

Requirements for Rail Vehicle Mechanical and Electrical Coupling Systems

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Synopsis

This document mandates the requirements for **mechanical** and **electrical coupling** systems, including drawgear and buffers, to control the safety risks associated with train separation and incorrect operation of **electrical** circuits. It covers traction, rolling stock and on-track machines.

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Railway Group Standard**GM/RT2190**

Issue Two

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**Requirements for Rail Vehicle Mechanical and
Electrical Coupling Systems**

Issue record

Issue	Date	Comments
One	April 1998	Original document
Two	February 2004	Replaces GM/RT2190 issue one and GM/RT2102 issue one and supersedes parts of GM/RC2509 issue one and GM/RC2519 issue one.

Revisions have not been marked by a vertical black line in this issue because the document has been revised throughout.

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Part 1 General information

1.1 Scope of Railway Group Standards

- 1.1.1 The overall scope of Railway Group Standards, and specifically of the controlled infrastructure (as used in this Railway Group Standard), is set out in Appendix A of [GA/RT6001](#). The specific scope of this Railway Group Standard is set out in Part 2.

1.2 General responsibilities

- 1.2.1 Railway Group Standards are mandatory on all members of the Railway Group and apply to all relevant activities that fall into the scope of each individual's Railway Safety Case. If any of those activities are performed by a contractor, the contractor's obligation in respect of Railway Group Standards is determined by the terms of the contract between the respective parties. Where a contractor is a duty holder of a Railway Safety Case then Railway Group Standards apply directly to the activities described in its Railway Safety Case.
- 1.2.2 The Railway Group comprises Rail Safety and Standards Board Limited, the infrastructure controller and the train and station operators who hold Railway Safety Cases for operation on or related to the controlled infrastructure (as set out in [GA/RT6001](#)).
- 1.2.3 Under the Railways (Safety Case) Regulations 2000, the duty holder (as defined in those Regulations) is responsible for ensuring that the requirements of Railway Group Standards are complied with. Contractual arrangements (including a lease at a station) do not of themselves relieve the duty holder of its obligations under those Regulations.

1.3 General compliance date

- 1.3.1 This Railway Group Standard comes into force and shall be complied with from 3 April 2004, except as specified in Part 2. Where the dates specified in Part 2 are later than the above date, this is to allow Railway Group members sufficient time to achieve compliance with the specified exceptions.
- 1.3.2 After the compliance dates, Railway Group members shall not deviate from the requirements set out in this Railway Group Standard. Where it is considered not reasonably practicable to comply with the requirements, authorisation not to comply shall be sought in accordance with [GA/RT6001](#), [GA/RT6004](#) or [GA/RT6006](#).

1.4 Health and safety responsibilities

- 1.4.1 Each Railway Group member is reminded of the need to consider its own responsibilities to ensure health and safety at work and its own duties under health and safety legislation. Rail Safety and Standards Board does not warrant that compliance with all or any documents published by Rail Safety and Standards Board is sufficient in itself to ensure safe systems of work or operation or to satisfy such responsibilities or duties.

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1.5 Technical content

1.5.1 The technical content of this Railway Group Standard has been approved by:

Haydn Peers, Principal Traction and Rolling Stock Engineer and Principal Plant Engineer, Rail Safety and Standards Board

1.5.2 Enquiries should be directed to Rail Safety and Standards Board – Tel. 020 7904 7518 or e-mail enquiries@rssb.co.uk.

1.6 Supply

1.6.1 Controlled and uncontrolled copies of this Railway Group Standard may be obtained from the Industry Safety Liaison Department, Rail Safety and Standards Board, Evergreen House, 160 Euston Road, London NW1 2DX or e-mail enquiries@rssb.co.uk.

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Part 2 Application of this document

2.1 Purpose

- 2.1.1 This Railway Group Standard mandates requirements for **coupling** systems, to control the safety risks associated with train separation and the incorrect operation of **electrical** circuits, due to connection incompatibility between vehicles. It covers traction, rolling stock and on-track machines.
- 2.1.2 This document is being updated to control the risks arising from incompatible vehicles being coupled together and operated, which has the potential to result in failure of the train's control system. The opportunity is also being taken to combine the requirements of GM/RT2102 into this new issue of GM/RT2190.

