Engineering Standard

Rolling Stock

CRN RS 004

MINIMUM OPERATING REQUIREMENTS FOR MULTIPLE UNIT TRAINS

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Document control

Revision	Date of Approval	Summary of change
1.1	27/9/11	For publication
1.2	21/11/11	Minor corrections
2.0	7/12/16	Minor corrections

Summary of changes from previous version

Section	Summary of change
1.1	Reference to trolleys and trailers removed
Page 7	DECCW replaced with EPA

Contents

1 Introduction

1.1 About this standard

This standard is a multiple unit train interface standard, covering the minimum technical requirements for the operation of multiple unit trains on the NSW Country Regional Rail Network (CRN).

John Holland Rail (JHR) 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 multiple unit trains and multiple unit trains that have not operated previously on the CRN. Multiple unit trains that have operated on the CRN prior to 25 November 2011 will be considered as deemed to comply with this standard. Older multiple unit trains with a historical background may not comply completely with this standard but will be assessed, considering the design and proposed use of the multiple unit train(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.

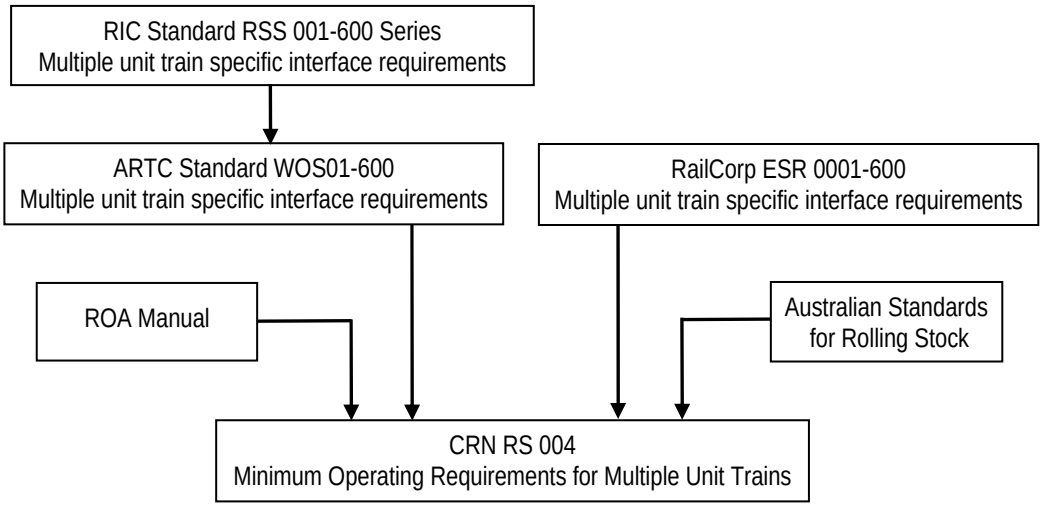
1.2 Rolling stock standards suite

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 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” or “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. The standards may be found at www.rissb.com.au/site/publications.php.

1.5 Definition of a multiple unit train

For the purposes of interpretation of this standard a multiple unit train is a self propelled passenger train consisting of a mixture of power and trailer vehicles, each designed to carry passengers. The distribution of power vehicles within a multiple unit train can be 100%, however in the majority of cases it is 50%. That is, one power vehicle per trailer vehicle.

Power cars, as used on the XPT, in the context of this standard, used for propulsion and which do not carry passengers shall be treated as a locomotive and meet the requirements specified in the CRN Standard CRN RS 001. Dedicated trailer vehicles and operate in conjunction with the above mentioned power cars shall be treated as locomotive hauled passenger vehicles and meet the requirements of CRN Standard CRN RS 003.

The relevance of this standard will be for the operation of diesel rail cars on the CRN.

1.6 Multiple unit train/vehicle design

Multiple unit train 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 reference is also made to, and excerpts 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 multiple unit train shall take into account and demonstrate compliance with the requirements of all environmental legislation, in particular those requirements relating to noise, vibration, exhaust emissions and waste discharge.

Existing multiple unit train designs authorised to operate within New South Wales as at 25 November 2011, will be permitted to operate on the CRN under existing vehicle approvals.

As of 25 November 2011, newly introduced or substantially modified multiple unit trains shall be subject to review and assessment, by the CRN Manager, for compliance with the relevant standards and legislation. Multiple unit train owner/operators will be required to submit the necessary documentary evidence to verify that their multiple unit train is compliant.

Multiple unit trains 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 Multiple unit trains authorised to operate on the NSW Country Regional Network

Only multiple unit trains 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.

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

Multiple unit train owner/operators shall be responsible for obtaining vehicle acceptance from the CRN Manager.

