UGL REGIONAL LINX

MINIMUM OPERATING REQUIREMENTS FOR LOCOMOTIVE HAULED PASSENGER VEHICLES

CRN-STD-ROL-713026361-2290

CRN RS 003

LINKING COMMUNITIES. CONNECTING CUSTOMERS.

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Document Control

Function	Position	Name	Date
Approver	A&E Manager	Lucio Favotto	30.01.2022

Revision	Issue Date	Revision Description
1.0	17/02/2022	UGLRL Template applied; First approved and issued UGLRL version

Summary of changes made from previous version

Section	Summary of change
All	This document is based on the previous rail infrastructure maintainer (RIM). Full revision history is available on request from UGLRL.

1 Introduction

1.1 About this standard

This standard is a locomotive hauled passenger vehicle interface standard, covering the minimum technical requirements for the operation of locomotive hauled passenger vehicles on the NSW Country Regional Rail Network (CRN).

UGL Regional Linx (UGLRL) has established interface requirements pertaining to all rail vehicles operating on the CRN. The requirements in this standard shall be read in conjunction with CRN RS 008, General Interface Requirements for Rolling Stock and CRN RS 010, Vehicle Acceptance Test and Inspection Requirements.

Users of this interface standard, be it owner/operators, designers, manufacturers, suppliers or maintainers of rail vehicles, or their component parts, are responsible for making their own enquiries in relation the applicability of this standard, as well as related national standards, guidelines and codes of practice, to their own situation or need. This standard was prepared with an awareness of known rail vehicle interface risks and seeks to address each of those risks, however it is the end users' duty of care, in preparing their own specifications, designs, processes and procedures, to assess the risks associated with and/or peculiar to their own situation.

When the words "shall" or "must" are used in this document, the requirements shall be read as mandatory for vehicles operating on the CRN.

When the word "should" is used in this document, the requirements shall be read as recommended.

When the word "may" is used in this document, the requirements shall be read as advisory.

The requirements of this standard will apply to all new, substantially modified locomotive hauled passenger vehicles and locomotive hauled passenger vehicles that have not operated previously on the CRN. Locomotive hauled passenger vehicles that have operated on the CRN prior to 30 January 2022 will be considered as deemed to comply with this standard. Older locomotive hauled passenger vehicles with a historical background may not comply completely with this standard but will be assessed, considering the design and proposed use of the vehicle(s).

In this standard, the terms "owner", "operator' and "owner/operator" are used. They refer to the owner of the rolling stock, the operator using that rolling stock or, where both owner and operator are the one organisation.

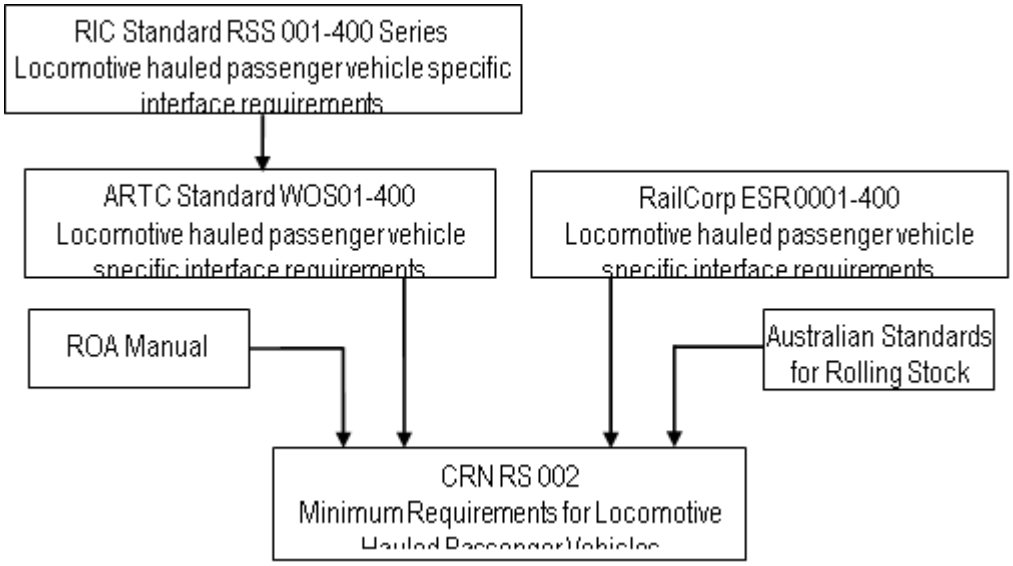
1.2 Rolling stock standards suite

This standard is a part of a suite of rolling stock standards covering the interface between rolling stock and the CRN operating environment. The following documents form the core standards suite.

CRN RS 001	Minimum Operating Requirements for Locomotives
CRN RS 002	Minimum Operating Requirements for Freight Vehicles
CRN RS 003	Minimum Operating Requirements for Locomotives Hauled Passenger Vehicles
CRN RS 004	Minimum Operating Requirements for Multiple Unit Trains
CRN RS 005	Minimum Operating Requirements for Rail Bound Infrastructure Maintenance Vehicles
CRN RS 006	Minimum Operating Requirements for Road/Rail Infrastructure Maintenance Vehicles
CRN RS 008	General Interface Requirements for Rolling Stock
CRN RS 010	Vehicle Acceptance Test and Inspection Requirements

1.3 Standard development

This CRN standard was developed from existing standards that were originally issued by the Rail Infrastructure Corporation to the ARTC for the technical management of rolling stock operating on the NSW country and defined interstate network. Those standards have been further enhanced and updated using relevant data from current RailCorp interface standards, the ROA Manual and the Australian Standards for Rolling Stock. The following flow chart shows the origins and development stages of the standard.



1.4 Australian Standards for Railway Rolling Stock

The RISSB (Rail Industry Safety and Standards Board), a part of the Australasian Railway Association, is currently producing the Australian Standards for Railway Rolling Stock which will eventually supersede the Railways of Australia (ROA Manual of Engineering Standards and Practices.

The current listing of Australian Standards for Railway Rolling Stock can be found on the website: www.rissb.com.au. The listed standards are categorised as being “Published”, “For Comment”, “Future”.

To obtain access to the published Australian Standards for Railway Rolling Stock, an organisation must be a full or an associate member of the Australasian Railways Association.

1.5 Definition of a locomotive hauled passenger vehicle

For the purposes of interpretation of this standard a locomotive hauled passenger vehicle is a vehicle designed to carry passengers, passenger facilities and/or crew accommodation. Locomotive hauled passenger vehicles are marshalled together to form a train which is hauled by one or more locomotives.

1.6 Locomotive hauled passenger vehicle design

Locomotive hauled passenger vehicle design must generally comply with the interface requirements of this minimum operating standard. Where the Australian Standards for Railway Rolling Stock have been published, then compliance may be required with those standards also.

The ROA Manual of Engineering Standards and Practices was produced primarily to cover new or substantially modified vehicles operating on the interstate standard gauge rail network, therefore requirements are included from the ROA Manual of Engineering Standards and Practices, where applicable.

The design of any rail vehicle shall also take into account the requirements of the Occupational Health and Safety Act, however this standard does not specifically cover Occupational Health and Safety requirements, which fall within the responsibility of the vehicle owner/operator.

The design of any locomotive hauled passenger vehicle shall take into account and demonstrate compliance with the requirements of relevant environmental legislation, in particular those requirements relating to noise and waste management.

Existing locomotive hauled passenger vehicle designs authorised to operate within New South Wales as at 30 January 2022 will be permitted to operate on the CRN under existing vehicle approvals.

As of 30 January 2022 newly introduced or substantially modified locomotive hauled passenger vehicles shall be subject to review and assessment, by the CRN Manager, for compliance with the relevant standards and legislation. Locomotive hauled passenger vehicle owner/operators will be required to submit the necessary documentary evidence to verify that their vehicle is compliant.

Locomotive hauled passenger vehicles that do not fully comply with the standards and legislative requirements will be subject to critical review and in some cases may be permitted to operate under nominated restrictions as determined by the CRN Manager.

An Exemption Certificate may be issued for non-compliances with these standards, where the CRN Manager deems that the non-compliance is acceptable and does not compromise safety or relevant legislation.

1.7 Locomotive hauled passenger vehicles authorised to operate on the NSW Country Regional Network

Only locomotive hauled passenger vehicles approved to operate on the New South Wales rail network, accepted by the CRN Manager and registered with an accredited owner/operator by ONRSR (the Office of the National Rail Safety Regulator) will be permitted to operate on the CRN.

Vehicle owner/operators shall be responsible for registering each vehicle type they wish to operate with the Office of the National Rail Safety Regulator.

Vehicle owner/operators shall be responsible for obtaining vehicle acceptance from the CRN Manager.

Locomotive hauled passenger vehicles, to be fully accepted on to the CRN, must have relevant operating details published in the CRN Train Operating Conditions (TOC) Manual. (For interim or conditional acceptance, see below.)

Vehicles not published in the CRN Train Operating Conditions manual shall not be operated or moved on the CRN unless special approval in the form of a CRN TOC Waiver is issued. This approval is required for any movement including that of vehicles undergoing tests.

Vehicles with a defect as specified herein, sufficient for that vehicle to be removed from service, detected or known to be operating, on an adjacent rail network, shall not enter the CRN without the authority of the CRN Manager.

All locomotive hauled passenger vehicles must be maintained in a condition that meets or exceeds the minimum operating requirements contained in this standard. Where it is deemed that the condition of a locomotive hauled passenger vehicle has deteriorated below these minimum requirements, then the authority to operate that vehicle on the CRN may be withdrawn until it can be demonstrated that the vehicle roadworthiness has been reinstated.

1.8 Acceptance of new locomotive hauled passenger vehicles

To apply for new locomotive hauled passenger vehicle acceptance the owner/operator shall complete the appropriate Vehicle Certification Request Form, CRN RF 003 and submit it to the CRN Manager.

Where testing is to be conducted on the locomotive hauled passenger, refer to section 1.10 below.

Once a locomotive hauled passenger vehicle has been approved, details of the vehicle will then be published in the CRN Train Operating Conditions manual along with any special operating conditions.

Locomotive hauled passenger vehicle acceptance is for vehicle type compatibility with the CRN only, and does not warrant the structural integrity of all vehicles of that type, based on design and/or construction. Locomotive hauled passenger vehicle acceptance for operation on the CRN requires that such vehicles continue to be maintained fit for purpose, in accordance with the accredited Owner/Operators' vehicle maintenance standards.

1.9 Change of locomotive hauled passenger vehicle design or operating conditions

Where a locomotive hauled passenger vehicle has been modified or is proposed to be modified, such that the modification is going to impact on the vehicle's performance then the owner/operator must advise the CRN Manager and apply for a vehicle re-approval.

This applies to any modifications that may affect vehicle on-track performance such as flexibility of a vehicle structure, suspension stiffness, braking performance, loading of the vehicle, etc.

1.10 Testing of locomotive hauled passenger vehicles

Testing of any locomotive hauled passenger vehicle/s on the CRN shall not be carried out without the prior approval of the CRN Manager and the issuance of an appropriate CRN TOC Waiver.