2.2 To whom these requirements apply

- 2.2.1 This Railway Group Standard contains requirements that are applicable to Rail Safety and Standards Board and the duty holders of the train operator category of Railway Safety Case.

2.3 Application – infrastructure controller

- 2.3.1 There are no requirements applicable to the infrastructure controller.

2.4 Application – station operator

- 2.4.1 There are no requirements applicable to the station operator.

2.5 Application – train operator

Scope

- 2.5.1 The requirements of this document apply to all new and existing vehicles, except Part 4 which is for new, or significantly modified (as set out in [GM/RT2000](#)), vehicles only.
- 2.5.2 The requirements of all of Part 4, and clauses 5.1.4 and 5.1.6 of this document are within the scope of Vehicle Acceptance Body approval.

Exceptions from scope

- 2.5.3 This document does not apply to vehicles operated by London Underground, or Nexus Tyne & Wear Metro, whilst on Network Rail controlled infrastructure.
- 2.5.4 The requirements in the document are not applicable to the following types of vehicles:
- Rail-Mounted Maintenance Machines (RMMMs)
 - Road-Rail Vehicles (RRVs)

Exceptions to general compliance date

- 2.5.5 The vehicle design requirements mandated in Part 4 of this document are to be complied with by all vehicles of previously uncertificated designs with a Certificate of Conformance for Vehicle Design signed on or after 2 October 2004. In addition to this the design requirements shall be complied with by any future vehicles, built to the same design as a vehicle already having Engineering Acceptance, which enter service on Network Rail controlled infrastructure on or after 2 October 2006.
- 2.5.6 Compliance with Parts 3 and 5 is required by no later than 3 April 2004.

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2.6 Application – Rail Safety and Standards Board

Scope

- 2.6.1 The requirements of this document (section 5.2) shall be complied with no later than 3 April 2004. In addition Rail Safety and Standards Board shall ensure that GM/RC2509 and GM/GN2590 are updated at a frequency commensurate with the magnitude of submissions from train operators.

Exclusions from scope

- 2.6.2 There are no exclusions from the scope specified in clause 2.6.1 for Rail Safety and Standards Board.

Exceptions to general compliance date

- 2.6.3 There are no exceptions to the general compliance date specified in clause 1.3.1 for Rail Safety and Standards Board.

2.7 Document management

Superseded documents

- 2.7.1 The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents:	Sections superseded	Date when sections are superseded
GM/RT2190, issue 1, April 1998 Mechanical and electrical inter-vehicle coupling systems	All	3 April 2004
GM/RT2102, issue 1, August 1994 Structural requirements for drawgear and buffers on railway vehicles	All	3 April 2004
GM/RC2509, issue 1, January 1996 Code of Practice for Traction and Rolling Stock Mechanical Coupling Systems	11.3.1 11.3.2 11.3.3 All other sections remain in force	3 April 2004
GM/RC2519, issue 1, December 1996 Code of Practice – Design and Construction of Freight Wagons	9 All other sections remain in force	3 April 2004

Related requirements in other documents

- 2.7.2 There are no known related requirements in other Railway Group documents at the time of publication.

Supporting documents

- 2.7.3 There is a supporting RSSB Approved Code of Practice (RACOP), GM/RC2509, which details the main types of rail vehicle mechanical coupling systems currently in use on rail vehicles that operate on Network Rail controlled infrastructure and provides basic information on the requirements for ensuring safe and reliable mechanical coupling system design for new or modified rail vehicles. There is also a supporting Guidance Note GM/GN2590 which describes the vehicle electrical interconnectors currently in use on rolling stock operating on Network Rail controlled infrastructure.

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2.8 Definitions

Adaptor coupling

2.8.1 A **coupling** that enables two railway vehicles with dissimilar **coupling** systems to be coupled together in a rescue or recovery situation.

Buffers

2.8.2 The fittings on the end of a railway vehicle designed to enable longitudinal compressive forces to be transferred between adjacent vehicles. Buffers can either be mounted at the sides as separate units or incorporated in the drawgear.

