly on to driving axles.

G 5.5.2 Requirements applicable to traction motors, transmissions and final drives are set out in GMRT2100, specifically section 4.3 (Equipment attached to bogie frames).

5.6 Fire safety performance for diesel and electric

5.6.1 Automatic or semi-automatic fire detection and prevention systems shall be fitted and operational where these were part of the proven historic design. Otherwise, appropriate firefighting equipment shall be carried.

Rationale

G 5.6.2 A diesel locomotive or multiple unit's principal source of power is the diesel engine. Together with the fuel tank, lubrication and cooling systems, these present a significant fire risk in the event of malfunction.

G 5.6.3 An electric locomotive or multiple unit's principal source of power is an external electrical power supply, typically fed into circuit breakers and transforming devices aboard the vehicles. These present electric arcing flashover and overload risks, which can lead to fire in the event of malfunction.

G 5.6.4 Low and / or intermittent use of diesel and electric traction units can additionally present start-up risks (due to, for example, water contamination) leading to fire / explosion.

Guidance

G 5.6.5 Requirements applicable to fire detection and prevention are set out in GMRT2130, specifically Part 2 (Fire Safety).

G 5.6.6 It can be the case that the proven, historic design featured fire prevention systems using a now banned extinguishant (for example, Halon); in such circumstances, the system would have to be modified accordingly to support any re-entry into service as a heritage rail vehicle.

Part 6 Specific Requirements for Heritage Passenger Vehicles

6.1 Risk profile of a heritage passenger vehicle

Guidance

G 6.1.1 Heritage passenger vehicles can have a distinctive risk profile compared to passenger vehicles in mainline service. The requirements in this part are intended to address these factors, including:

a) Full loading (all pre-booked tickets).
b) Older demographic of passengers than a typical mainline service (higher proportion of persons of reduced mobility).
c) Passengers who do not regularly travel by train and may be unfamiliar with railway safety and operating practices.
d) The presence of on-board personnel in a 'steward' capacity (possibly with a merchandise sales trolley).
e) At seat catering particularly at the luxury (Pullman) end of the market.
f) Trains can go some considerable distances / time (for example, three hours) without a station stop (hence the importance of on board facilities, for example, heating, lighting, toilets).
g) Trains can be longer than the platform of the stations they call at; hence, a considerable number of people walking through the train during boarding / alighting.

G 6.1.2 Notwithstanding the principle outlined in *2.2.2* of demonstrating compliance through maintaining a historic, proven design, it is considered reasonable that the risks to members of the public travelling in heritage passenger vehicles are managed through compliance with current standards where reasonably practicable.

6.2 Vehicle types

6.2.1 Mark 1 passenger vehicles

6.2.1.1 Use of former British Railways 'Mark 1' passenger vehicles in their proven, historic design condition for heritage train services shall be subject to an exemption to the Railway Safety Regulations 1999 (RSR 99) granted by the ORR.

Rationale

G 6.2.1.2 RSR 99 required the staged withdrawal of Mark 1 rolling stock due to the poor crashworthiness performance of this type of vehicle. Regulation 6 of RSR 99 permits the granting of exemption (by the ORR) from any requirement imposed by the regulations and to attach conditions to any such exemptions. As an alternative to an exemption, RSR 99 outlines the work necessary to upgrade a Mark 1 vehicle to make it suitable for unrestricted use.

Guidance

G 6.2.1.3 Guidance on the exemption process reference is available on the ORR website. Applicants are advised to take note of the timescales in the ORR document.

6.2.2 Wooden-bodied passenger vehicles

6.2.2.1 Use of wooden-bodied passenger vehicles for heritage train services shall be prohibited apart from the following exceptions:

a) Wooden-bodied vehicles which are already registered on the Rolling Stock Library.
b) Wooden-bodied vehicles subject to special risk-control measures to support operation for a one-off or limited operation.

Rationale

G 6.2.2.2 Vehicles from an era earlier than the former British Railways Mark 1 type typically featured partial or complete wooden-bodied construction, which not only exhibited poor crash-worthiness performance but also gave rise to secondary hazards in an accident scenario such as splintered wood and fire risk.

Guidance

G 6.2.2.3 Appendix H2 of withdrawn GMRT2000 continues to provide a useful description of the conditions to support the continued use of those wooden-bodied vehicles that are already registered on the Rolling Stock Library. An example would be the Belmond British Pullman vehicles.

G 6.2.2.4 It can be the case that controlled operation of a wooden-bodied heritage rail vehicle can be managed to support a one-off or limited operation. Typically, these would more likely be operational-based controls – see RIS-3440-TOM. An example would be the operation of the Great Western Society steam railmotor under virtual possession conditions.

G 6.2.2.5 Another example would be the extension of a heritage railway operation on to an adjacent stretch of GB mainline railway that is of a similar nature to the heritage railway (for example, the North Yorkshire Moors Railway extended operation from Grosmont to Whitby).

6.2.3 Other vehicle types

Guidance

G 6.2.3.1 Other types of passenger vehicles can be registered as ‘heritage’ according to the principles set out in Part 2.

G 6.2.3.2 Operation of heritage locomotives (in particular steam locomotives) is typically supported by the use of a combined passenger/brake vehicle used as a support vehicle for carrying of spares and supplies and providing accommodation for the locomotive support crew; they are not used to carry members of the public. Such vehicles can be regarded as outside the scope of the requirements set out in this section in terms of any passenger interior requirements concerned with the safety of

the general public; however, other requirements relating to the safe operation of the vehicle on the GB mainline railway (for example, carrying flammable liquids and gas) can be relevant according to the configuration of the particular vehicle concerned.

6.3 Exterior doors for heritage passenger vehicles

6.3.1 Minimum number of doors for heritage passenger vehicles

6.3.1.1 All heritage passenger vehicles shall be equipped with a minimum of four external doors intended for passenger use (two per side). This may be reduced to two (one per side) where the passenger accommodation accounts for 50 % or less of the complete vehicle length or if the total accommodation is significantly lower than a typical passenger vehicle.

Rationale

G 6.3.1.2 This requirement reflects the risk profile of heritage passenger vehicles, including a higher than normal proportion of persons of reduced mobility and the common requirement for whole train boarding or alighting at a destination station.

Guidance

G 6.3.1.3 Requirements applicable to exterior doors are set out in GMRT2100, specifically section 5.4 (external vehicle doors).

G 6.3.1.4 Traditional 'Pullman' vehicles typically only have two doors available for passenger use at any one time but only have accommodation for 30 passengers or less per vehicle, compared to 64 passengers in some standard class vehicles. The boarding / alighting risk is further mitigated by the high staff to passenger ratio.

6.3.2 Central locking for heritage passenger vehicles

6.3.2.1 Use of passenger heritage passenger vehicles without central locking shall be subject to an exemption to the Railway Safety Regulations 1999 (RSR 99) granted by the ORR.

Rationale

G 6.3.2.2 RSR 99 required the staged withdrawal of rolling stock with hinged doors without central locking fitted. Regulation 6 of RSR 99 permits the granting of exemption (by the ORR) from any requirement imposed by the regulations and to attach conditions to any such exemptions (for example, deployment of on-train stewards to supervise use of manual, secondary door locks and to police any passenger mis-use, for example, leaning out of drop-light windows).

Guidance

G 6.3.2.3 As an alternative to an exemption, RSR 99 outlines the work necessary to upgrade a Mark 1 vehicle to make it suitable for unrestricted use.