New or substantially modified locomotive hauled passenger vehicles shall successfully undergo type testing in accordance with the guidelines and tests specified in CRN Standards CRN RS 008 and CRN RS 010, respectively, being conducted prior to acceptance, to confirm safe operation and compliance with the appropriate environmental requirements.

All of the static tests must be satisfactorily completed before the vehicle will be permitted to move on the CRN.

The CRN Manager reserves the right to:

- have a representative present for each of the tests.
- request the owner/operator to conduct further testing where it is suspected that the vehicle performance has deteriorated.
- have access to all relevant raw test data (this may apply to a number of tests).

Once the CRN Manager is satisfied with the performance of the vehicle/s, further testing may be carried out at the discretion of the owner/operator but only with prior notification and agreement of the CRN Manager.

For locomotive hauled passenger vehicles tested on the CRN or tested on other rail systems, the test results shall be submitted to CRN Manager for assessment, using the appropriate Vehicle Information Pack listed above.

2 Locomotive hauled passenger vehicle components

The following sections cover component requirements which are specific to the operating safety of locomotive hauled passenger vehicles. Refer to CRN Standards CRN RS 008 and CRN RS 010 for general interface requirements and testing requirements, respectively.

3 Wheels

All locomotive hauled passenger vehicle wheels shall be designed, generally in accordance with the standard dimensions shown in AAR Specification M 107, Figures 6, 7 and 8 for wrought steel

wheels, or AAR Specification M 208 figures 6, 7 and 8, for cast steel wheels, with the following additional requirements:

3.1 Wheel diameter

The wheel diameter is measured at the wheel tread centre line, which is 70 mm from the back face of the wheel, as shown on the relevant profile drawing.

In determining and/or approving locomotive hauled passenger vehicle operating conditions, the CRN Manager will consider maximum axle load and the maximum P/D ratio, (ie the ratio of maximum static wheel load to minimum [worn] wheel diameter).

The maximum allowable P/D ratios for the operation of worn wheels on the CRN are specified in CRN Standard CRN RS 008, Section 3.4 Table 2

Where it is proposed to operate locomotive hauled passenger vehicles having P/D ratios exceeding these limits, approval must be obtained from the CRN Manager.

Refer to CRN Standard CRN RS 008, Section 3.4 Table 3 for currently approved bogie/wheel load/wheel diameter combinations for new wheels.

3.2 Wheel width

Wheel overall width, measured from the back of the flange to the wheel rim face, shall nominally range from 130 mm to 140 mm.

3.3 Wheel web shape

S-Plate, low stress wheels are preferred for all locomotive hauled passenger vehicles where tread braking is performed, and shall be used on all locomotive hauled passenger vehicles where AAR Class C wheel material is used in conjunction with tread braking. Refer to Section 3.6 herein for brake block compatibility.

Conventional curved plate wheels are acceptable for AAR Class A and B wheel material applications. Refer to Section 3.6 herein for brake block compatibility.

Straight webbed wheels are to be avoided on tread braked vehicles where possible.

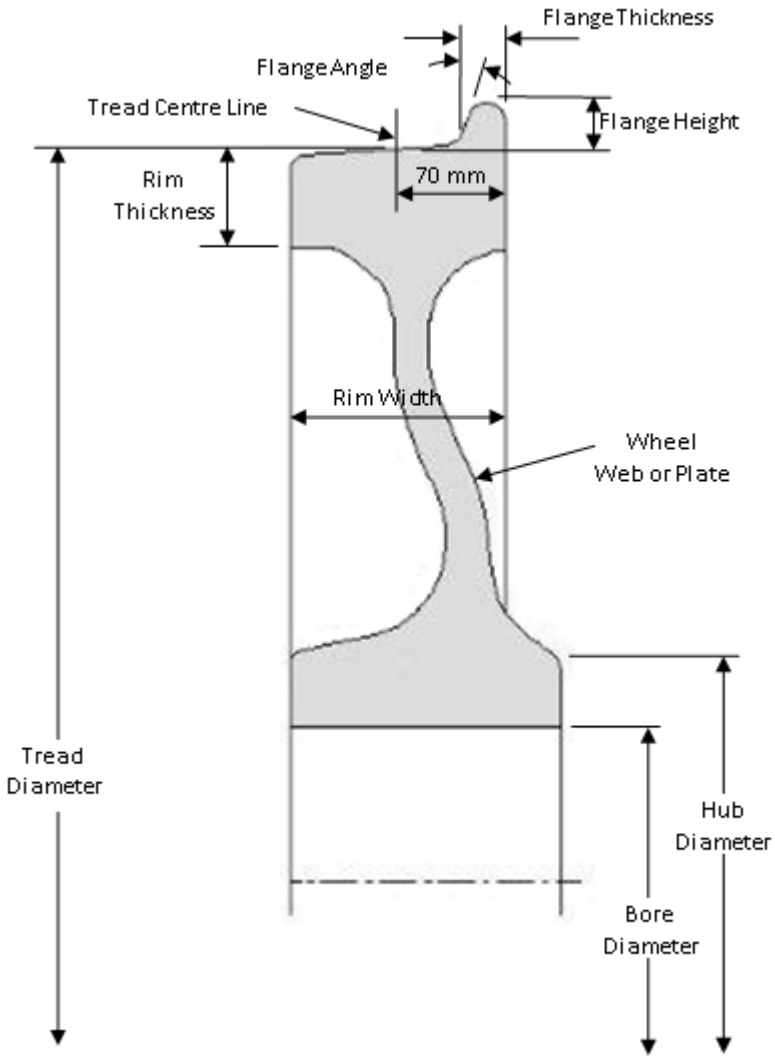


Figure 1 - Wheel parts and principal dimensions

3.4 Alternate wheel designs

Alternate design methods may be used for integral steel wheels only, however, such proposals shall be subject to review by the CRN Manager.

This review will require submission of an analysis and the relevant technical information required by AAR Standard S660 - Procedure for Analytic Evaluation of Loco and Freight Car Wheel Designs, however the application of loads, rim condemning thickness and wheel profiles shall relate to the local conditions and the final approval shall be at the discretion of the CRN Manager.

3.5 Wheel manufacture

Wheels shall be either cast steel or wrought steel, and manufactured in accordance with the following standards or CRN approved standards:

The CRN Manager has adopted the technical requirements referred to in AAR specifications M-107, Class A, B or C, as being suitable for application to locomotive hauled passenger vehicles operating or intended for operation on the CRN.

3.6 Wheel material and brake block compatibility

Only the combinations of wheel material and brake block type shown in Table 1 are recommended, in order to reduce the incidence of thermal tread damage.

Type of brake block	Class of wheel
Low friction	AAR Class A or equivalent
Medium friction	AAR Class A or equivalent
High friction	AAR Class A, B or C or equivalent
Cast iron	AAR Class A, B or C or equivalent

Table 1 - Wheel material brake block compatibility

Refer to CRN Standard CRN RS008, Section 7 for brake block friction characteristics.

3.7 Wheel identification

The serial numbers on all wheels must be traceable back to the manufacturer and the specific heat batch.

The method specified in Figure 2 below is common practice and is recommended.

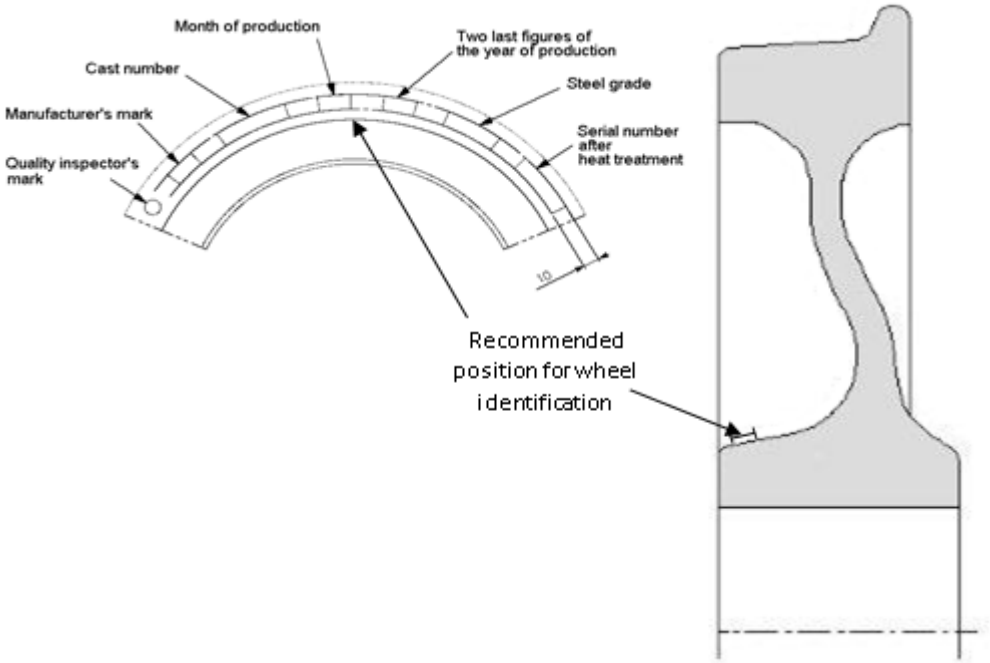


Figure 2 - Wheel identification

3.8 Wheel profiles

The following wheel profiles are approved for use on the CRN.

3.8.1 WPR 2000 wheel tread profile

The WRP 2000 wheel tread profile is a generated worn wheel profile designed to match the prominent NSW worn rail profile. Refer to CRN Standard CRN RS 008, Appendix 2 for co-ordinate details for the WPR 2000 wheel tread profile. Whilst this worn wheel profile was developed with a view to providing increased wheel life, in-service experience has shown that some freight vehicles are sensitive to the higher conicity produced at the root radius resulting in bogie hunting instability. If locomotive hauled passenger vehicles are prone to hunting with the WPR 2000 profile, the ANZR1 profile may be used as a substitute.

3.8.2 Wheel test profile

For the test wheel tread profile refer to CRN Standard CRN RS 010 Section 19.3.

3.8.3 Standard ANZR profile (also known as the ANZR-1 profile)

This profile is depicted in Figure 3 below and is the base standard profile for all rolling stock operating on the CRN.