Coupling system

2.8.3 The **mechanical** system, including buffers, drawgear and gangway where fitted, that connects two rail vehicles together, and the **electrical** connections between vehicles.

Drawgear

2.8.4 A set of fittings used to connect railway vehicles for the purpose of transmitting longitudinal forces between adjacent vehicles; connection can be made manually or automatically.

Duty holder

2.8.5 The Railway Group member having responsibilities under their Railway Safety Case.

Electrical interconnector

2.8.6 Jumper or auto-connector designed to carry **electrical** conductors between vehicles, irrespective of whether or not they interact with the vehicle through which they pass. These include cables that leave one vehicle for use in **electrical** circuits on another vehicle.

Engineering Acceptance Certificate

2.8.7 The formal declaration by a Vehicle Acceptance Body (VAB) that the rail vehicle(s) conforms to all the relevant mandatory requirements, to the process described in [GM/RT2000](#).

Gangway

2.8.8 Enclosed connection between two vehicles for passengers to transfer from one vehicle to the other.

On-track Machines

2.8.9 On-track Machines (OTM) are any rail-mounted machine, whose primary function is for the renewal, maintenance, inspection or measurement of the infrastructure, and permitted to be moved, either self-propelled or in train formation, outside a possession, as defined in [GM/RT2400](#).

Rail-Mounted Maintenance Machines

2.8.10 Rail-Mounted Maintenance Machines (RMMMs) are any self-propelled rail mounted machine restricted by the Rule Book ([GE/RT8000](#)) from being moved, either self-propelled or in train formation, outside a possession, as defined in [GM/RT2402](#).

Railway Group member

2.8.11 Railway Group members (RGM) are infrastructure controller(s), train and station operators who hold Railway Safety Cases for operation on, or related to, the controlled infrastructure, as set out in [GA/RT6001](#), and Rail Safety and Standards Board.

Road-Rail Vehicles

2.8.12 Road-Rail Vehicles (RRVs) are any vehicles that can travel on the road under their own power and also travel on-rail by virtue of a rail wheel guidance system under its own power system, as defined in [GM/RT1300](#). Such vehicles are not allowed to operate outside possessions.

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Train wire

- 2.8.13 Cable whose function is to transmit signals or information between coupled vehicles, via **electrical** interconnectors. Bifurcated interconnectors have two **electrical** interconnectors per train wire.

Vehicle Acceptance Body

- 2.8.14 A Vehicle Acceptance Body (VAB) is a qualified body acting on behalf of Rail Safety and Standards Board with authority to issue engineering acceptance certificates for rail vehicles operating or intended to operate on Network Rail controlled infrastructure

Vehicle type

- 2.8.15 For the purposes of this document this shall mean a group of vehicles which have similar design and operating characteristics and with identical **electrical** circuitry associated with train wires and their function.

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Part 3 Ensuring the compatibility of existing **coupling** systems

3.1 Compatibility of vehicles with **electrical** interconnectors

3.1.1 For vehicles that have **electrical** interconnectors, train operators shall ensure that for each type of vehicle that is to be coupled within a credible train consist of more than one vehicle type, the integrity of the train's safety systems is proven in that exact combination of vehicle types. Where there is evidence that the exact combination of vehicles has a documented history of successful operation this shall be deemed as fulfilling the requirements of this clause.

3.1.2 Where a train operator plans to operate vehicles together in a new formation to that stated in clause 3.1.1, a test shall be carried out to ensure the integrity of the train's safety systems. The test shall determine that the formation does not interfere with the control of any safety feature, that the integrity of the train's safety systems is maintained and any circuit features designed to provide safety mitigation in the event of a failure occurring are not compromised. The tests only need to be carried out once only for each vehicle type combination. The tests shall be reported as set out in clause 5.1.1. The tests shall, as a minimum, include, but not be limited to:

- a) **mechanical** security of **coupling**
- b) full brake functionality in every step, including the passenger communication apparatus (PCA)
- c) ensuring that door control is maintained, including door interlock and traction interlock functions being transmitted between vehicles
- d) ensuring that, where fitted, the following work correctly in the driving cab in use:
 - i) drivers safety device - DSD
 - ii) automatic warning system - AWS
 - iii) train protection and warning system - TPWS
 - iv) automatic train protection - ATP
 - v) drivers reminder appliance - DRA
 - vi) on train monitoring recorder - OTMR
- e) ensuring that all warning lights and audible warnings work correctly in the driving cab in use to give warning from any part of the train formation
- f) ensuring train communication systems, such as radios and public address, function correctly
- g) forward and reverse function compatibility
- h) after completion of the tests the **coupling** shall be examined to ensure no physical damage has occurred

3.1.3 Where a **coupling** design is modified, or **electrical** wiring to any safety system or train wire is modified an assessment shall be carried out to assess the potential to affect compatibility. Where the assessment shows it is necessary tests as set out in clause 3.1.2 shall be carried out.

3.1.4 For the purposes of this section 3.1, operators of a vehicle type which have had their couplings, or **electrical** circuitry associated with train wires and their function, modified since first built shall treat these vehicles as a separate vehicle type to those normally operated by another train operator. Where two train operators agree that vehicles have been modified to an identical modification procedure these need not be treated as different vehicle types.

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3.2 Compatibility of vehicles without **electrical** interconnectors

- 3.2.1 For vehicles fitted with **mechanical** and pneumatic connections only it shall be sufficient to state which types of vehicles can be safely coupled together.

Part 4 Design requirements

4.1 General design requirements for **coupling** systems

- 4.1.1 The design of **coupling** systems shall not expose persons to risk of injury from contact with **electrical** connections, or from being struck or trapped during foreseeable use of the system.
- 4.1.2 The **coupling** system shall be designed to transmit, safely and without suffering significant permanent deformation, all the sustained and maximum forces that arise between rail vehicles associated with:
- coupling** and uncoupling
 - traction and braking
 - traversing straight track
 - traversing curved track
 - vertical changes in alignment
 - shock loadings caused by play and flexibility in the train **coupling** and buffers.
- 4.1.3 The **coupling** system, with the exception of buffers, shall engage positively with the **coupling** system of any rail vehicle to which it is intended to couple in a train formation. For the purposes of this document engage positively shall be taken to mean to remain connected without risk of coming apart within designed parameters.
- 4.1.4 **Coupling** and uncoupling shall be possible on the range of track features foreseeable to be encountered by the particular vehicles.
- 4.1.5 The **coupling** systems, with the exception of buffers, shall remain positively engaged during all normal operations of the rail vehicles over the track features that they are required to negotiate. The design minimum curvature is shown on the Engineering Acceptance Certificate, as an example this could mean negotiating:
- straight track to 75 m radius - no transition
 - continuous curve of 75 m radius
 - reverse ('S') curve of 120 m radius with 3 m intermediate straight
 - reverse ('S') curve of 180 m radius with no intermediate straight.
- 4.1.6 Any system that controls the operation of the **coupling**/uncoupling shall be protected from reasonably foreseeable interference that could result in the system's inadvertent or malicious operation.
- 4.1.7 The design of the system shall ensure that it is possible to determine that the **coupling** systems are positively engaged, either directly or by a suitable system of indication.
- 4.1.8 The design of the system shall ensure that it is possible to arrange manual uncoupling of the two rail vehicles if the systems normally required for uncoupling are unavailable, whilst protecting against malicious operation.

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4.2 Particular requirements for passenger vehicles

- 4.2.1 Rail vehicles that are designed to carry passengers or personnel other than the train operator's own staff, or that are required to be coupled in passenger trains, shall be fitted with a **coupling** system. Such a **coupling** system, including the attachment to the vehicle structure, shall, during a collision or derailment, provide restraint that will resist the adjacent coupled vehicle:
- a) uncoupling
 - b) overturning
 - c) over-riding.
- 4.2.2. In addition the **coupling** system shall be fitted with a positive locking arrangement that prevents inadvertent uncoupling when the locking components are subject to a minimum acceleration of 5 g (for sufficient time) in any direction. This requirement is to ensure the **coupling** interface has a resistance to inadvertent release and does not constitute a structural load case on the coupler or other **inter-vehicle** connection elements.