G 6.3.2.4 Requirements for fitment of central locking to heritage passenger vehicles are set out in GOOTS303. This is the preferred approach compared to granting of an exemption from RSR 99 and would make the vehicle suitable for unrestricted use in this respect.

6.4 Body side windows

6.4.1 Windows of heritage passenger vehicles that are not fitted with laminated or toughened glass shall be fitted with anti-spall films.

Rationale

G 6.4.2 Some heritage passenger rolling stock are still fitted with single pane fixed glass windows. Older style of windows can produce undesirable fragments of glass if broken.

Guidance

G 6.4.3 Requirements applicable to bodyside windows are set out in GMRT2100, specifically 5.3 (Bodyside windows).

6.5 Vehicle interiors

6.5.1 Modifications to the interior configuration and facilities of heritage passenger vehicles shall meet the requirements of the applicable standards where reasonably practicable.

Rationale

G 6.5.2 This requirement reflects the risk profile of heritage passenger vehicles, including a higher than normal proportion of persons of reduced mobility, the requirement for whole train loading or disembarkation at a destination station and the presence of on-board catering provision.

Guidance

G 6.5.3 Requirements applicable to vehicle interiors are set out in the following documents:

a) GMRT2100, specifically Part 6 (interior design, seats, tables, toilets, catering equipment).
b) GMRT2130, specifically Part 6 (Emergency and Safety Information) and Part 7 (Requirements for Evacuation).

G 6.5.4 The following list sets out typical areas for consideration to address the risk profile of a heritage passenger vehicle:

a) The interior configuration of vehicles (internal doors, gangways, tables etc) does not impede the free movement of people, bearing in mind likely alighting and evacuation scenarios.
b) Provision of secure stowage of moveable items (for example, merchandise trolleys, catering equipment).

c) Instructional and warning signs and notices for personnel who may otherwise be infrequent rail travellers.
d) Toilets and washing facilities to be suitable and sufficient, bearing in mind the number of passengers and time on board.
e) Catering equipment, including independent power supplies (for example, gas cylinders) and provision of drinking water on board and any attendant sterilisation devices.

Note: This list is not exhaustive.

G 6.5.5 Electrical protection arrangements for any new electrical equipment installed as part of a modification is set out in *3.10.1*.

6.6 Persons of reduced mobility

Guidance

G 6.6.1 The Rail Vehicle Accessibility Regulations (RVAR) requires the fitment of accessibility compliant features to existing vehicles by 2020.

G 6.6.2 As non-mainline vehicles, heritage passenger vehicles are exempt from the application of the PRM TSI; hence, the UK-specific regulations apply in this case.

G 6.6.3 The Rail Vehicle Accessibility (Networks) Exemption Order 2010 (SI 2010 No. 904) makes provision for heritage or tourist vehicles, whereby a non-compliant rail vehicle first brought into use before 1999 can be used for carriage on a heritage or tourist network, on a depot, or on the mainline for no more than twenty days a year without having to be fitted with accessibility features.

G 6.6.4 Heritage passenger vehicles that do not meet the restrictions in the exemption order may apply for exemption in their own right from elements of the RVAR. It is considered that such an application would have to be justifiable as a one-off case; passenger vehicles routinely used for heritage services are unlikely to be exempted.

G 6.6.5 It is suggested that provision of one accessibility compliant passenger vehicle per heritage train would meet the intent of the RVAR.

6.7 Interior systems

6.7.1 Internal air quality

6.7.1.1 All heritage passenger vehicles originally equipped with pressure ventilation or full air-conditioning shall retain this equipment as fitted and operational. As an alternative, subsidiary ventilation devices (for example, hopper windows) may be fitted.

Rationale

G 6.7.1.2 Adequate internal air quality / ventilation is considered to be an area where the requirements for passengers are equivalent to those travelling on mainline services.

Guidance

G 6.7.1.3 This requirement considers the effects on the health and well-being of passengers on a heritage train service (taking into account the likely older demographic) if either the heating fails on a cold day or the internal temperature becomes uncomfortably high on a warm day.

6.7.2 Interior lighting

6.7.2.1 All heritage passenger vehicles shall be provided with emergency lighting in the event of the loss of the primary lighting facility.

Rationale

G 6.7.2.2 Adequate internal lighting is considered to be an area where the requirements for passengers are equivalent to those travelling on mainline services.

Guidance

G 6.7.2.3 Requirements applicable to emergency lighting are set out in GMRT2130, specifically Part 4 (Requirements for Emergency Lighting).

G 6.7.2.4 Provision of portable battery lighting, for use by train stewards, may provide a solution to this requirement.

6.7.3 Communication requirements for incidents and emergency situations

6.7.3.1 All heritage passenger vehicles shall have the capability of communicating train emergency and safety procedures to passengers in a readily comprehensible manner.

Rationale

G 6.7.3.2 Adequate internal communication on heritage train services for incidents or emergencies is considered to be an area where the requirements for passengers are equivalent to those travelling on mainline services.

Guidance

G 6.7.3.3 Requirements applicable to internal communications are set out in GMRT2130, specifically Part 6.3 (Information for passengers).

G 6.7.3.4 This requirement can be influenced by the aspects of the risk profile of heritage passenger vehicles such as a higher than normal proportion of persons of reduced mobility and the presence of passengers who may be unfamiliar with railway safety and operating practices.

G 6.7.3.5 Typical approaches to addressing this requirement can involve fitment and use of the following equipment:

a) Public address equipment.
b) Passenger emergency alarm
c) Driver-to-guard communication.

G 6.7.3.6 The provision of stewards on heritage trains and the use of devices such as mobile telephones or two-way radios may provide alternative or additional ways of addressing aspects of this requirement.

6.8 Fire and evacuation for heritage passenger vehicles

6.8.1 Emergency and safety information

6.8.1.1 All heritage passenger vehicles shall have appropriate emergency and safety information signs fitted in the interior passenger areas.

Rationale

G 6.8.1.2 Provision of emergency and safety information signs on heritage train services is considered to be an area where the requirements for passengers are equivalent to those travelling on mainline services.

Guidance

G 6.8.1.3 Requirements applicable to emergency and safety information are set out in GMRT2130, specifically Part 6 (Provision of and positioning of information).

G 6.8.1.4 The provision of stewards on heritage trains may provide an alternative way of addressing aspects of this requirement.

6.8.2 Fire performance of materials

6.8.2.1 During restoration / rebuild or modification work, all materials used shall meet the requirements of the applicable standards.

Rationale

G 6.8.2.2 Fire performance of materials in heritage passenger vehicles is considered to be an area where the requirements for passengers are equivalent to those travelling on mainline services.

Guidance

G 6.8.2.3 Requirements applicable to fire performance of materials are set out in GMRT2130, specifically Part 2 (Fire performance categories, material properties).

G 6.8.2.4 For certain materials, fire performance can be achieved through application of surface treatment

G 6.8.2.5 Certain materials that could have originally been fitted to vehicles (for example, asbestos) are prohibited by reference to general safety legislation and regulations.

6.8.3 Fire protection equipment

6.8.3.1 All heritage passenger vehicles shall be equipped with portable fire extinguishers within or adjacent to interior passenger areas. Fire blankets shall be provided in catering vehicles where the method of cooking could cause a fire.

Rationale

G 6.8.3.2 Provision of fire protection equipment on heritage train services is considered to be an area where the requirements for passengers are equivalent to those travelling on mainline services.