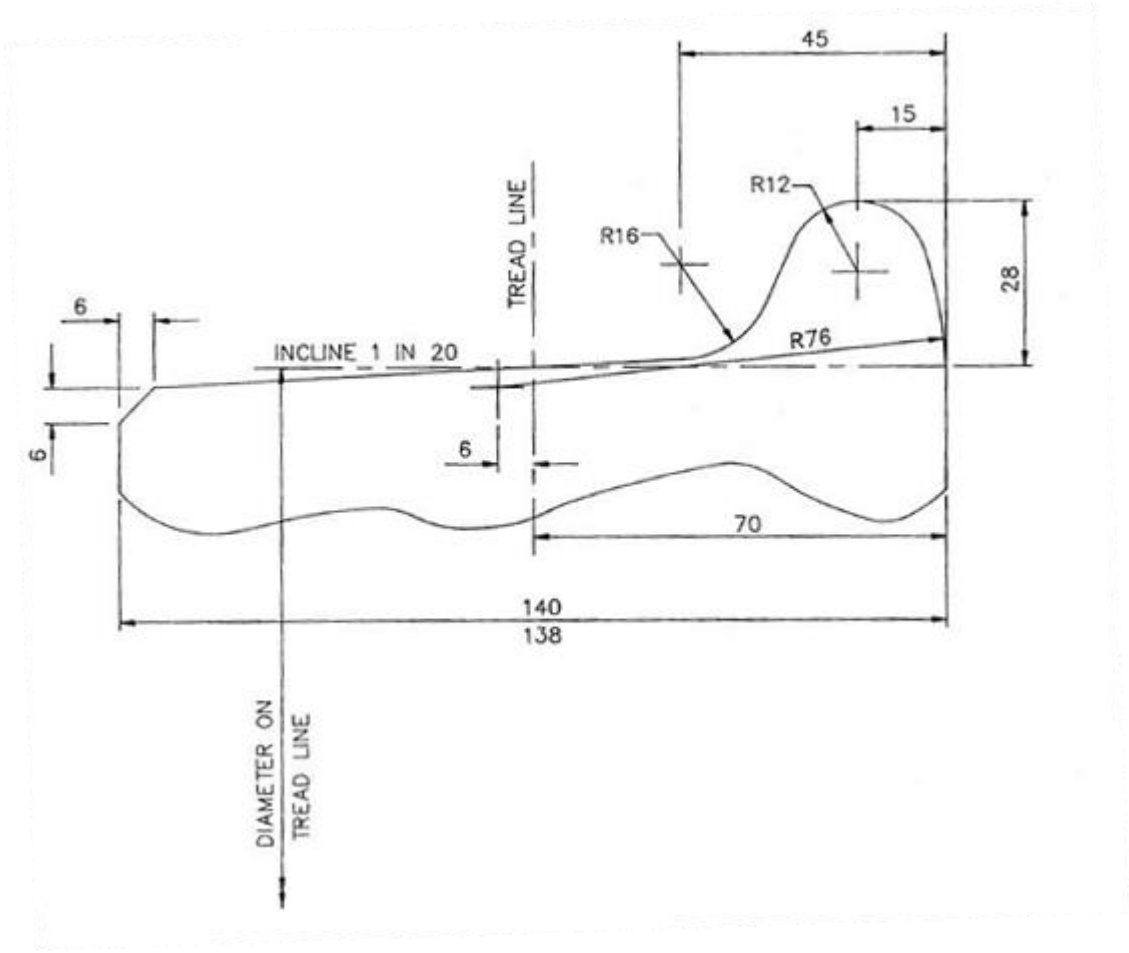


Figure 3 - ANZR1 Wheel Tread Profile

The 7/8 flange variant of this profile is also permitted on the CRN.

3.8.4 Alternate wheel tread profiles

Alternate wheel tread profiles will be considered, however, such proposals must be compatible with the rail profile and the CRN rail management methods and can only be used with the approval of the CRN Manager.

3.9 Wheel profile machining

3.9.1 Surface Finish

It is important when machining the wheel tread and flange profile that the surface finish be maintained within acceptable limits. This is to ensure that surfaces which normally contact the rail and/or check rail are smooth, free of machine chatter marks, surface waviness or grooving, which could contribute to a wheel flange climb derailment.

The surface finish of the wheel tread and flange, after machining shall not exceed 12.5 µm (micrometres) RA (Roughness Average).

3.9.2 Machine tolerance & undercutting

The profile of a freshly machined wheel tread and flange shall not deviate below the true profile by more than 0.25 mm. That is, it shall not be possible to insert a 0.25 mm feeler gauge beneath a profile gauge positioned on the wheel tread.

Undercutting, grooving or waviness of the tread surface between the flange back and the outer edge of the tread, is permitted but shall not exceed 0.25 mm in depth below the true tread profile.

3.9.3 Witness marks

Witness marks used for an indication of machining efficiency, are permitted between the flange tip and a point 10 mm above the wheel tread baseline and shall not exceed 6 mm in width.

Witness marks permitted shall only be as a result of the wheel machining process, where the witness mark represents a section of the wheel surface which has not been machined, and contains the original surface material surface. Refer to Figures 4 and 5 for unacceptable and acceptable witness marks, respectively.

Witness marks shall not include wheel damage from derailments etc. or an incorrect machining process.

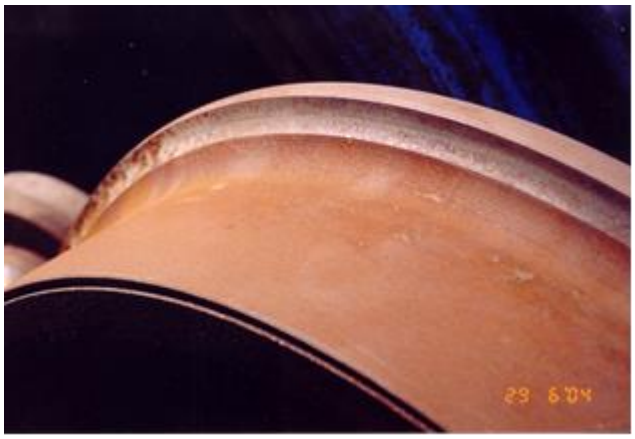


Figure 4 - An unacceptable witness mark

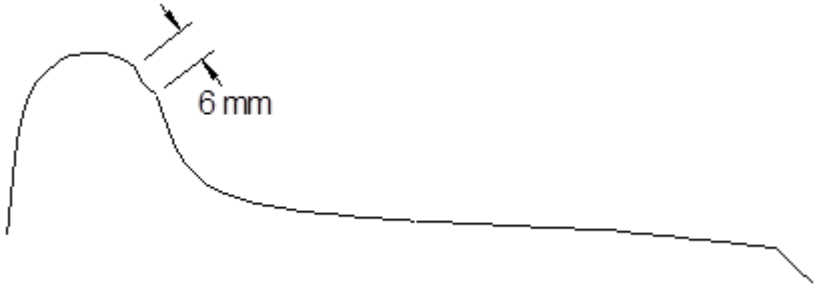


Figure 5 - Witness mark dimensional limit

3.10 Tyred wheels

3.10.1 Locomotive hauled passenger vehicles fitted with tyred wheels

The use of tyred wheels will only be permitted on steam locomotives and historical vehicles where such vehicles were originally equipped with tyred wheels. Owner/operators of vehicles with tyred wheels shall have in place adequate maintenance procedures to ensure that tyred wheels are inspected regularly to prevent the possibility of loose tyres.

All other locomotive hauled passenger vehicles must be equipped with integral steel wheels unless otherwise approved by the CRN Manager.

3.10.2 Brake block compatibility with tyred wheels

Only cast iron brake blocks shall be used with tyred wheels.

3.11 Wheel generated noise

Noise pollution has become an important environmental issue for the rail system as a whole, and owners/operators are encouraged to seek a wheel design that attenuates wheel noise emissions such as curve squeal.

3.12 Wheel minimum operating requirements

The following describes the minimum dimensional limits under which locomotive hauled passenger vehicle integral steel wheels may continue in service.

3.12.1 Wheel rim thickness limits

A locomotive hauled passenger vehicle shall not remain in service if it has a wheel rim thickness less than the limit specified below.

Vehicle Type	Minimum wheel rim thickness
Locomotive hauled passenger vehicle	25 mm

Table 2 - Minimum wheel rim thickness

3.12.2 Permissible Variation in Wheel Diameter

On locomotive hauled passenger vehicles, the diameter variation between wheels on the same axle shall be in accordance with locomotive hauled passenger vehicle manufacturer's requirements, but they shall not exceed that specified in Table 3.

Passenger Vehicle Wheel	Maximum Variation in Wheel Tread Diameters
per axle (new or re-turned)	0.5mm
per axle (in service)	1mm
per bogie	25mm
per vehicle	60mm

Table 3 - Permitted variations in wheel diameter

3.12.3 Wheel defects and defect limits

For wheel defects, defect limits and risk mitigation measures refer to CRN Standard CRN RS 015.

4 Axles

Locomotive hauled passenger vehicle axles shall be designed in accordance with one of the following standards:

- Standard dimensions given in AAR Specification M-101, for the load ratings given on page G-II-30.
- UIC 515-3
- British Rail T 72
- Modified Reuleaux method.

The design method and the material grade of the axle shall be selected with due regard for its application.

Alternate design methods may be used, however such proposals shall be subject to approval by the CRN Manager.

4.1 Axle manufacture

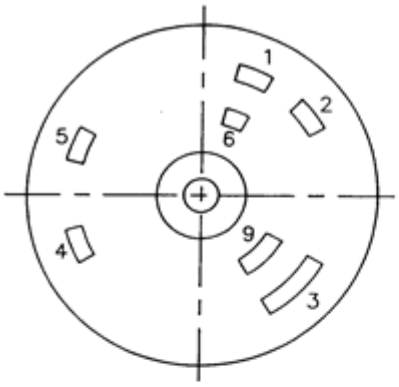
Locomotive hauled passenger vehicle axles shall be of forged steel and be manufactured in accordance with AAR Specification M-101, or approved equivalent.

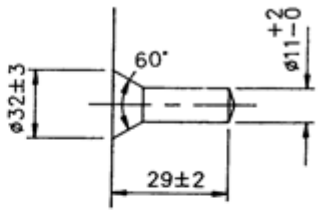
4.2 Axle remanufacture

All reclamation and/or modification of axles shall be in accordance with AAR M-101, Section G part 2, rules 2A4 and 2A5. Locomotive hauled passenger vehicle axles that are unable to be reused for their normal application due to dimensional limits may be cascaded to a lesser duty for an alternate axle application provided the re-machined axle has no defects.

Any other proposal for the reclamation of axles must first be approved by the CRN Manager.

4.3 Axle identification





DETAIL OF CENTRE

1. OWNER'S INITIALS.
2. MANUFACTURER'S NAME OR INITIALS.
3. AXLE SERIAL NUMBER. (ALLOTTED BY SYSTEM OR MANUFACTURER)
4. HEAT NUMBER
5. YEAR ULTRASONICALLY OR MAGNETICALLY TESTED.
6. WHEEL MOUNTING FIRM'S NAME OR INITIALS.
7. SIZE OF BRANDING 5mm MIN. TO 8mm MAX.
8. THE AXLE NUMBER SHALL BE STAMPED ON BOTH, THE LEFT AND RIGHT HAND ENDS OF THE AXLE. ALL OTHER BRANDINGS SHALL BE ON THE RIGHT HAND END OF THE AXLE ONLY.
9. L AND R TO BE STAMPED ON THE LEFT AND RIGHT HAND ENDS OF EACH AXLE.

NOTE: TO FACILITATE ULTRASONIC TESTING ALL BRANDING TO BE DRESSED FLUSH.

Figure 6 - Recommended axle Identification Method

The serial numbers on axles must be traceable back to the manufacturer and their specific heat batch.

The method specified in Figure 6 below or AAR Specification M-101, Figure 2 are the recommended alternatives.

4.4 Axle minimum operating requirements

The following describes the minimum allowable conditions under which solid forged steel axles may continue in service.

4.4.1 Axle condemning diameters

Locomotive hauled passenger vehicle owner/operators shall have proven industry standards clearly specifying the condemning diameters for the axle component parts.

No axles shall be permitted to enter service if the axle size falls below the condemning diameter specified for that part of the axle.

Refer to Clause 4.2 above for axle remanufacture requirements.