4.3 Particular requirements for international traffic vehicles

- 4.3.1 Requirements for the mandatory position of air pipes and **electrical** cables on locomotives and driving trailers on international duty are set out in UIC leaflet 648.

4.4 Design requirements for drawgear

- 4.4.1 The strength of drawgear and its attachment to the vehicle body shall be less than the longitudinal tensile forces at the coupler positions on vehicle bodies. **GM/RT2100** sets out permissible forces on the vehicle body.
- 4.4.2 Drawgear shall withstand without failure the maximum longitudinal forces caused by **coupling** and by traction and braking, on straight and curved track, and switches and crossings, together with any shock loadings caused by play and flexibility in the train **coupling** systems.
- 4.4.3 Drawgear, and its attachment to a vehicle body, shall be designed to contribute to, or not conflict with, the requirements of **GM/RT2100** for body structural collapse and energy absorption.
- 4.4.4 Drawgear designed to be capable of transferring shear forces between adjacent vehicles shall withstand without significant permanent deformation the transfer of 100 kN in both the vertical and transverse directions simultaneously.
- 4.4.5 The structural adequacy of drawgear shall be:
- a) established by calculations, or
 - b) verified by testing, or
 - c) verified by comparison with other vehicles.

4.5 Design requirements for buffers

- 4.5.1 The strength of buffers and their attachments to the vehicle body shall, under axial loading, be the same as the longitudinal compressive forces at the buffer and coupler positions on vehicle bodies. **GM/RT2100** sets out permissible forces on the vehicle body.

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- 4.5.2 Buffers shall be designed to enable safe negotiation of the track geometry of the route accepted for, without buffer-locking. The design minimum curvature is shown on the Engineering Acceptance Certificate, as an example this could mean negotiating:
- straight track to 75 m radius - no transition
 - continuous curve of 75 m radius
 - reverse ('S') curve of 120 m radius with 3 m intermediate straight
 - reverse ('S') curve of 180 m radius with no intermediate straight.
- 4.5.3 For a vehicle, or outside faces of semi-permanently coupled vehicles, in tare condition buffers shall not exceed 1065 mm above rail level to centre of buffer. A design height of 1054 mm permits the upward adjustment that is sometimes necessary.
- 4.5.4 Minimum buffer height for a vehicle in fully laden condition shall be 940 mm above rail level to centre of buffer.
- 4.5.5 Buffers shall be designed to withstand contact with fixed buffer stops to arrest the train speed without damage to vehicle or buffer stops. The impact force shall be calculated, including using the following factors:
- maximum train weight, it is permissible to make an allowance of 25% of kinetic energy absorption by the vehicle and load
 - the impact speed to be used in design calculations shall be not less than 7 km/h.
- 4.5.6 The adequacy of buffer strength shall be:
- established by calculations, or
 - verified by testing, or
 - verified by comparison with other vehicles.
- 4.6 Design requirements for electrical interconnectors**
- 4.6.1 New rail vehicles that have electrical interconnectors that are physically compatible with existing vehicles but which have incompatible electrical systems shall be designed to prevent operation or damage if inadvertently coupled.
- 4.6.2 Interconnectors not in use when the vehicle is in service shall be provided with a method of secure stowage to prevent hazard to the interconnector and/or the infrastructure and/or people.
- 4.7 Design for rescue**
- 4.7.1 Rescue/recovery of rail vehicles shall be achieved by using the fully compatible coupling systems fitted to the vehicles or by an adaptor coupling system that enables two rail vehicles with dissimilar coupling systems to be coupled together.

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4.8 Adaptor couplings

- 4.8.1 Except when used only for rescue and recovery, adaptor couplings shall comply in all respects with the requirements of this document.
- 4.8.2 Where used for rescue and recovery the adaptor **coupling** and rail vehicle **coupling** system shall accept the forces and movements involved in the recovery of the failed vehicle or train without permanent deformation or damage. Where the adaptor **coupling** is designed for a particular vehicle any limitations on vehicle movement and operation, arising from the use of the adaptor **coupling** system, shall be identified and shown as a limitation on the Certificate of Engineering Acceptance.