Guidance

G 6.8.3.3 Requirements applicable to fire protection equipment are set out in GMRT2130, specifically section 2.9 (Fire protection).

G 6.8.3.4 The provision of other emergency and safety equipment is covered in *3.11*.

6.8.4 Specific measures for flammable liquids and gas

6.8.4.1 Flammable fluids shall be enclosed within a container (or equivalent) whose explosion / corrosion resistance is at least as good as the proven, historic design. Any such equipment fitted that is new shall comply with the relevant requirements of GMRT2130.

Rationale

G 6.8.4.2 Requirements for storage of flammable liquids and gas on heritage passenger vehicles are considered to be an area where the requirements are equivalent to those for mainline vehicles. Where the storage arrangements are unaltered from previous mainline service (such as cubicles housing catering car gas bottles) then the proven, historic design can generally be sufficient. Where any new or modified equipment is installed (such as a fuel tank to power an on-board generator) then this can be regarded as an additional installation to the overall proven, historic design of the vehicle; hence, it is reasonable to require that it complies with current standards.

Guidance

G 6.8.4.3 The relevant requirements of GMRT2130 are set out in section 2.6 (Fuel systems and storage).

Part 7 Maintenance Requirements for Heritage Rail Vehicles

7.1 Documented maintenance plan

7.1.1 Each heritage rail vehicle shall have a recognised maintenance plan identified against it.

7.1.2 The content of the maintenance plan for a heritage rail vehicle shall enable the vehicle to maintain compliance with the relevant requirements of Part 3 to Part 6, dependent on vehicle type.

Rationale

G 7.1.3 This requirement is based on established engineering practice for any rail vehicle in that the primary purpose of maintenance is to keep a vehicle compliant with standards such that it is in a safe condition for continued operation.

Guidance

G 7.1.4 A maintenance plan can be outlined in one single document or consist of a suite of documents and can have more than one heritage rail vehicle identified against it. Some vehicles (more typically heritage traction units) can have unique features that require specific instructions, which would better suit an individual plan.

G 7.1.5 Requirements for rail vehicle maintenance are set out in RIS-2004-RST.

G 7.1.6 The arrangements for independent review and approval of maintenance plans for heritage rail vehicles are set out in RIS-2003-RST.

G 7.1.7 A historic / established maintenance document, previously used when the vehicle type was in mainline service, can be a suitable basis for a maintenance plan for a heritage rail vehicle (although this is unlikely to be sufficient in its own right – see G 7.1.8). For steam locomotives, former BR Common Domain document MT276 can form the basis of a suitable maintenance plan. For heritage passenger vehicles, a combination of former BR Common Domain documents CMS123 and MT250 can form a suitable basis. Historic maintenance instructions can also be a suitable basis for obsolete equipment for which no current maintenance documents exist (for example, plain bearings, vacuum brakes).

G 7.1.8 It is likely that historic maintenance documents will require to be augmented to create a comprehensive plan to address all risk areas. This can be due to:

a) The long-term effects of corrosion, wear and fatigue on the integrity of components and overall vehicle structure (as set out in *3.1*) having an increasingly dominant effect on the condition of the heritage rail vehicle, particularly if the vehicle has reached or gone beyond the end of its theoretical design life.
b) The inclusion of additional or modified features that the historic maintenance document does not cover. Examples can include modern train safety systems (such as TPWS and data recorders), air braking (where the vehicle was originally vacuum braked), auxiliary power generators etc. This can also include modifications made during the service life of the vehicles that post-date the version of any historic maintenance document that is being used.
c) Changed / updated legislative requirements.

G 7.1.9 Previous knowledge of typical failure modes for the vehicle type can be used to prioritise areas for examination (for example, wheelset fractures, cracking around hornguides, diesel engine crankcases, distortion of Mark 1 bodyshell due to corrosion in structural members).

G 7.1.10 The inclusion of work arising and out-of-course test instructions for reasonably foreseeable events is established good practice for rail vehicle maintenance plans.

G 7.1.11 Use of contemporary inspection techniques (for example, NDT) can assist with the examination of critical components such as frame structures, load-bearing bogie components, wheelsets, crank pins / crank axle assemblies, steam locomotive cylinders, motion and valve gear. For higher-level maintenance events (for example, periodic overhaul), grit-blasting back to bare metal may be necessary to achieve the appropriate level of examination. Use of corrosion protection surface treatment can assist with preventing excessive build-up of corrosion.

Note: Grit blasting can peen over and mask defects and must be avoided in the vicinity of bearings where the grit can cause subsequent damage when combined with grease deposits etc.

G 7.1.12 Notwithstanding the content of Parts 3 to 6 and any historic maintenance documentation, the following maintenance activities are highlighted in particular:

a) The monitoring of wheel tyres and treads in accordance with recognised tread profiles to ensure that wear limits are not exceeded.
b) NDT of axles according to established frequencies and methods for the design of axle.
c) Inspection of crank pins and crank axle assemblies to check for excessive wear or signs of fatigue (use of NDT can assist with determining condition) and the integrity of crankpin and axle to wheel and crank web interfaces.
d) NDT of load-bearing bogie components (for example, equalising beams on English-Electric class 37, 50 and 55 diesel locomotives).
e) Side-to-side wheel weight variations (reference criteria is no greater than 5 % of the axle load, for example 9.5 tons on one wheel and 10.5 tons on the other wheel for a combined 20-ton axle load).
f) Brake testing (functional and measured), including parking (hand) brake.
g) Train Safety Systems (TPWS / AWS, Data Recorders, GSM-R etc), including fitment of numbered seals on isolation switches.
h) Examination of steam locomotive boilers (further information is set out in RIS-2003-RST).
i) Condition monitoring of diesel engines, main transformers and final drives (for example, regular oil or coolant sample testing / analysis).
j) Condition of end gangways and associated supporting structure on passenger vehicles. (Note – this requires removal of gangway to fully assess, typically during a periodic overhaul.)
k) Checks of vehicle heights and suspension condition to ensure vehicle remains within declared static gauge limits.
l) Correct functioning of bearings and lubrication systems (including possible contamination of associated equipment, for example, brake equipment, piping and hoses affected by an air compressor lubricant).

m) Condition of electrical safety precautions including earth bonding arrangements.
n) Cleanliness of diesel / electric engine and equipment compartments.
o) Competent person checks of fuel gas equipment on a scheduled basis.

G 7.1.13 Notwithstanding the content of Parts 3 to 6 and any historic maintenance documentation, the following servicing and operational aspects are highlighted, in particular:

a) Operational instructions (this may be a separate document).
b) Basic vehicle data.
c) Lifting diagram and instructions.
d) Rescue / recovery equipment and instructions (scotches etc).
e) Cleaning of driver's cab windscreen.
f) Toilet discharge / emptying.
g) Refuelling arrangements.

7.2 Delivery of maintenance

7.2.1 Ongoing inspection and repair

7.2.1.1 Heritage rail vehicles shall be subject to an ongoing programme of inspection and repair, as outlined in the recognised vehicle maintenance plan.

Rationale

G 7.2.1.2 This is established and understood engineering practice for any rail vehicle to support safe operation on the GB mainline railway.