4.4.2 Welding on axles

An axle is a component subject to fatigue loading due to cyclic bending and torsional reversals during normal operation, therefore under no circumstances is welding permitted on any part of an axle.

4.4.3 Axle defects

The following axle defects will require a locomotive hauled passenger vehicle axle to be immediately removed from service. Defects may consist of scoring, grooves, scratches, flame cutting marks, welding, grinding, chisel marks or similar indentations.

- Any axle defect greater than 3 mm deep which has a sharp edge or base, no radius evident on either side or at the base of the imperfection, has a pronounced lip adjacent to the imperfection, or any doubt exists as to the depth of the defect.
- Any axle defect greater than 5 mm deep.
- Any axle with visible cracks in the axle body, either between the wheel seats or adjacent to the wheel hub.
- Any axle which is bent, suspected of being bent, damaged due to overheating through bearing failure, or otherwise distorted.

  Where the following defect is detected on an operational locomotive hauled passenger vehicle axle, the vehicle is to be worked out of service for repairs:

- Any locomotive hauled passenger vehicle with an axle defect greater than 3 mm deep, but less than 5 mm deep which has smooth even wear, is well radiused, and does not have any other imperfection such as a lip or roll over on the edge of the damaged area. If any doubt exists as to the severity of this defect, the vehicle shall be immediately removed from service.

4.5 Wheel and axle assembly

The following applies to wheelsets comprising both integral steel wheels and tyred steel wheels.

4.5.1 Wheel and axle assembly

Locomotive hauled passenger vehicle owner/operators/manufacturers shall follow proven industry standards for the assembly of vehicle wheels onto axles. These standards may allow either a conventional wheel press-on assembly using a suitable approved lubricant, or a shrink fit assembly. In each case the wheel clamping force shall be provided by the required interference fit.

4.5.2 Wheel press-on lubricant

A proven wheel mount lubricant shall be used for wheelset assembly. Where a proposed lubricant is unproven under Australian conditions the application shall be subject to the approval of the CRN Manager.

WARNING

Some wheel mounting lubricants are affected by increased wheel temperatures due to braking, which may result in relative movement between wheel and axle.

Also some wheel mounting lubricants may affect electrical conductivity between wheel and axle and thus may compromise signal shunting

Wheel mounting lubricant, Rocol Wheelmount Compound, has been used successfully, but approved alternatives may be used provided the wheel interference force on the axle wheel seat is not compromised.

4.5.3 Wheelset assembly records

The following information shall be recorded and retained for the life of each wheelset assembly, for audit purposes and for tracking purposes in the event of an in-service wheelset failure investigation:

- Individual wheel and axle identification.
- Axle wheelseat diameter, measured at 90 degree intervals around the circumference, and in two (2) planes on the wheelseat.
- Wheel bore diameter, measured at 90 degree intervals around the circumference, and in two (2) planes of the wheel bore.
- Method of assembly; whether press-on or shrink fit
- Analogue record of press-on tonnage verses displacement, achieved for each wheel pressed on, where applicable.
- Results of a back pressure test load on wheels, where it is necessary to confirm wheel interference fit security.
- Wheelset back to back dimension, measured at three (3) points equidistant around the back of the wheel rim at a point 40 mm below the outer circumference of the wheel flange.

4.5.4 Wheel back to back measurement

The wheel back to back dimension shall be measured at three (3) points, equidistant around the back of the wheel rims at a point 40 mm below the outer circumference of the wheel flange. The measurements # between the two (2) wheels shall be within the following range.

Minimum	1357 mm
Maximum	1360 mm

The difference between any two (2) dimensions shall not exceed 1 mm.

4.5.5 In-service back to back dimension

Whilst wheelsets are in service, beneath the vehicle and the wheels are sitting on the rails under load, the wheel back to back dimension shall be measured where possible at four (4) points representing the 3 o'clock, 6 o'clock, 9 o'clock and 12 o'clock positions around the wheel, at a point 40 mm below the outer circumference of the flange. The dimensions measured at the 3 o'clock and 9 o'clock positions should be within the limits specified above whilst the dimensions measured at 6 o'clock and 12 o'clock may be outside the above limits. Note: This discrepancy is normal and is due to the axle deflection under load, resulting in the 12 o'clock dimension being larger than the 6 o'clock dimension.

When the vehicle is moved such that the wheelset is rotated 180 degrees, and the back to back is measured again at four (4) points representing the 3 o'clock, 6 o'clock, 9 o'clock and 12 o'clock

positions, there shall not be more than 3 mm variation between the two (2) measurements taken at 6 o'clock and 12 o'clock, respectively.

4.5.6 AAR wheelsets with reduced back to back

The AAR wheelset design with a thick flange profile and reduced back to back dimension is not compatible with the NSW rail network and thus will not be permitted to operate on the CRN.

5 Axle bearing assemblies

With the design and selection of locomotive hauled passenger vehicle roller bearings, due regard shall be given to the fatigue life of the bearing assembly, taking into account all the factors relevant to the application.

Axle roller bearing assemblies shall be operated within their designed load capacity.

5.1 Approved axle roller bearings

Only roller bearings, including package unit bearings, with a proven reliability in an Australian mainline railway operating environment, for a particular bearing application, shall be used.

Where bearings are proposed which fall outside that specified above, the owner/operator shall advise the CRN Manager and indicate the proposed method of testing/evaluation of such bearings to substantiate their reliability and suitability for the application.

5.2 Axle roller bearing maintenance

The owner/operator shall follow proven industry standards and have procedures in place for the following maintenance activities:

- Installation and removal of roller bearing assemblies to and from axles.
- Lubrication of axle roller bearing assemblies.
- Remanufacture of axle roller bearing assemblies, where applicable.
- Requalification of axle journals, axle boxes and bearing adaptors.
- Regular field inspection of axle roller bearing assemblies for defects.
- Field adjustment of axle roller bearing assemblies where applicable.

5.3 Axle roller bearing defects detected in the field

Axle roller bearing assemblies with any defects as listed below shall not enter service or if found in service, shall be removed from service for maintenance attention.

- Loose, misaligned, visibly damaged or distorted seals or where there is evidence of recent leakage or loss of grease
- Damaged or distorted end cap or locking plate (where applicable)
- Loose or missing cap screws or locking plate (where applicable)
- Visible evidence of overheating or a temperature at inspection considerably greater than that of the other bearings in the same bogie or locomotive hauled passenger vehicle.
- Visible evidence of water damage, submersion or penetration
- Visible evidence of damage caused by arc welding, flame cutting, etc.
- Any other visible evidence or Indication of external damage
- Loose or damaged backing ring or back cover and/or fixings (where applicable)
- Loose, missing or damaged end plugs or grease nipples (where applicable)

5.4 Action required following derailments for axle roller bearings

The owner/operator shall have procedures in place for bearing inspection and requalification following any derailment, in order to mitigate the risk of future premature in-service failure of bearing components.

5.5 Axle package unit bearing adaptors

Axle package unit bearing adaptors, where applicable, shall be designed in accordance with the standard dimensions for the particular bearing size.

Any evidence of bearing adapter misalignment or distortion of the adaptor seating radius, shall be cause for the vehicle not entering service or being immediately removed from service.

The use of an incorrect adaptor size for a package unit bearing application can cause premature bearing failure and that shall be cause for adaptor replacement or the passenger vehicle being immediately removed from service.

5.6 Axlebox plain bearing assemblies

Plain bearing applications shall be limited to heritage locomotive hauled passenger vehicles and such vehicles shall not operate on the CRN without the approval of the CRN manager.

Plain bearing assemblies, where used, shall be operated within their design capacity.

5.6.1 Plain bearing maintenance

The owner/operator shall follow proven industry standards and have procedures in place for the following maintenance activities:

- Installation of plain bearing assembly and axlebox.
- Lubrication of plain bearing assembly, including maintenance of oil at the correct level, and prevention of water ingress.
- Operational life, and replacement of bearing brass.
- Operational life, preparation and replacement of lubricator or wick.
- Operational life of wedge.
- Operational life of axle journal.
- The regular inspection of plain bearing axlebox assemblies for defects.

5.6.2 Plain bearing axlebox assembly defects

The owner/operator shall not place or continue in service a locomotive hauled passenger vehicle with the following defects:

- A plain bearing axlebox containing no visible free oil.
- A plain bearing axlebox which has a lid missing, broken or open, except to receive servicing.
- A plain bearing axlebox containing foreign matter, such as dirt, sand, or coal dust that can reasonably be expected to damage the bearing, or have a detrimental effect on the lubrication of the journal and the bearing.

5.6.3 Plain bearing journal lubrication system defects

The owner/operator shall not place or continue in service a locomotive hauled passenger vehicle with the following defects:

- Lubricating pads with a tear extending half the length or width of the pad or more.
- Lubricating pads showing evidence of being scorched, burned or glazed.

- Lubricating pads which contain decaying or deteriorated fabric impairing proper lubrication of the pad.
- Lubrication pads contaminated by grease.
- Lubricator pads with an exposed centre core, except by design.
- Lubricator pads with metal parts contacting the journal.
- Lubricator pads which are missing or not in contact with the journal

5.6.4 Plain bearing defects

The owner/operator shall not place or continue in service a locomotive hauled passenger vehicle with the following defects:

- A plain bearing which is missing, cracked or broken.
- A plain bearing liner which is loose, or has a piece broken out.
- A plain bearing showing signs of having been overheated, as evidenced by melted babbitt, smoke from hot oil, or journal surface damage

5.6.5 Plain bearing wedge defects

The owner/operator shall not place or continue in service a locomotive hauled passenger vehicle with the following defects:

- A plain bearing wedge that is missing, cracked or broken.
- A plain bearing wedge that is not located in its designed position.

6 Bogie frame components

Bogie frame components, in relation to locomotive hauled passenger vehicles, include, but are not limited to side frames, bolsters, spring planks, swing links, control rods, frame adaptors and other structural bogie components.

Bogies and their associated components shall be operated within their original design capacity and not overloaded.

6.1 Design and manufacture

Bogie designs which have been proven to be reliable under Australian operating conditions are recommended.

Designs for new unproven concepts, substantially modified bogies or bogies intended to be used in an alternate application where they will be subjected to higher loads, shall be designed in accordance with the following methodology:

6.1.1 Load cases

Load cases shall be developed for all loads acting independently or in combination on the bogie in the vertical, lateral and longitudinal directions, and reacted at suitable points as determined by the bogie design. The load cases shall be in the form of a force magnitude and number of cycles reflecting the severity of the intended application. The loads shall have due regard for the track condition and geometry, intended bogie service life, operating speed, vehicle mass, and any other factors considered relevant.

6.1.2 Stress analysis

A stress analysis shall be performed using the developed load cases to ensure that all stresses on the bogie frame and associated components are within the safe working stress for the material used for construction.

In addition, a fatigue analysis shall be performed, using the relevant load case combinations to ensure that all stresses in the bogie frame and associated components do not exceed the endurance limit stress for the intended service life of the bogie.

6.1.3 Fatigue analysis

Fatigue analysis may be carried out in accordance with AAR Specification M-1001, Volume one, Chapter seven, Fatigue design of freight cars, Sections 7.1, 7.2, and 7.4.