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Part 5 Provision and publication of compatibility information

5.1 Provision of information

- 5.1.1 Train operators shall inform the infrastructure controller of which vehicle types are compatible in which combination following the decisions and tests carried out in section 3.1 or decisions taken in section 3.2.
- 5.1.2 Train operators shall ensure that the infrastructure controller is advised that where a failed train is to be assisted by another train that either the vehicles are fully compatible, as set out in Part 3 or the scope of the incompatibility is known and its impact can be mitigated (for example where vehicles are mechanically joined but the **electrical** connections are incompatible).
- 5.1.3 Details of the vehicle **electrical** interconnectors, including the cable number connected to each pin/tube/contact, the associated circuit(s) and the supply voltage, which are fitted to all vehicles shall be registered by the train operator with Rail Safety and Standards Board, submitted to the Principal Traction and Rolling Stock Engineer.
- 5.1.4 Any modification to the design of **electrical** interconnectors, including change of use of cables, shall be registered with Rail Safety and Standards Board, as set out in clause 5.1.3. The receipt received (as set out in clause 5.2.1) shall be proof of compliance with this clause.
- 5.1.5 Details of the vehicle **mechanical** couplings, including the adaptor couplings, which are fitted to all vehicles shall be registered by the train operator with Rail Safety and Standards Board, submitted to the Principal Traction and Rolling Stock Engineer.
- 5.1.6 Any modification to the design of **mechanical** couplings, or adaptor couplings, shall be registered with Rail Safety and Standards Board, as set out in clause 5.1.5. The receipt received (as set out in clause 5.2.1) shall be proof of compliance with this clause.

5.2 Publication of information

- 5.2.1 Rail Safety and Standards Board shall provide a receipt to the sender of information supplied as required by clauses 5.1.4 and 5.1.6
- 5.2.2 Details of vehicle **electrical** interconnectors currently in use are listed in GM/GN2590 and the additional information supplied as set out in clauses 5.1.3 and 5.1.4 shall be added to the GM/GN2590 so that other vehicle designers requiring to use through cables with conflicting cable and circuit connections do not use similar **mechanical coupling** arrangements.
- 5.2.3 Details of vehicle **mechanical** couplings currently in use are listed in GM/RC2509 (which is due to be replaced by GM/GN2690), and the additional information supplied as set out in clauses 5.1.5 and 5.1.6 shall be added to GM/RC2509 so that the information on compatibility is available to all Railway Group members.
- 5.2.4 GM/GN2590 and GM/RC2509, which is due to be replaced by GM/GN2690, shall be reissued at a frequency commensurate with the magnitude of submissions by train operators.

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References

The Catalogue of Railway Group Standards and the Railway Group Standards CD-ROM give the current issue number and status of documents published by Rail Safety and Standards Board.

Documents referenced in the text

Railway Group Standards

- GA/RT6001** Railway Group Standards Change Procedures
- GA/RT6004** Temporary Non-Compliance with Railway Group Standards
- GA/RT6006** Derogations from Railway Group Standards
- GE/RT8000** Rule Book
- GM/RT1300** Engineering Acceptance of Road-Rail Vehicles and Associated Equipment
- GM/RT2000** Engineering Acceptance of Rail Vehicles
- GM/RT2100** Structural Requirements for Railway Vehicles
- GM/RT2400** Engineering Acceptance and Design of On-Track Machines
- GM/RT2402** Engineering Acceptance of Rail Mounted Maintenance Machines

Railway Group documents

- GM/GN2590** Guidance Notes for Traction and Rolling Stock Vehicle **Electrical** Interconnections
- GM/RC2509** Code of Practice for Traction and Rolling Stock **Mechanical Coupling** Systems
- GM/RC2519** Code of Practice – Design and Construction of Freight Wagons

Other references

Railways (Safety Case) Regulations 2000

Other documents

UIC leaflet 648 Connections for electric cable and air pipes on headstocks of locomotives and driving trailers.

Further related documents

Railway Group Standards

- GM/RT2260** Design for Recovery of Railway Vehicles After Accidents
- GC/RT5033** Terminal Tracks – Managing the Risk