Guidance

G 7.2.1.3 When procuring replacement materials, parts or services as part of maintenance delivery, the degree of assurance offered by the supplier of such products and services can be critical. Requirements for supplier assurance are set out in RIS-2750-RST. *G 3.1.5.3* highlights the situation where replacement materials, parts or services might have to be supplied to a different specification (due for example to obsolescence or legislation changes). Certain specialist products and services have specific and recognised assurance requirement, for example:

a) NDT (requirements are set out in RIS-2701-RST).
b) Welding.
c) The industry standard for suppliers of wheelsets and wheelset components is to be RISAS-approved.

G 7.2.1.4 Good practice is for heritage train operators (RUs) to review the ongoing delivery of maintenance work (including the competence of staff undertaking the work) as part of the process of accepting heritage rail vehicles owned by other organisations for operation under their Safety Management System (SMS) (as outlined in RIS-3440-TOM). This can include periodic audit and sample inspection of vehicles.

7.2.2 Fitness to run examination

7.2.2.1 Heritage traction units shall be subject to an independent safety (Fitness to Run) examination prior to a heritage train operation.

Rationale

G 7.2.2.2 A heritage traction unit contains the principal safety systems governing the safe operation of a heritage train service, including interface with signalling systems and control of train braking. It is established practice that the integrity and operation of all safety-critical equipment on a heritage traction unit is checked during a safety (Fitness to Run) examination, carried out prior to each heritage train operation.

G 7.2.2.3 In many cases the heritage traction unit will be owned and maintained by an organisation other than the heritage train operator (RU). The Fitness to Run examination is a key part of the handover process (acceptance) of the heritage traction unit into the heritage train operator's SMS covering the operation – this is set out further in RIS-3440-TOM. This is in addition to any ongoing review of maintenance delivery as set out in *G 7.2.1.4*.

Guidance

G 7.2.2.4 The requirement for independence refers to the person undertaking the safety (Fitness to Run) examination compared to the person / organisation undertaking the maintenance work on the vehicle concerned. A key principle is that the person undertaking the examination is free from any commercial pressure that might influence the outcome of the examination.

G 7.2.2.5 The content of a safety (Fitness to Run) examination is determined by the heritage train operator or his authorised representative and is separate to the maintenance arrangements for the heritage traction unit concerned. A lower order examination in a typical heritage vehicle maintenance plan can form a suitable basis for a safety (Fitness to Run) examination; however, the heritage train operator can have specific requirements that need to be checked in order to align with the requirements derived from their SMS.

G 7.2.2.6 It can be the case that a heritage traction unit is being presented for an operation on the GB mainline railway following a period of running at a heritage railway where speed is typically limited to 25 mph or possibly following a period of prolonged inactivity altogether. In such circumstances, the sudden increase in running speed can present additional risks (for example, a prolonged period of running at limited speed may limit the movement of suspension components or use of lubrication systems). In extreme cases, a separate test run ('shake down') at mainline speeds might be advisable prior to the planned heritage operation.

G 7.2.2.7 A heritage train operation is regarded as the advertised heritage train service(s) involving the heritage traction unit in any one day plus any associated light engine and / or empty coaching stock movements on the GB mainline railway immediately prior or afterwards. If the heritage traction unit was to be involved in a further heritage train service on the following day, then a further safety (Fitness to Run) examination would be required. Depending on circumstances, it may be sufficient for

this to be undertaken as an extension to the previous day's safety (Fitness to Run) examination where the same heritage operator is involved.

7.2.3 Maintenance records

7.2.3.1 Records shall be kept of maintenance and associated repair work undertaken to heritage rail vehicles, including work undertaken following a safety related defect.

Rationale

G 7.2.3.2 Records are required to be kept as evidence that the recognised maintenance plan is being undertaken. These records can periodically be required by both the heritage train operator (railway undertaking) and independent certification body (as set out in RIS-2003-RST). Records can also be required when there is an investigation following an incident / accident (for example, RAIB investigation).

Guidance

G 7.2.3.3 Requirements for safety-related defects occurring to heritage rail vehicles are set out in the following documents:

a) RIS-8250-RST Reporting High Risk Defects.
b) RIS-0707-CCS Management of Safety Related Control, Command and Signalling System Failures.

Part 8 Competence Requirements for Personnel Working on Heritage Rail Vehicles

8.1 Competence Requirements

8.1.1 Engineering personnel

8.1.1.1 Personnel undertaking build, re-build, restoration, overhaul and on-going maintenance / repair of heritage rail vehicles shall be competent to undertake the tasks assigned to them.

Rationale

G 8.1.1.2 This requirement reflects the principle outlined in *2.2.1*, recognising that heritage rail vehicles are specialist vehicles for which the collective body of knowledge and experience within the mainline rail industry is no longer available. It is therefore incumbent on the heritage sector to maintain the skills required to support the continued safe operation of heritage rail vehicles on the GB mainline railway.

Guidance

G 8.1.1.3 The content of Parts 3 to 6 of this document can provide the basis for determining competence requirements according to the type of vehicle(s) involved.

G 8.1.1.4 It is good practice for competence requirements to take into account relevant Health & Safety provisions, including Control of Substances Hazardous to Health (COSHH), Provision of Use of Work Equipment Regulations 1998 / Lifting Operations Lifting Equipment Regulations 1998 (PUWER / LOLER), Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), Personal Protective Equipment (PPE), first aid etc.

G 8.1.1.5 In many cases a heritage rail vehicle can be owned and maintained by an organisation other than the heritage train operator (RU). Locomotive / vehicle owning groups within the heritage sector can be of the volunteer / charity / museum style of organisation and the personnel within them can be from a wide variety of backgrounds and therefore not have the same intrinsic level of awareness and appreciation of railway operations and associated safety systems compared to a railway undertaking.

G 8.1.1.6 Competence requirements can be fulfilled by personnel within the locomotive / vehicle-owning group, engaging suitably qualified personnel or by contracting work out to suitably qualified organisations. In the latter instance, the guidance to clause *7.2.1* concerning RIS-2750-RST is relevant.

8.1.2 Personnel working on steam boilers

8.1.2.1 Personnel undertaking work on steam locomotive boilers shall be subject to specific competence arrangements.

Rationale

G 8.1.2.2 Notwithstanding the generic requirement in *8.1.1*, steam locomotive boilers are recognised items of pressure equipment and therefore personnel undertaking work on them are required to be competent in the relevant disciplines.

Guidance

G 8.1.2.3 Competence requirements for the on-going maintenance and repair of steam locomotive boilers include routine activities such as boiler washout and any repairs arising to the boiler / firebox assembly itself and associated devices such as safety valves, injectors, fusible plugs, gauge glasses etc. To ensure this is achieved, good practice is for an appointed person within or affiliated to the locomotive-owning group to co-ordinate the work necessary and that this person be recognised by the heritage train operator and the independent certification body. The appointed person can then oversee the training and authorisation of personnel within the locomotive-owning group or the engaging of suitably qualified personnel to undertake work on the locomotive boiler.

G 8.1.2.4 Available supporting information in the operation and maintenance of steam locomotive boilers is given in the guidance to clause *4.1*.

8.1.3 Personnel responsible for modification of design

8.1.3.1 Personnel responsible for modification and alteration work affecting the design configuration of heritage rail vehicles shall be competent in the management of engineering change.

Rationale

G 8.1.3.2 This requirement reflects the principle outlined in *2.2.2* and is aligned to clause *3.1.5*.

Guidance

G 8.1.3.3 Requirements for management of engineering change to rail vehicles are set out in RIS-2700-RST; section 3.3 and Appendix A refer to competence requirements.