This fatigue analysis shall use the AAR nominal stress method taking into account all relevant welded details as per the AAR Manual. Bogie dynamic fatigue testing shall be carried out, analysed and verified in accordance with Appendix A10 in the AAR Manual.

Alternate fatigue analysis methods which are rail industry accepted may be proposed.

6.1.4 Safe working stress

As a minimum requirement, the safe working stress shall be taken as follows:

- The maximum combined (principal) stress in the bogie structure shall be taken as one half (1/2) of the yield strength or one third (1/3) of the ultimate strength of the materials, whichever is the lesser.
- The maximum uni-axial stress shall be taken as one half (1/2) of the yield strength or one third (1/3) of the ultimate strength of the material, whichever is the lesser.
- The fatigue limit stress is the endurance limit stress for the specific component or joint being considered.

6.1.5 Load testing.

Load testing on a test rig may be used to validate any numerical stress analysis, or may be used as an alternative to numerical stress analysis. Fatigue testing on a test rig may be used to validate, or as an alternative to, numerical fatigue analysis.

6.2 Bogie frame component maintenance

The owner/operator shall follow proven industry standards and have procedures in place for all locomotive hauled passenger vehicle maintenance activities. These maintenance activities shall include but not be limited to the following:

- Trammelling of bogie frames (where applicable)
- Non destructive testing of critical joints and connections
- Repair of bogie frames and associated components, including welding, straightening and heat treatment.
- Maintenance of pedestal openings and other important component interface dimensions (where applicable)

6.2.1 Bogie frame/component defects

The owner/operator shall not place into service, or continue in service, bogie frames, including associated components, with the following defects:

- Critically cracked bogie frame/components and associated components.
- Bogie frames and associated components which are bent or distorted causing an imbalance in wheel loads, and/or incorrect tracking of the bogie.
- Loose, missing, or broken fixings and connections, locating bolsters, transoms, headstocks or other major bogie frame components, where applicable.

The owner/operator shall follow proven industry standards and have procedures in place for the regular monitoring of frame/component cracks with due regard to their propagation rate to ensure that the components are removed from service before the crack reaches a critical dimension.

6.2.2 Bogie frame/components, action required following derailments

The owner/operator shall have procedures in place for bogie frame/component inspection and requalification following any derailment, in order to mitigate the risk of future premature in-service failure of bogie frame/components.

7 Bogie suspension

This section covers the requirements applicable to locomotive hauled passenger vehicle suspension systems, including steel helical and flexicoil springs, friction snubbers and other damping devices. It specifies the design, manufacture, maintenance and operating conditions where appropriate.

7.1 Suspension coil springs

Springs shall be designed and manufactured in accordance with accepted industry standards for maximum fatigue life, without exceeding maximum stress when fully compressed.

7.1.1 Suspension spring defects

The owner/operator shall not place into service, or continue in service, vehicles with any configuration of defective, broken, misplaced, or incorrectly fitted springs which could results in the freight vehicle failing to meet the requirements for track twist negotiation.

The owner/operator shall follow proven industry standards and have procedures in place which set safe operational limits for freight vehicles with missing, broken springs or incorrectly fitted springs.

Possible freight vehicle spring defects/anomalies are:

- Adjacent springs in any concentric spring nest at risk of binding due to being wound the same hand.
- Coil springs missing, cracked or broken, misaligned or displaced within the spring seat.
- Spring coils are heavily bruised or show flat spots caused by coil binding
- There are nicks, gouges, indentations or any corrosion with pit marks greater than 1 mm long.
- Spring groups that don't have the correct number, type and capacity of springs appropriate to the bogie model, vehicle class and maximum axle load.
- There is insufficient clearance between adjacent steel coils in load bearing springs to accommodate the necessary dynamic deflection without the spring bottoming or going solid.

7.2 Resilient (rubber) suspension components

Resilient suspension components, including axlebox pivot bushes, Alsthom Link bushes, lateral control rod bushes, traction rod bushes, and rubber element suspension springs shall be designed and manufactured and fatigue tested in accordance with accepted industry standards, with due regard to the service conditions to be experienced by the vehicle over the life of the component. In addition, the design of resilient suspension components shall take into account the requirement for compliance with the twist test requirements in CRN RS 010, Section 4.

7.2.1 Resilient suspension maintenance

Resilient steel/rubber laminated springs and air springs have become common place in vehicle secondary suspensions. In the majority of applications the resilient component provides the vertical, lateral and rotational suspension flexibility and thus the spring is a critical component for safe operation. The owner/operator shall follow proven industry standards and have procedures in

place to ensure that resilient suspension components are periodically inspected and tested to prevent in-service failure and to maintain their required performance.

7.2.2 Resilient suspension defects

The owner/operator shall not place into service, or continue in service, resilient suspension components with the following defects:

- De-lamination between resilient material and any backing plate, which is likely to compromise suspension performance or operating safety.
- Distortion of resilient material due to the application of excessive heat or contact with detrimental chemical or other substances which is likely to compromise suspension performance or operating safety.
- Resilient material which is cracked or perished and thus likely to compromise suspension performance or operating safety.
- Resilient material which has incorrect characteristics for the application.
- A suspension element with any indication of buckling under vertical loading.

7.2.3 Air spring defects

The owner/operator shall not place into service, or continue in service, vehicles with any configuration of deflated air springs which results in the vehicle failing to meet the requirements for track twist negotiation.

The owner/operator shall follow proven industry standards and have procedures in place which set safe operational limits for vehicles with defective levelling and or balancing valves.

Air springs with evidence of external physical damage shall not enter service until it is established the air spring is safe to operate. If damage is detected in service the vehicle shall be worked out of service for maintenance attention.

7.2.4 Operation of vehicles with deflated air springs

Vehicles with deflated air spring assemblies shall be operated in accordance with the vehicle owner's operating procedures applicable to this defect.

7.3 Suspension damping

The owner/operator shall follow accepted industry standards for the design and selection of damping devices to control suspension stability, whilst ensuring that track twist safety requirements are not compromised, for all conditions of loading and all serviceable states of vehicle wear.

Damping devices include but are not limited to vertical, lateral and yaw snubbers, hydraulic dampers as well as axlebox/pedestal guides (coulomb damping).

7.3.1 Suspension damper maintenance

A damper is an important component of a vehicle suspension and requires regular inspection and replacement. Owner/operators shall have maintenance procedures which cater for the regular maintenance and re-qualification of suspension dampers to ensure optimum vehicle ride performance.

7.3.2 Suspension damper defects

For all friction damping devices, the friction surfaces or wear plates shall not be lubricated or painted (except by design) under any circumstances. Dampers with lubricated or painted friction surfaces (except by design) shall not be permitted to enter service.

Hydraulic dampers exhibiting signs of fluid leakage or physical damage to the body or end connections shall be requalified for correct operation.

Dampers shall not be permitted to enter service and shall be removed from service for the following defects.

- Wear components which are loose, missing, or worn beyond their condemning limit.
- Broken or missing snubber/damper end connections.
- Damaged or missing rubber end connection bushings
- Excessive hydraulic fluid loss.

Vehicles exhibiting instability such as bogie hunting, bouncing or pitching shall have their suspension dampers checked for possible damage or failure.

Axlebox/pedestal guide assemblies, which rely on coulomb (random friction) damping shall not be lubricated, under any circumstances.

8 Bogie side bearers

Some locomotive hauled passenger vehicles are fitted with side bearers which assist in controlling body rock. There are gapped side bearers and constant contact side bearers with the latter providing bogie rotational resistance.

8.1 Gapped side bearers

Whilst the role of a side bearer is to provide vehicle body roll or rock stability it is important that the gap provided, be sufficient to allow the vehicle to safely accommodate track twist.

The owner/operator shall have procedures in place to monitor and maintain the correct side bearer gap of 10-14 mm, with the combined side bearer clearance within 17 mm to 31 mm.

8.2 Constant contact side bearers

Constant contact side bearers are designed to support part of the vehicle load and at the same time permit bogie rotation. Whilst bogie rotational resistance will control bogie hunting tendencies, a too higher rotational resistance will result in excessive wheel flange wear and increase the risk of wheel climb derailment. It is important that the constant contact force and friction coefficient be designed and controlled to maintain the rotational resistance at the correct level.

The owner/operator shall have procedures in place to monitor and maintain the constant contact side bearer characteristics.

9 Bogie brake equipment

Locomotive hauled passenger vehicles may be fitted with a clasp brake lever and pull rod system applying braking effort through tread brakes acting on both sides of each wheel.

Alternatively, modern passenger vehicles are fitted with disc brakes, either wheel cheek mounted or axle mounted.

9.1 Securing of brake gear

All wheel tread brake rigging shall be securely mounted or supported and brake blocks shall be centred laterally on the wheel tread.

Disc brake rigging or levers shall be securely mounted and suspended from the bogie frame.

Spring loaded type pin securing mechanisms such as ‘R’ clips, grip clips, or lynch pins shall not be used below the axle centreline. Only split cotter pins shall be used in this area. Spring loaded type mechanisms may be approved for specific applications.

Split cotter pins shall be split to a minimum angle of 60 degrees.

All bogie mounted brake rigging shall have safety loops or other means of security, in case of loss of brake rigging support.

Passenger vehicles with tread brake blocks which overhang the edge of the wheel tread will not be accepted for operation on the CRN.

9.2 Spring parking or hand brake

The spring parking or handbrakes shall be able to hold the crush loaded passenger vehicle on a 1 in 30 grade, indefinitely.

The following net brake ratios are recommended in order to provide an effective parking brake:

Brake Block Type	Vehicle Condition	Net Brake Ratio
Low friction composite	Fully loaded	28% minimum
Medium friction composite	Fully loaded	20% minimum
High friction composite	Fully loaded	13% minimum
Cast iron	Fully loaded	13% minimum

Table 4 - Minimum Net brake ratios for parking brake

In the case of a hand operated hand brake, the brake block/pad forces are measured based on an input force of 560 N applied tangentially to the hand brake wheel.

When measuring the brake block/pad forces produced by the parking/handbrake, the rigging pins shall not be disturbed to overcome static friction in the brake rigging.

There should be some form of detection on the spring parking or handbrake system to indicate that the brake is applied or released. Where locomotive hauled passenger vehicles have provision for train line control, this indication shall be train lined, to ensure the leading drivers cab has indication covering all parking brakes in the train consist.

9.3 Locomotive hauled passenger vehicle brake block force

As a guide the following minimum net brake ratios are recommended for a full service application of the automatic brake (with a brake cylinder pressure of 350 kPa).

The net brake ratio is the sum of measured brake block loads divided by the freight vehicle weight expressed as a percentage.

Brake Block Type	Vehicle Condition	Net Brake Ratio
Low friction composite	Tare or empty	55% maximum
	Fully loaded	28% minimum
Medium friction composite	Tare or empty	55% maximum
	Fully loaded	20% minimum
High friction composite	Tare or empty	35% maximum
	Fully loaded	13% minimum
Cast Iron	Tare or empty	55% maximum
	Fully loaded	28% minimum

Table 5 - Minimum Net brake ratios for air brake

Brake block forces are measured with the air brake in both empty and loaded conditions for a brake pipe reduction of 150 kPa. When measuring the brake block forces produced by the air brake, the rigging pins shall be tapped with a hammer to overcome static friction in the brake rigging.

Refer to CRN Standard CRN RS 008, Section 19, for brake block friction, recommended brake blocks and brake block alternatives.

9.4 Disc brakes

New locomotive hauled passenger vehicles fitted with disc brakes shall be tested in a train consist and meet the stopping distance requirements specified in Section 12.4.2, Table 7.

10 Brakes and pneumatic equipment

All vehicles that are required to operate within a train or as a train shall be fitted with a failsafe automatic brake system.

The automatic brake system fitted to passenger vehicles operating on the CRN shall be compatible with all existing hauled vehicles and locomotives to ensure that the brakes apply and release as required. Refer to CRN Standard CRN RS 001 for the locomotive brake system.

10.1 General requirements

Locomotive hauled passenger vehicles shall generally comply with the following requirements:

- The control valve should be of the diaphragm type with timings selected to suit a passenger train service and operate with a train of up to 1000 metres in length. The brake system may also incorporate gradual release, electro-pneumatic control, and control of the brake cylinder pressure by means of a relay valve.

Some older passenger vehicles may not fully comply with these requirements but will be assessed considering the brake equipment fitted and the proposed use of the vehicle.

Alternate brake systems, such as electronically controlled pneumatic (ECP) brake, will be permitted provided hauling locomotives are pneumatically compatible with the vehicle brake system. Where it is required to mix ECP equipped vehicles with older vehicle types, the vehicle automatic brake systems must be compatible.

10.2 Location of end brake equipment

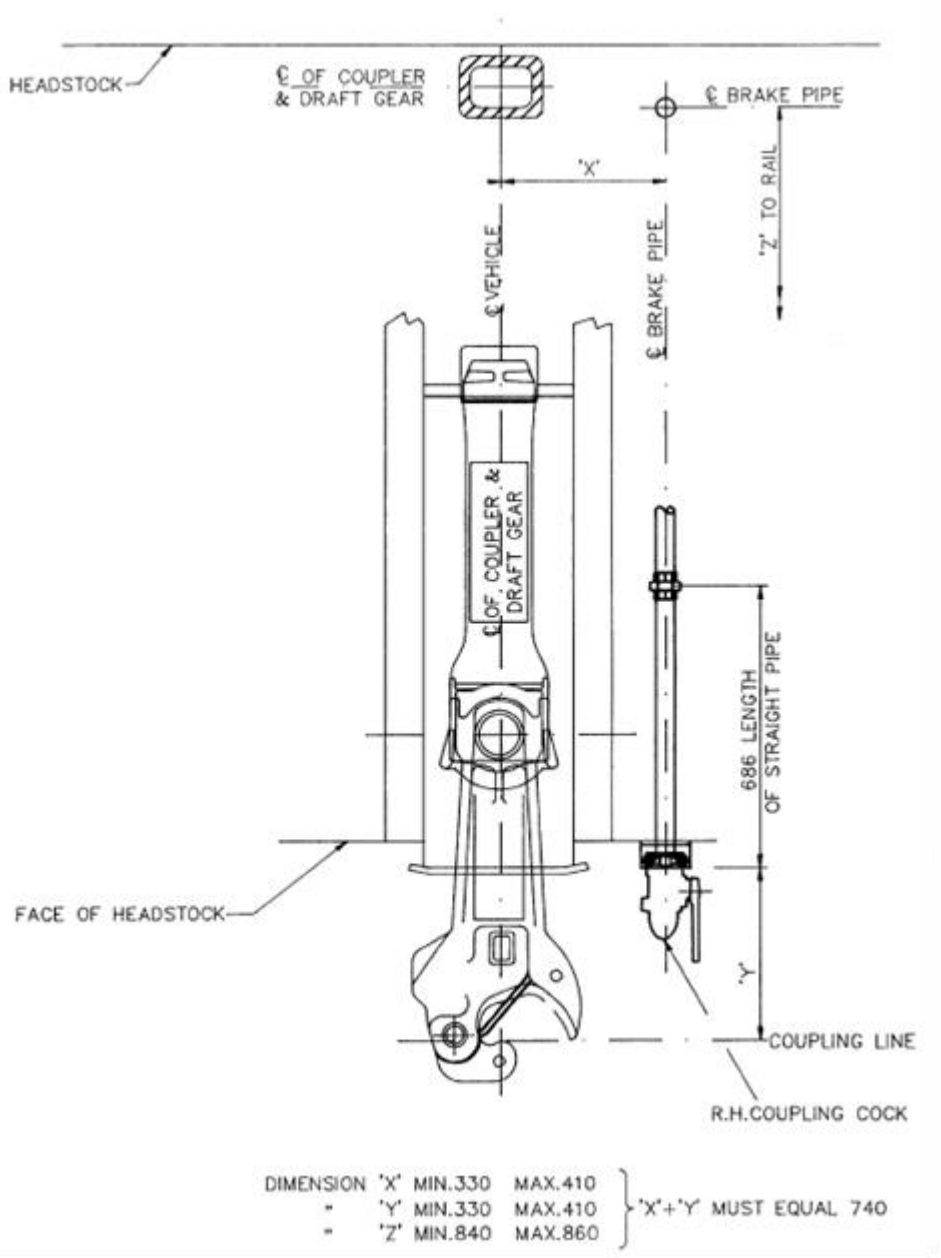


Figure 10 - Single brake pipe layout

Passenger vehicles shall have coupling cocks located on the terminal ends as follows:-

- Brake pipe

The brake pipe coupling cocks shall be located as shown in the Figures 10 and 11

- Main reservoir pipe (optional)

Main reservoir and independent brake control hoses and cocks shall be located such that they can couple to a locomotive or adjacent vehicle without causing hose damage or kinking.

Vehicles not fitted with standard automatic couplers, shall have emergency couplers provided, with standard coupling hoses, which will couple with standard vehicles.

Passenger vehicles with a long overhang beyond the bogie centre may require bifurcation of the brake pipe and the hose connections as shown in Figure 11.

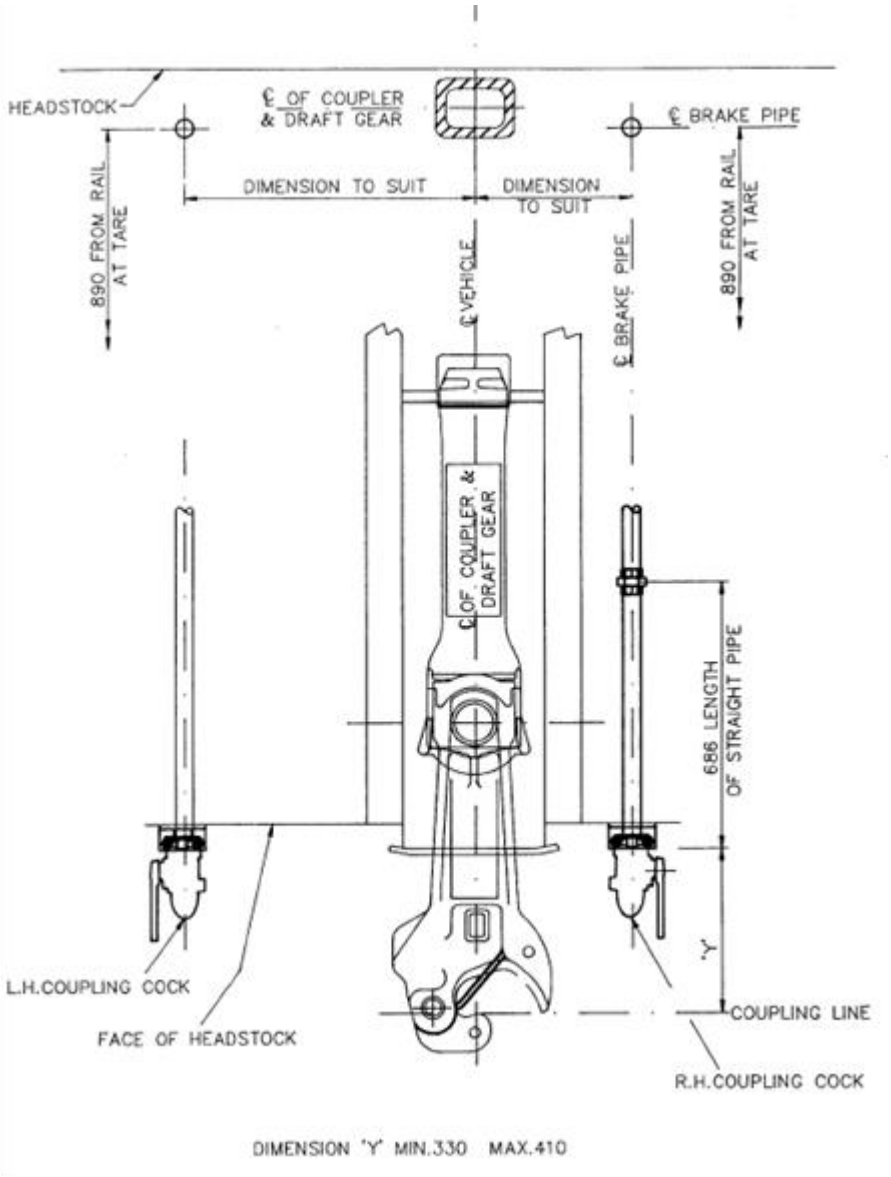


Figure 11 - Bifurcated brake pipe layout for long vehicles

10.3 Brake pipe coupling cocks

Brake pipe coupling cocks shall be 32 mm nominal bore (NB) and shall be of such design as to ensure that the cock will remain in the desired position whilst the vehicle is in motion.

The cock shall be designed to prevent accidental closure which may be achieved by providing:

- a detent to ensure the cock remains in the open position and,
- a ramp to ensure the cock remains closed.

Movement of the handle shall be by the application of force in the direction of rotation only. All coupling cocks shall be vented on the flexible coupling hose side when closed. The cock shall generally conform to the drawing shown in Figure 12.