G 8.1.3.4 Lessons learnt from previous accident / incident reports are considered an important aspect of competence in the management of engineering change.

8.1.4 Owner's representative or technical rider

8.1.4.1 Personnel undertaking the role of owner's representative or technical rider in the cab of a heritage traction unit shall be competent to offer guidance (when asked) about the technical features and traits of the heritage traction unit concerned.

Rationale

G 8.1.4.2 This requirement supports these roles as set out in RIS-3440-TOM.

Guidance

G 8.1.4.3 Heritage traction unit owner groups will typically have personnel who have deep technical knowledge of their vehicle and its operational characteristics and this can form the basis of the competence for this role. Such knowledge can be of assistance to the traincrew when the heritage rail vehicle is in operation on the GB mainline railway as, notwithstanding their own competence requirements, they are unlikely to be so familiar with the particular characteristics of the vehicle concerned.

G 8.1.4.4 Operational competence requirements for an owner's representative or techinical rider, including any requirements related to the Rule Book (GERT8000), are addressed in RIS-3440-TOM.

8.2 Competence management arrangements

8.2.1 The competence of personnel undertaking build, re-build, restoration, overhaul and on-going maintenance / repair of heritage rail vehicles shall be managed through the application of appropriate competence processes and procedures.

Rationale

G 8.2.2 The operation of competence management systems is established and understood practice for any rail vehicle to support safe operation on the GB mainline railway. The adoption of the competence requirements outlined in section 8.1 within a competence management system ensures that it is aligned to the particular skills associated with heritage rail vehicles.

Guidance

G 8.2.3 ORR Railway Safety Publication No.1 ‘Developing and Maintaining Staff Competence’ outlines a recommended way to design and implement a competence management system. RSSB / RISAS document ‘Engineering Excellence into Competence’ provides further guidance for developing a competence management system for a maintenance environment.

G 8.2.4 It is recognised that the complexity and completeness of competence management arrangements can vary depending upon the type / style of each heritage rail vehicle-owning group. If the competence management arrangements are well-developed and mature, then a higher degree of reliance may be placed on them compared to a situation whereby more direct and frequent inspection of the heritage rail vehicle is required by the independent certification body and / or the heritage train operator in order to manage the risks involved.

Appendices

Appendix A Guidance on Vehicle Dynamics

A.1 Vehicle dynamic effects

Note: This appendix sets out vehicle dynamics in relation to steam locomotives which have never traditionally been subject to this kind of analysis. However, the principles outlined are equally applicable to other types of heritage rail vehicles.

A.1.1 Vehicle dynamic issues are normally assessed in a combination of theoretical modelling and practical testing.

A.2 Dynamic stability and vertical damping (peak counting)

A.2.1 This involves running the vehicle at the required speed on jointed and welded rails and monitoring the vertical and lateral accelerations in the body over the wheelsets or bogie centres, depending on the vehicle configuration. The resulting data is filtered and plotted in a form showing the percentage of acceleration peaks exceeding a certain level. The resulting line tends to drop from a high number of small cycles at the left to a small number of large ones at the right. The plots are compared to established limit lines for vertical and lateral behaviour, and if the plot is below the limit a pass is achieved. If the limit is exceeded towards the large cycle end, it is still possible to achieve a pass if it can be argued that the accelerations were caused by 'untypical' track features. If, however, the exceedance occurs at the small cycles end, this is taken as an indication of poor dynamic performance and usually the vehicle is deemed to have failed.

A.2.2 Tests undertaken on 60163 'Tornado' and 70013 'Oliver Cromwell' in 2008 demonstrated that this was feasible to do on a steam locomotive. Accelerometers were fitted to both locomotives and tenders. A vertical accelerometer was fitted near to each corner, lateral accelerometers fore and aft and a longitudinal accelerometer on each vehicle. For a bogie vehicle the accelerometers are placed over the pivots, but there is no directly equivalent position on a steam locomotive, so measuring at the extreme ends, and vertically near to the outer corners is regarded as conservative.

A.2.3 The peak counting method has served the UK railway well for many years and is widely understood. An assessment of this type can be valid as an acceptance method for heritage rail vehicles, with the provisos that:

a) A rationale for the placing of the accelerometers be agreed, and
b) The limit curves be reviewed for use with steam locomotives.

A.2.4 In the lateral direction particularly, the dynamic behaviour of a steam locomotive can be lively due to the reciprocating masses causing yawing and, while this is a genuine effect, it is not the same as instability, which can build up to dangerous levels without an increase in speed.

A.3 Track forces

A.3.1 The requirements for track forces are set out in GMTT0088. These are considered in turn.

- Static wheel load- ≤ 125 kN

A.3.2 All UK steam locomotives will meet this if correctly set up.

- Q/d ratio ≤ 0.130

A.3.3 Where Q = static wheel load in kN and d = wheel diameter in mm. Steam locomotives tend to have high wheel loads and large wheels, particularly the driving wheels. Hence, Q/d ratios are unlikely to be a cause for concern. Their calculation and a measure of comparison may be used to indicate a measure of relative acceptability in this area.

- P2 force- ≤ 322 kN per wheel

A.3.4 This is an area where the RGS requirements are unlikely to give favourable results for a steam locomotive. However, there is a plausible argument that the large diameter of steam locomotive driving wheels effectively spreads the load over a greater length of track than is normally the case, 'averaging out' the effects. The P2 force calculations can therefore be unnecessarily onerous for steam locomotives, particularly considering that they form an extremely small proportion of the traffic on the GB mainline railway. In respect of the build-up of fatigue damage in the rails, then the occasional exceedance may be acceptable (as set out in clause 6.3 of GMTT0088).

A.3.5 Nevertheless, calculations can be undertaken to establish the P2 forces. This is an area where the degree of balancing on the driving wheels of steam locomotives can have a significant effect. Comparison arguments can be proposed to demonstrate that the locomotive is 'no worse than' other comparable examples.

- Track shifting force- ≤ Prud'homme limit- W/3+10 kN

A.3.6 In general, this force is calculated using VAMPIRE® or other similar software as it is not usually practical to measure it. A limited amount of measurement was undertaken in the 2008 tests using track-mounted strain gauges on a curved section of track. In the absence of a validated computer model for a particular type of vehicle, similar such tests can be used to establish that actual forces measured are within the Prud'homme limits for each axle.

- Lateral ramp force ≤ 71 kN

A.3.7 This is similar in formulation to the P2 force and is calculated according to a formula in GM/TT0088. It is considered that a well-balanced steam locomotive can comply with these requirements by straightforward calculation.

- Hammer blow

A.3.8 The phenomenon known as 'hammer blow' is a peculiar property of steam locomotives. Cyclical vertical forces arise from the balancing of the locomotive's reciprocating parts (that is, the motion and valve gear acting on the driving wheels), producing a dynamic augment to the axle loads. This is an area that GMTT0088 does not specifically address; however, it can be calculated by well-established methods.

A.3.9 Such calculations can then be validated by running over a Wheel Impact Load Detector (WILD) site during testing.

A.3.10 As the railway is generally more robust than in the days of regular steam operation, with heavy flat bottom rail and concrete sleepers on most high-speed lines, then the network is more able to withstand hammer blow; the focus of attention therefore is on the effects on underline bridges (where, for example, traditional girder designs have been replaced by concrete structures which may exhibit a different response). The forces as recorded by WILD sites may be correlated with design information supplied by the civil engineer.