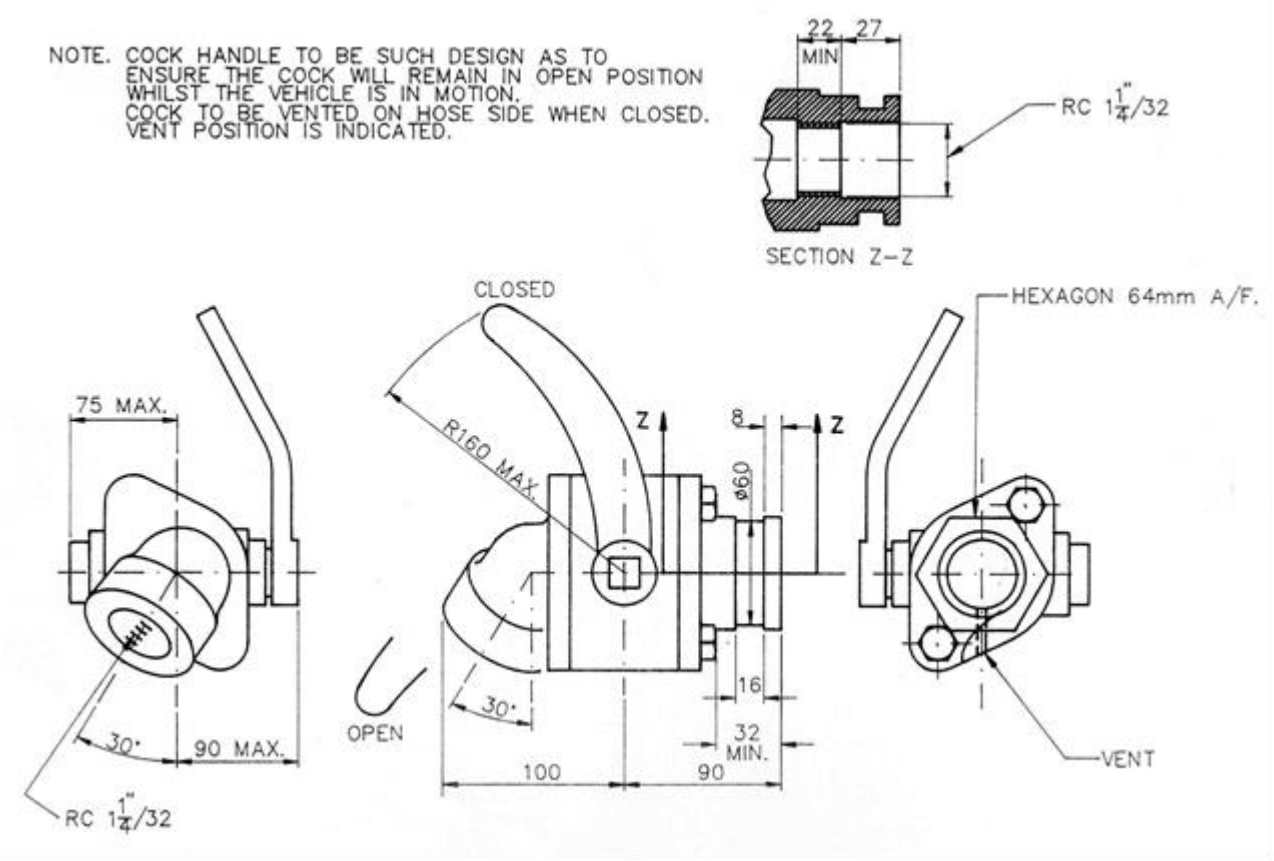


Figure 12 - Brake pipe coupling cock

10.4 Coupling hoses

Flexible coupling hoses shall comply with the requirements of Australian Standard AS 2435 Elastomeric Hose for Railway Air Brake Hose.

Internal diameters (nominal bore) shall be:

- Brake pipe — 32 mm
- Main reservoir — 25 mm
- Locomotive control pipe — 12 mm

Coupling heads shall be:

- Brake pipe — 32 mm coupling hose head
- Main reservoir — 25 mm coupling hose head
- Locomotive control pipe — 19 mm coupling hose head

Brake hose coupling heads shall be in accordance with Figure 13.

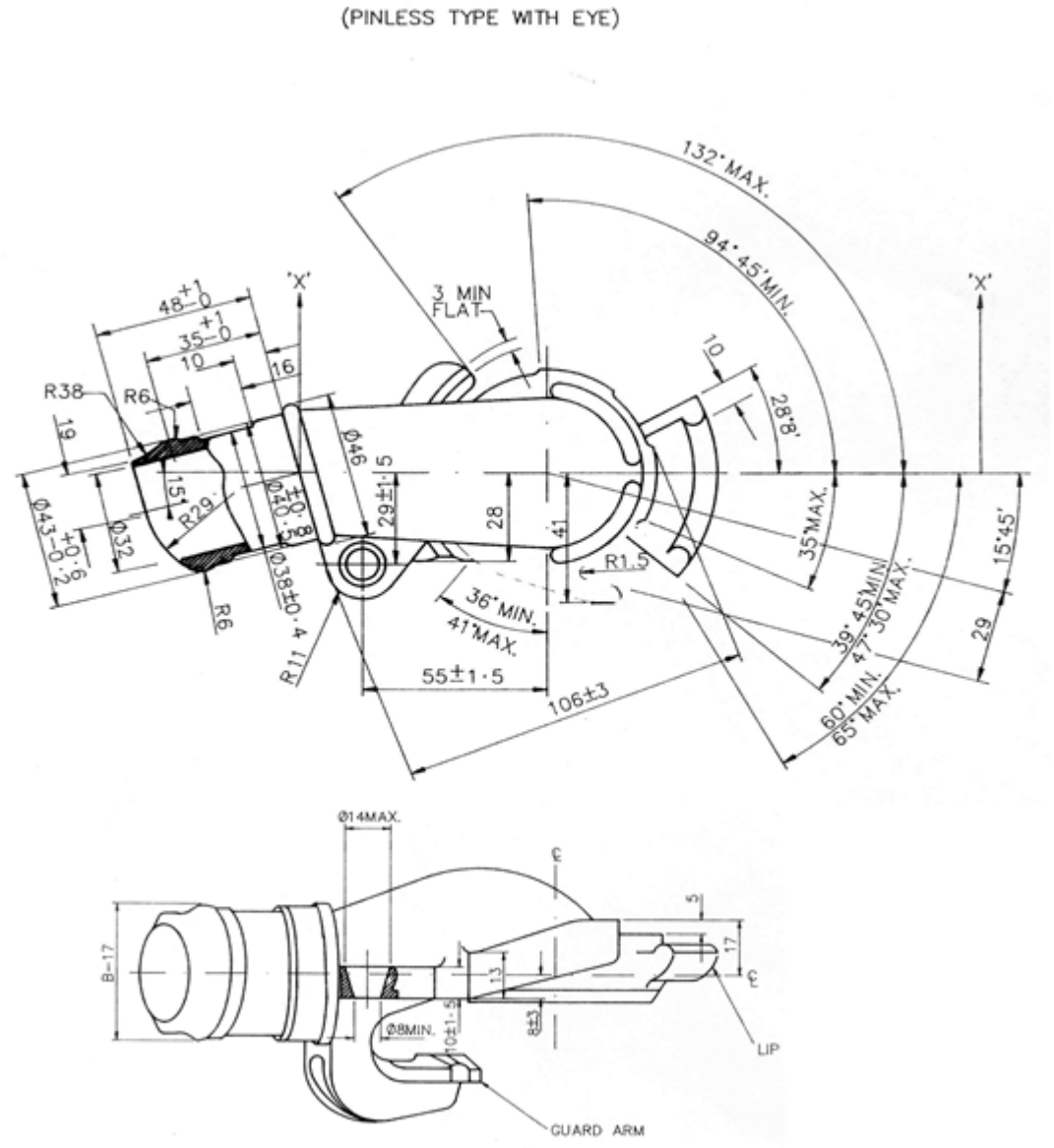


Figure 13 - Air brake coupling hose head

10.5 Dummy couplings

All terminal end vehicles shall be fitted with dummy couplings or provided with a suitable receptacle for safely storing the unused coupling hose heads clear of the track.

10.6 Identification and marking of cocks and brake equipment

All cut-out or isolation cocks, operating handles and embossed letters of the air brake equipment shall be painted white. An inverted “U” or the word release shall be painted on the vehicle underframe on each side of the attachment of the release cable.

10.7 Brake equipment maintenance

The owner/operator shall follow proven industry standards and have procedures in place to ensure that brake and pneumatic components are periodically inspected and tested to prevent in-service failure and to maintain the required performance.

10.8 Standard brake pressures and timings

For compatibility with other rolling stock and locomotives, standard pressures and timings shall comply with the following requirement.

The following information shall apply for a single vehicle:

- Brake pipe: 32 mm N.B. throughout the vehicle Inclusive of end coupling cocks, hoses, coupling connections and bifurcations.
- Brake pipe pressure: 500 kPa nominal
- Brake cylinder diameter: 254 mm, 305 mm or according to bogie design
- Brake cylinder pressure: nominal 350 kPa (loaded condition), design 380 kPa maximum
- Braking ratio: See net brake ratio
- Brake cylinder piston travel requirements are as follows for underframe mounted brake cylinders.
- Nominal operating: 100 mm
- Design for reservoir volumes 200 mm
- Brake cylinder filling time from 0-275 kPa: 10-13 seconds
- Charging time of auxiliary reservoir:

  Initial fill: 0-400 kPa in 60 seconds,

  Recharge: 250-450 kPa in 20-25 seconds.
- Accelerated release reservoir charging time: 0-420 kPa in 180 seconds nominal
- Supplementary reservoir charging time:

  Initial fill: 100-110 seconds
- Propagation rate in a train:

  Brake application: 250 m/s – minimum

  Brake release: 80 m/s - minimum,
- Inshot capability

  70 to 84 kPa brake cylinder pressure shall be obtained in 1.5 to 2 seconds after control valve operation
- Performance requirements:

  Control valve performance shall comply with the requirements specified in the latest revision of the AAR. Manual of Standards, Section E, wherever applicable, except as specified above.

11 Body and underframe

The passenger vehicle body and underframe shall be designed to the following design loads and stresses.

Some earlier designs of multiple unit vehicles may not fully comply with these requirements but will be assessed considering the equipment fitted and the proposed use of the vehicles.

11.1 Design loads and stresses

11.1.1 Underframe structure

The underframe shall be designed to act in conjunction with the body structure in resisting the forces listed below.

The structure of passenger vehicles shall be capable of sustaining repetitive longitudinal coupler forces of five (5) times the vehicle mass i.e. 5g, without fatigue damage occurring to the vehicle or the coupler. When loaded to its nominal capacity the structure of the vehicle shall be capable of withstanding the following forces applied through the centreline of the coupler without exceeding the maximum stresses for the material as specified below:

Force (kN)	Maximum stress	Force type
3500	Ultimate	High impact
2000	Yield	impact
+1000 -1000	Larger of 1/2 yield or 1/3 ultimate	Steady force

Table 6 - Maximum allowable stresses

The steady force used in the above stress calculations shall not be less than the maximum combined tractive effort of the number of power units expected to be used for hauling the vehicle(s).

Vehicles shall be marshalled in trains so that the trailing load on any vehicle does not exceed the rated capacity of that vehicle's draft gear or underframe.

The underframe shall withstand the following conditions, with the vehicles in crush load condition.

- The vehicle complete with bogies being lifted with one jack placed centrally near the drawgear carrier plate or from the coupler at either end of the vehicle without exceeding the critical design stress for any member with the vehicle supported on the other bogie.
- The vehicle, complete with bogies, being lifted from the jacking pads and lifting brackets at the sides of the vehicle, without exceeding the safeworking stress for any member.
- A longitudinal shock load, as specified above, applied to any component attached to the underframe without exceeding the critical design stress for any member.
- A vertical live load as specified above comprising the weight of all fully serviced components supported by the underframe, without exceeding the critical design stress on any member.
- A vertical load of 225 kN applied to the coupler at the coupling line, both upwards and downwards, without exceeding the safe working stress for any member.

11.1.2 Body structure

Vertical anti-collision members shall be provided at each end of the vehicle. These members shall withstand, without permanent deformation, a longitudinal force of 540 kN applied at a point 1650 mm above rail level combined with a lateral force of 90 kN applied to diagonally opposite corners at the same height.

The longitudinal force applied to the ends of the vehicle shall be considered to be proportionately distributed to all longitudinal members according to area.