A.4 Maximum cant deficiency and gauging

A.4.1 An increase in operating speed implies an increase in cant deficiency on curves. It is assumed that any steam locomotive which is a candidate for increased operating speed is capable of operating at 4¼ degrees of cant deficiency, and that on curves where a higher value is permitted a differential speed restriction will be given which would allow the steam locomotive to remain within its design operating envelope. The location of the centre of gravity above rail level can have an impact on these assumptions.

Appendix B Method for Managing Increased Speed Limits

B.1 Introduction to method for managing increased speed limits

B.1.1 Any proposal to increase the current maximum permitted speed of a heritage rail vehicle (the 'proposed speed') is regarded as a certification project to be undertaken in accordance with RIS-2003-RST and overseen by an independent certification body.

B.1.2 As a general principle, it is reasonable to require the degree of work required to be proportionate to the scale of the proposed increase (for example, an increase of 75 mph to 90 mph is more significant than an increase from 70 mph to 75 mph).

B.1.3 The proposal shall be managed in accordance with the following sequence of steps:

a) Structural integrity of the heritage rail vehicle.
b) Modifications to support proposed speed of operation.
c) Vehicle dynamic performance (including track forces and derailment risk).
d) Maintenance plan.
e) Recommendation.

B.2 Structural integrity of the heritage rail vehicle

B.2.1 The existing speed of the heritage rail vehicle will typically be lower than its potential safe running speed to safeguard its structural integrity, given its status as a heritage rail vehicle and therefore of advanced age, with a history of corrosion, wear and fatigue. Running at the proposed speed could therefore lead to an unacceptable risk in terms of the structural integrity of the heritage rail vehicle.

B.2.2 To evaluate this, the applicant shall produce a report, detailing the current engineering condition of the heritage rail vehicle. The report shall include relevant sections of the Engineering Condition Report set out in RIS-2003-RST.

B.2.3 The report shall be reviewed and verified by the independent certification body.

B.2.4 For a new-build heritage rail vehicle, the risks involved with corrosion, wear and fatigue are largely replaced by risks associated with the robustness of the new-build construction methods. Residual age-related risks can still be present if the project has incorporated re-conditioned existing parts as part of the overall build project. An equivalent report is therefore required which addresses these issues.

B.3 Modifications to support proposed speed of operation

B.3.1 An assessment shall be undertaken as to the need for modifications to the heritage rail vehicle to support the proposed speed. Depending on the scale of the proposed increase in speed and the absolute value of the maximum speed involved, modifications can be required or at least deemed to be desirable. Examples are given in the guidance to *G 3.5.3.2.4* .

B.3.2 The output from the assessment shall be reviewed and any resulting modifications agreed with the independent certification body.

B.4 Vehicle dynamic performance (including track forces and derailment risk)

B.4.1 The applicant shall demonstrate, by the most suitable means, that running of the heritage rail vehicle at the proposed speed:

a) Does not produce unacceptable levels of track forces.
b) Does not produce unacceptable levels of derailment risk.

B.4.2 A typical approach would be as follows:

a) Initial theoretical calculations based on known parameters of the heritage rail vehicle. Modelling using Vampire® has now been proven and is the preferred method, particularly for more significant changes in speed of operation.
b) Instrumented testing, within the vehicle's present speed limit, to validate the above calculations.
c) Subject to satisfactory results from the above, an instrumented mainline test run at the proposed speed. This shall include a full brake test at the proposed speed.

B.4.3 Depending on the scale of the proposed increase, use of mobile test instrumentation (for example, Simret) may provide a practical alternative compared to fully instrumented testing.

B.4.4 A more detailed description of the areas for consideration and the type of testing to be considered are given in Appendix *A*.

B.4.5 The results from such calculations and tests shall be verified by the independent certification body.

B.5 Maintenance plan

B.5.1 With increased speed of operation comes increased wear of parts, implying therefore that a more rigorous, usage-based maintenance regime is required. The maintenance plan shall be reviewed by the independent certification body and confirmed as suitable to support operation at the proposed speed.

B.6 Recommendation

B.6.1 The conclusions from the above work shall be offered to review by the ORR, as per the process for a significant project, as set out in RIS-2003-RST.

B.6.2 The new maximum speed of operation shall be agreed with the independent certification body, based on the outcome of the process outlined in this appendix. This may be any speed from the existing speed of operation up to the proposed speed of operation, depending on the suitability of the results of the analysis and testing work. This can be conditional on completion of any remedial work that might be required prior to commencing operations at the new maximum speed of operation.

Appendix C Steam Locomotive Gauging

Note: This section is to be read in conjunction with *3.2.1* of this document.

C.1 Introduction to steam locomotive gauging

C.1.1 Steam locomotives (and their tenders) are generally irregularly shaped and thus present some difficulty in defining those dimensions that are critical to gauging. Although drawings are often available, these may not reflect modifications to the vehicle over its lifetime.

C.1.2 During a gauging assessment it is important that critical dimensions are measured, using suitable equipment (laser scanning equipment is an established process), to ensure that clearance is measured to the actual vehicle rather than as it was designed.

C.2 Determining the physical dimensions of steam locomotives

C.2.1 The critical dimensions of the locomotive shall be measured, or otherwise determined, and presented as cross-sections at significant points along the length of the locomotive. Significant points on a steam locomotive include:

a) Outside (for example over the cylinders).
b) Buffer beam.
c) Front footplating (this may be wider at a point further back than the buffer beam).
d) Valve gear.
e) Boiler features such as chimney, dome, safety valves, whistle etc.
f) Cab.
g) Tender side sheets.

C.2.2 Each cross-section shall be recorded separately (that is, not as a composite cross-section combining cross-sections from several points along the steam locomotive), in order that the effects of curve overthrow and dynamic movement may be applied appropriately to particular cross-sections.

C.3 Determining overthrow on curves

C.3.1 Vertical overthrow on curves need not be considered, provided that the steam locomotive is not intended to operate on vertical curvatures of less than 500 m radius.

C.4 Determining dynamic movements due to motion

C.4.1 Dynamic movements in the lateral, vertical, roll, pitch and yaw directions occur due to the interaction between track irregularities and the forward motion of the vehicle. For steam locomotives, dynamic movement can also be influenced by:

a) The effects of reciprocating masses on steam locomotives and balance weights fitted to wheels.
b) The consumption and subsequent refilling of coal and water.
c) The surging of water in the boiler and water tank.

Note: This list is not exhaustive.

C.4.2 Dynamic movements shall be determined, either based on limits of suspension movements or through a validated dynamic simulation. Where it is not possible to establish actual limits of dynamic movement, it is permissible to use established typical values. Such values and their application are set out in GERT8573.

C.4.3 Cross-sections already adjusted for overthrow shall be further adjusted to include the effects of dynamic movements that may be expected to occur in operation.

C.5 Reporting of results

C.5.1 Results can be presented as a series of critical cross-sections at a variety of radii spanning the anticipated operation of the locomotive. These cross-sections shall include the dynamic effects prescribed above.

Appendix D Steam Locomotive Speeds

D.1 Steam locomotive speeds

D.1.1 The following table sets out the maximum speed limits considered suitable for operation of steam locomotive types on the GB mainline railway. The maximum speed limit for any particular locomotive may be lower, as outlined in *3.5.2*.

Type	Example loco	Driving wheel diameter			Piston stroke (in)	No. of cyls	Max. speed limit (mph)
Ex-GWR		ft	in	Total (in)			
Saint 4-6-0	2999	6	8½	80.5	30	2	70 (see *a)*)
Hall 4-6-0	4965	6	0	72	30	2	65
Castle 4-6-0	5043	6	8½	80.5	26	4	75
King 4-6-0	6024	6	6	78	28	4	75
57xx 0-6-0PT	9600	4	6	54	24	2	45
94xx 0-6-0PT	9466	4	8	56	24	2	45
Ex - SR							
N15 Arthur 4-6-0	30777	6	7	79	28	2	70
Lord Nelson 4-6-0	850	6	7	79	26	4	75
WC/BB 4-6-2	34067	6	2	74	24	3	75
MN 4-6-2	35028	6	2	74	24	3	75
Ex- LMS							

Type	Example loco	Driving wheel diameter			Piston stroke (in)	No. of cyls	Max. speed limit (mph)
5MT 4-6-0	45407	6	0	72	28	2	65
5XP 4-6-0	5690	6	9	81	26	3	75
6P 4-6-0	46115	6	9	81	26	3	75
Pr Royal 4-6-2	6201	6	6	78	28	4	75
Duchess 4-6-2	6233	6	9	81	28	4	80
8F 2-8-0	48151	4	9	57	28	2	50
Ex-LNER							
A4 4-6-2	60007	6	8	80	26	3	80
A3 4-6-2	4472	6	8	80	26	3	75 (see *b)*)
A1 4-6-2	60163	6	8	80	26	3	80
A2 4-6-2	60532	6	2	74	26	3	75
P2 2-8-2	2007	6	2	74	26	3	75
V2 2-6-2	4771	6	2	74	26	3	75

Type	Example loco	Driving wheel diameter			Piston stroke (in)	No. of cyls	Max. speed limit (mph)
B1 4-6-0	61264	6	2	74	26	2	70
K1 2-6-0	2005	5	2	62	26	2	55
K4 2-6-0	3442	5	2	62	26	3	60
BR Standard							
7P 4-6-2	70013	6	2	74	28	2	75 (see *c)*)
8P 4-6-2	71000	6	2	74	28	3	75
4MT 2-6-0	76079	5	3	63	26	2	60

Table 3: Steam locomotive speeds

D.1.2 The stated speeds are based on a formula which takes into account:

a) Wheel diameter rotational speed of 6 revs per second.
b) Piston stroke and oscillation speed of 1600 ft per minute.
c) Number of cylinders (see *b)*).
d) Presence of leading pony truck or bogie to add steering and derailment resistance.
e) Age of original design (see *a)*).

D.1.3 For steam locomotives of engine-tender configuration, a lower speed limit is required for tender-first running due to relative lack of stability when running in this mode. This shall be determined during the certification process in accordance with RIS-2003-RST. A typical tender-first speed limit would be 45 mph for a 75 mph pacific locomotive. Factors for consideration include traincrew visibility when running tender first.

D.1.4 Derivation and application of the formula used to derive the speeds set out in the table is overseen by RSSB, to whom any related enquiries shall be directed.

D.1.5 All stated speeds are within 10 mph of the previous speed limits applied to steam locomotives as set out in GORT3440 issue two, taking into account the three derogations that were previously issued against that document.

D.1.6 The following general criteria have been applied:

a) The cut-off for age of design (by which a lower speed is allocated) is 1923. This date is suggested partly because it is the date of the post WWI ‘grouping’ (that created the London, Midland and Scottish Railway (LMS), London and North Eastern Railway (LNER), Great Western Railway (GWR) and Southern Railway (SR) ‘big 4’) but also due to the landmark bridge stress committee work, begun in 1923 and reported in 1928. The output of this work, including the determination of the hammer blow effect, influenced locomotive design philosophy thereafter in a manner beneficial to track force considerations.
b) 2-cylinder locomotives are those most prone to display the ‘hammer blow’ effect as there is no natural balancing to the effect, with piston sequence at 90 degrees. By contrast, 3-cylinder (120 degrees) and 4-cylinder (180 degrees) locomotives are naturally better balanced and exhibit a less pronounced effect.
c) The additional rear wheelset on the 4-6-2 pacific types, although adopted mainly to spread axle load, generally offered additional benefit in ride quality; conversely, certain 4-6-0 types displayed deterioration in ride quality as speed increased. This has therefore been taken into account in setting speeds for the two generic design types.
d) A marginal increase in maximum speed (75 > 80mph) has been allocated to certain pacific types with 6' 8''driving wheels or greater, on the basis that this is a significant increase over 6' 2'' (the basis for the previous maximum limit for 75 mph). One consequence of this is the requirement for fixed rather than portable headlights, as set out in *3.7* where operations are proposed at that speed.

D.1.7 In two cases, the speed limit is 5 mph lower than the previous limit for the locomotive, as set out in GORT3440 issue two. Whilst a justification could be put forward that safe operation at the higher speed has been proven, it is considered that application of the formula be consistent across all types, as a way of baselining the new

requirements. Justification to retain the previous limit can be made in accordance with the process set out in *3.5.3* and Appendix *B* (taking into account that this is a marginal increase rather than a significant one).

D.1.8 The following notes (indicated in the table) are provided on particular locomotive types:

a) Design dates from 1905.
b) Although having 6' 8'' driving wheels, the speed limit has not been increased to 80 mph as per *d)*. This takes into account the age of the original design (1922) and the considerable life mileage of the one surviving example.
c) This type was particularly renowned for the hammer blow effect and the formula computes a limit of 70 mph. However, the two examples of the class have successfully operated at 75 mph on the network as heritage rail vehicles and are of the post-1948 BR-designed pacific type.

Acronyms and Abbreviations

AABP	Automatic Air Brake Pipe
AWS	Automatic Warning System.
DFT	Department for Transport.
DMI	Driver Machine Interface
EMC	Electromagnetic Compatibility.
ETCS	European Train Control System.
FTR	Fitness to Run
LPG	Liquified Petroleum Gas
NDT	Non-destructive testing
NoBo	Notified Body.
NOSS	National Operating Systems Specification
OLE	Overhead Line Equipment.
ORR	Office of Rail and Road.
OTM	On-Track Machine
OTMR	On Train Monitoring Recorder
RA number	Route Availability
RAIB	Rail Accident Investigation Branch.
REC	Railway Emergency Call
RETB	Radio Electronic Token Block.
RIR	Railways (Interoperability) Regulations 2011.
RISAS	Rail Industry Supplier Approval Scheme
ROSCO	Rolling Stock Owning Company.
SMS	Safety Management System.
TOPS	Total Operations Processing System.
TPWS	Train Protection and Warning System.
TRUST	Train Running Under System TOPS.
TSI	Technical Specification for Interoperability.
TU	Traction Unit
WILD	Wheel Impact Load Detector