Walls, partitions, fixtures and other interior and exterior fittings shall be designed and attached so as to withstand accelerations of 3 g laterally, 5 g longitudinally and 3 g vertically without failure of the component or fastenings.

11.1.3 Collision protection and energy absorption

All passenger vehicles shall be fitted with collision protection and energy absorbing elements to provide vehicle end structural protection as well as crew and passenger protection in the event of a collision.

Vehicles shall be fitted with end structural columns or other satisfactory means of preventing vehicle body telescoping in the event of collision.

11.2 Couplers and draftgear

Standard automatic couplers may be used on locomotive hauled passenger vehicles provided that they are fitted with a vertical interlocking feature to prevent vehicle over riding and/or telescoping in the event of collision.

Coupler heights shall be generally within the following limits:

New condition	890 to 900 mm.
In service condition	875 to 915 mm.

Multi function couplers may be used in place of standard automatic couplers. Multi function couplers must be maintained level.

Where a non standard coupler is fitted to terminal vehicles, an emergency coupler adaptor shall be provided to match up with a standard automatic coupler 10A contour and coupler height.

11.3 Towing fixtures, jacking and lifting points

Locomotive hauled passenger vehicles shall be fitted with facilities for towing in emergencies. Two (2) emergency towing fixtures as shown in CRN Standard CRN RS 008 Section 14 shall be attached to each headstock.

Suitable jacking points shall be supplied at the junction of the underframe side sill and body bolster adjacent to each bogie centre and also under the drawgear pocket.

Vehicles shall have suitable lifting points or brackets to insert lifting hooks and shackles.

The lifting brackets shall consist of pairs of vertical plates preferably mounted at the ends of the body bolsters and located to align with bolster web plates. Features to be incorporated in each lifting bracket are shown in CRN Standard CRN RS 008, Section 14.

11.4 Doors

Passenger entry doors shall be fitted with a positive latching system to prevent doors being opened accidentally whilst train is in motion.

Hinged doors must not open outward.

Plug type doors, where fitted, must be positioned in the designated areas as specified in CRN Standard CRN RS 008, section 2.5.2, Figure 6

Crew plug doors, where fitted, shall be designed such that an open door will not close if struck whilst the train is in motion.

11.5 Crew compartment security

All passenger vehicles containing a crew compartment should be fitted with a positive means of locking the compartment when it is unattended.

11.6 Passenger vehicle toilets

Toilets installed on passenger vehicles shall not discharge to the track. Self contained chemical toilets are acceptable provided the owner/operator has facilities for decanting or removal of waste products.

Toilet facilities shall meet the environmental requirements specified in CRN Standard CRN RS 008.

11.7 Wooden bodied vehicles

All wooden-bodied passenger vehicles proposed for operation on the CRN shall be fitted with approved steel collision posts at each end of the underframe to provide protection against vehicle over riding and/or telescoping in the event of a collision.

It is recommended that double shelf or limited interlocking couplers be provided as added protection against vehicle over riding and/or telescoping in the event of a collision.

Any passenger vehicle not fitted with the above collision protection will only be permitted to move on the CRN under complete block working in accordance with the Train Marshalling section in the General Instruction Pages of the CRN Train Operating Conditions manual.

11.8 Marking and identification

11.8.1 Code and number

Each passenger vehicle shall have a unique identification code/number clearly marked externally on each side the vehicle and inside the vehicle at each end of the main compartment or corridor.

The minimum height of external lettering shall be 125 mm. The colour of marking shall contrast with the background colour of the vehicle. The vehicle code and number shall be readable from trackside, on station platforms and from signal boxes.

11.8.2 Markings

Passenger vehicles shall have the fully provisioned mass, the tare mass and the coupled length stencilled on each side of the vehicle at or about underframe/solebar level.

11.8.3 Reflective delineators

To enhance visibility of freight vehicles from the side at level crossings, they shall be fitted with reflective delineators (reflectors) in accordance with CRN Standard CRN RS 008.

11.8.4 AEI Tags

All passenger vehicles shall be fitted with standard AEI tags as specified in CRN Standards CRN RS 008 and CRN RS 014.

11.8.5 Maintaining visibility

Owner/operators shall have maintenance procedures in place and conduct regular maintenance covering the cleaning and preservation of the reflective qualities of reflective delineators.

12 Passenger vehicle performance

The performance of passenger vehicles shall be in accordance with the requirements of this standard and CRN Standard CRN RS 008. The performance specified in these standards relates to the operation of the vehicle on the CRN. For performance testing refer to CRN Standard CRN RS 010.

12.1 Passenger vehicle ride performance

Refer to CRN Standard CRN RS 008, Section 19, for ride performance requirements.

12.2 Passenger vehicle noise

Passenger vehicle noise is an important performance consideration in terms of brake squeal on descending grades and may require endorsement by the Environmental Protection Authority (EPA) before the vehicle will be approved to operate on the CRN. For noise requirements refer to CRN Standard CRN RS 008.

12.3 Passenger vehicle mass and mass distribution

Locomotive hauled passenger vehicles shall be type tested to determine the wheel and axle load distribution and to confirm an even load distribution.

It is in the interest of passenger vehicle owner/operators that their vehicle mass, axle and wheel load distribution be within acceptable limits for optimum on-track performance. The axle and wheel load distribution shall therefore be within the limits specified in CRN Standard CRN RS 012.

The maximum axle load for a passenger vehicle mass for unlimited operation on the CRN is 19 tonnes. Vehicles with a higher axle load may be permitted to operate but will be subject to restricted operations.

12.4 Braking performance

Braking performance is specified to ensure that a passenger vehicle is compatible with current CRN signalling systems and can safely contribute to the overall train braking performance.

12.4.1 Static brake performance

Refer to CRN Standards CRN RS 008 for static brake performance requirements and CRN RS 010 for static brake performance tests.

12.4.2 On-track brake performance

Braking performance is specified to ensure that passenger vehicles are able to stop under all weather conditions within the current signalling system spacings.

	Maximum stopping distance (metres)	
Speed (km/h)	Full service brake application	Emergency brake application
0	0	0
10	7	10
20	22	27
30	44	50
40	74	80
50	113	115
70	215	207
80	278	265
90	349	330
100	516	480
115	565	521
120	620	565
130	720	657

Table 7 - Maximum stopping distances for new locomotive hauled passenger vehicles

12.5 Vehicle structural strength

Refer to Section 11.1 herein and CRN Standard CRN RS 008 for vehicle structural requirements.

13 Special purpose locomotive hauled passenger vehicle requirements

Special purpose passenger vehicles such as buffet, dining, lounge, sleeping cars and power/hotel supply vehicles, shall be designed to comply with all of the requirements specified herein and in particular, the environmental requirements in terms waste management.

Appendix 1 CRN Rolling Stock Glossary

This appendix defines words that are used in the CRN Rolling Stock Standards

Agreed	Agreed between the Owner/Operator and the CRN Manager.
Approved	Approved by the CRN Manager.
Authorised person	Person authorised to travel in the cab of an infrastructure maintenance vehicle/train and stop the vehicle/train in the event of an emergency.
Cant deficiency	The difference in superelevation between: - that required to balance the actual vehicle centrifugal force due to curve negotiation such that there is equal wheel loading on the high and low rail, (equilibrium or balancing speed), and - the actual superelevation existing in the curve. Cant deficiency is a function of superelevation, curve radius and vehicle speed.
Continuous tractive effort	The tangential force that can be applied at the wheel/rail interface by a self powered vehicle for an indefinite period without causing wheel spin or overheating of the traction equipment.
Curved wheel web	Wheel web or plate which is domed such that its cross section is curved.
Design speed	The maximum speed at which a vehicle is expected to operate on the CRN.
Flat top trolley or trailer	A small non-powered infrastructure maintenance vehicle which is used for conveying tools and equipment along the track and which can be easily removed from the track.
Freight Train	A train predominantly consisting of freight vehicles.
Full supplies, Fully provisioned	Locomotive with all equipment and full of fuel, oil, water, coolant and sand.
Handbrake	A mechanical device provided on a train/vehicle in order to secure the train or an individual vehicle so as to prevent it from moving. Note: Where the term “handbrake” is used, it will also mean “parking brake”.
Heritage vehicle	Locomotive, passenger vehicle, freight vehicle or trolley that has historical significance and/or is not used in regular revenue service but used in special interest operations, such as steam tours.
Infrastructure maintenance vehicle	A rail bound self propelled vehicle which is used to carry out inspection and/or maintenance on railway infrastructure. Some of these vehicles may be removed from the railway track by the use of special take-offs or portable turnouts.
Light locomotive	One or more locomotives coupled together without hauled vehicles attached.
Locomotive	A self propelled vehicle, powered by any form of energy, which does not convey passengers or freight but which is used to move one or more other vehicles thus forming a train.
Multiple unit train	A distributed power train made up of similar electric or diesel powered vehicles and non-powered vehicles operating as a unit.
Net brake ratio	The ratio of the sum of the actual measured brake block forces divided by the total vehicle weight.
On-track infrastructure maintenance vehicle	Any infrastructure maintenance vehicle which operates exclusively on railway track.
Overhead wiring vehicle	An infrastructure maintenance vehicle with an elevating platform or equipped for maintenance of the overhead traction wiring system.

Power car	A self propelled vehicle, which may or may not convey passengers and/or freight, and operates in conjunction with similar vehicles in a multiple unit consist.
Quadricycle	A small self propelled rail-bound track vehicle which can be easily removed from the track.
Qualified worker	A worker certified as competent to carry out the relevant task.
Rail-bound infrastructure maintenance vehicle	An on-track infrastructure maintenance vehicle that cannot be removed from track without the use of a heavy crane. These vehicles are transferred around the network by rail.
Road/rail vehicle	Any type of track vehicle which can travel on either road or rail and can readily transfer from one mode of operation to the other.
Rolling Stock Exemption Certificate	A Certificate issued to a vehicle owner/operator covering vehicle non-conformances which are technically acceptable. These certificates remain in place for the life of the vehicle.
Rolling Stock Standards Waiver	A Waiver issued for a vehicle covering non-conformances that are deemed acceptable for a limited time period, until corrected.
Starting tractive effort	The tangential force applied at the wheel/rail interface that can be applied by self powered vehicle, to move itself and its trailing load from a stationary state without causing excessive wheel slip.
Straight wheel web	Wheel web consisting of a flat plate with no curvature such that its cross section is straight. Used primarily with wheel cheek mounted disc brakes
S-plate wheel	Wheel with a web such that its cross section forms an S shape, designed to provide low wheel rim stresses
Substantially modified vehicle	Vehicle modified to accommodate its use for a different purpose. Vehicle undergoing major refurbishment with updated equipment which can alter the braking, traction or suspension system performance. Vehicle being moved with equipment removed resulting in a reduction of vehicle mass that could alter the vehicle performance. Vehicle modified such that it may be incompatible with the infrastructure.
TOC Waiver	An authority issued for the movement of a vehicle for which there are no published operating conditions, or for which the operating conditions are different from those published in the CRN Train operating Conditions Manual.
Track maintenance vehicle	Infrastructure maintenance vehicle used for the maintenance, construction or inspection of track.
Train	One or more rail vehicles operating singularly or coupled together, hauled or self powered and capable of operating track signal circuits