Definitions

Automatic Warning System (AWS)	A system that gives train drivers in-cab warnings of the approach to signals, reductions in permissible speed and temporary / emergency speed restrictions, and to apply the brakes in the event that a driver does not acknowledge cautionary warnings given by the system within the specified time. *Source: GERT8075*.
Electromagnetic Compatibility (EMC)	The ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.
European Train Control System (ETCS)	The signalling, control and train protection part of the European Rail Traffic Management System designed to provide interoperability and standardisation across European railways.
Global System for Mobile Communications - Railway (GSM-R)	The European Standard specific to railway applications for the transmission by radio of voice and data between train and trackside installations. *Source: GERC8517 Iss 1*
Heritage Rail Vehicle	Vehicle reserved for a historical (heritage) or touristic use. Such vehicles typically are of a type that no longer have a continuous history of regular mainline service but have a proven previous history of safe operation. They are classified as non-mainline vehicles for the purpose of interpretation of RIR and ROGS.
Heritage Traction Unit	A heritage rail vehicle capable of providing traction power for or within a heritage train and / or with a driving cab.
Heritage Train Service	A train formed of one or more heritage rail vehicles for the predominant purpose of recreating a railway service of a bygone era (typically organised by a rail heritage company).
Independent Certification Body	A suitably competent, third party organisation ('third party' refers to the degree of independence) or the combination of a suitable competent, independent person / organisation and a heritage rail operator, undertaking certification under the safety management system supporting its safety certificate (degree of independence referred to as 'second party'), as set out in RIS-2003-RST.
Mainline service	Timetabled or other commercial services over the GB mainline railway that are not seeking to recreate a railway service of a bygone era.
Mainline vehicle	Vehicle used for mainline service.
Non-destructive testing (NDT)	Non-destructive testing is the process of examination of a wheelset to enable its integrity to be assessed by a means which does not compromise the service life or the design life of the wheelset.
Office of Rail and Road (ORR)	The independent safety and economic regulator for Britain's railways.
On-Track Machine (OTM)	Any rail-mounted machine, whose primary function is for the renewal, maintenance, inspection or measurement of the

	infrastructure, meeting the requirements of GMRT2400 and permitted by the Rule Book to be moved, either self-propelled or in train formation, outside a possession.
Proven, historic design	The original design of the vehicle, together with any authorised modifications to address design weaknesses (for example, the addition of strengthening / doubler plates to combat frame cracking) defining a configuration that is 'good' by design.
R2	The national central database of rail vehicle design and operational data, owned and maintained on behalf of the industry by RSSB. It incorporates what was previously known as the Rolling Stock Library (RSL). It integrates with key Industry Systems, including TOPS, Gemini, GENIUS, and National Vehicle Register (NVR).
Radio Electronic Token Block (RETB)	RETB is a method of protecting a single line of railway through the use of an electronic interlocking and a radio link to the trains which use the line.
Total operations processing system (TOPS)	Computer system for managing the locomotives and rolling stock owned by and / or operated on the GB mainline railway.
Train protection and warning system (TPWS)	Train Protection and Warning System (TPWS) is a system mitigating Signals Passed At Danger and non-respect of permissible speeds.

References

The Standards Catalogue gives the current issue number and status of documents published by RSSB. This information is available from http://www.rssb.co.uk/railway-group-standards.co.uk.

RGSC 01	Railway Group Standards Code
RGSC 02	Standards Manual

Documents referenced in the text

Railway Group Standards

GERT8000	The Rule Book
GERT8006	Assessment of Compatibility of Rail Vehicle Weights and Underline Bridges
GERT8014	Axlebox Condition Monitoring - Hot Axlebox Detection
GERT8015	Electromagnetic Compatibility between Railway Infrastructure and Trains **Note:** This standard is due to be withdrawn in December 2017. A new document RIS-0725-CCS describes the EMC susceptibility of train detection systems
GERT8075	AWS and TPWS Interface Requirements
GERT8270	Assessment of Route Compatibility of Vehicles and Infrastructure
GMRC2532	Recommendations for Rail Vehicles Emergency and Safety Equipment
GMRT2000 (withdrawn)	Engineering Acceptance of Rail Vehicles
GMRT2045	Compatibility Requirements for Braking Systems of Rail Vehicles
GMRT2100	Requirements for Rail Vehicle Structures
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 and Evacuation
GMRT2131	Audibility and Visibility of Trains
GMRT2141	Resistance of Railway Vehicles to Derailment and Roll-Over
GMRT2142	Resistance of Railway Vehicles to Roll-Over in Gales
GMRT2160	Environment Inside Railway Vehicles (Audibility of detonators)
GMRT2161	Requirements for Driving Cabs of Railway Vehicles
GMRT2173	Requirements for the Size of Vehicles and Position of Equipment

GMRT2176	Air Quality and Lighting Environment for Traincrew Inside Railway Vehicles
GMRT2185	Train Safety Systems
GMRT2453	Registration, Identification and Data to be Displayed on Rail Vehicles
GMRT2466	Railway Wheelsets
GMRT2470 (withdrawn)	Wheelset Supplier Qualification
GMRT2472	Requirements for Data Recorders on Trains
GMTT0088	Permissible Track Forces for Railway Vehicles
GOOTS303	Secondary Door Locking - Operational Requirements
GORT3440 (withdrawn)	Steam Locomotive Operation

RSSB Documents

GKGN0554	Guidance on Radio Electronic Token Block (RETB)
GMGN2611	Guidance on Rolling Stock Subsystem and Interfaces to AC Energy Subsystem
GMGN2613	Guidance on Rolling Stock Subsystem and Interfaces to DC Conductor Rail Energy Subsystem
RIS-0707-CCS	Management of Safety Related Control, Command and Signalling System
RIS-0794-CCS	GSM-R Train Voice Radio Systems
RIS-2003-RST	Certification and Registration of Heritage Rail Vehicles Operating on the GB Mainline Railway
RIS-2700-RST	Rail Industry Standard for Verification of Conformity of Engineering Change to Rail Vehicles
RIS-2750-RST	Rail Industry Standard on Supplier Assurance
RIS-2773-RST	Format for Vehicle Gauging Data
RIS-3440-TOM	Steam Locomotive Operation
RIS-8250-RST	Urgent Safety-Related Defect Report Form
T1049	Operating non-mainline vehicles on mainline infrastructure

Other References

CMS123	Regulations for the Repair of B.R. Standard Locomotive Hauled Coaching Vehicles at Main Works
COSHH	Control of Substances Hazardous to Health Regulations 2002
EaWR	The Electricity at Work Regulations 1989

EU Directive No. 97/23/EC	Pressure Equipment No. 97/23/EC
HRA	Heritage Railway Association Guidance Documents
HSR25	Guidance on the Electricity at Work Regulations 1989
LOLER	The Lifting Operations Lifting Equipment Regulations 1998
MT250	Examination and Repair of Privately Owned Coaching Stock Operating Over B.R Lines
MT276	Examination Schedule for Preserved Steam Locomotives Running on British Railways Lines
ORR Railway Safety Publication No.1	Developing and Maintaining Staff Competence
ORR Railway Safety Publication No.6	Management of Steam Locomotive Boilers
SI 1999 No.2001	Pressure Equipment Regulations 1999 (as amended), enacting 97/23/EC
PSSR	Pressure Systems Safety Regulations 2000
PUWER	Provision and Use of Work Equipment Regulations 1998 (1999 in Northern Ireland)
RAIB Report 08/2016	Signal passed at danger on approach to Wootton Bassett Junction, Wiltshire 7 March 2015
RAIB Report 13/2014	Locomotive failure near Winchfield 23 November 2013
ROGS 2006 (as amended)	The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended)
RSR 99	Railway Safety Regulations 1999
RVAR	Rail Vehicle Accessibility Regulations
SI 2010 No. 904	Rail Vehicle Accessibility (Networks) Exemption Order 2010