Multiple unit train owner/operators must consult with the Environmental Protection Authority (EPA) and the CRN Manager on the environmental standards that do or will apply to a multiple unit train type, and shall demonstrate compliance with the appropriate standards and regulations thereby nominated, prior to operation of the multiple unit train on the CRN.

The same environmental standards will apply to the same multiple unit train type, irrespective of the owner/operator, except where a multiple unit train type has been substantially modified from its original configuration.

Multiple unit trains, 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.)

Multiple unit trains 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 multiple unit trains undergoing tests.

A multiple unit train with a defect as specified herein, sufficient for that train 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 multiple unit trains 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 multiple unit train 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 multiple unit train roadworthiness has been reinstated.

1.8 Acceptance of new multiple unit trains

To apply for new multiple unit train acceptance the owner/operator shall complete the appropriate Vehicle Certification Request Form, CRN RF 004 and submit it to the CRN Manager.

Where testing is to be conducted on the vehicle/s refer to section 1.10 below.

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

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. 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 multiple unit train design or operating conditions

Where a multiple unit train 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, increase in adhesion performance, loading of the vehicle, etc.

1.10 Testing of multiple unit trains

Testing of any multiple unit train/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 multiple unit trains 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 multiple unit train 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 multiple unit train 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 multiple unit train/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 multiple unit trains tested on the CRN or tested on other rail systems, the test results shall be submitted to CRN Manager for assessment, using the appropriate multiple unit train Information Pack listed above.

2 Multiple unit train components

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

3 Wheels

All multiple unit train 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 multiple unit train 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 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 multiple unit trains 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.

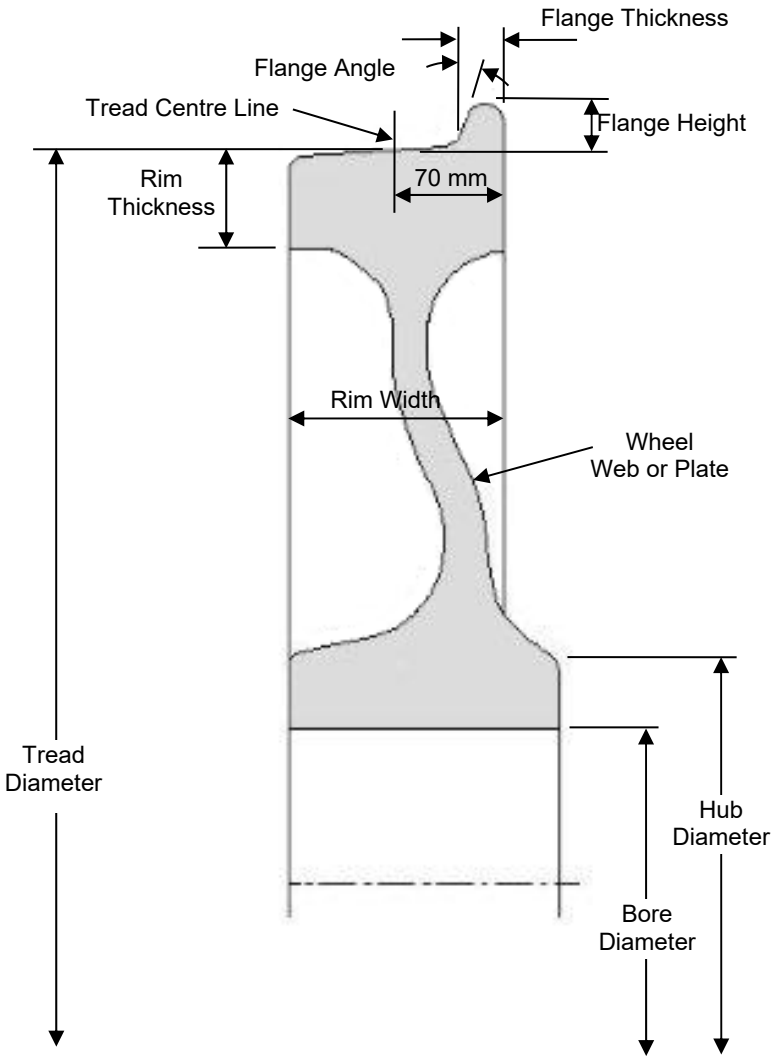


Figure 1 – Wheel parts and principal dimensions

3.3 Wheel web shape

S-Plate, low stress wheels are preferred for all multiple unit trains where tread braking is performed, and shall be used on all multiple unit trains 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, however it is common practice for straight webbed wheels to be used in conjunction with wheel cheek mounted disc brakes and this is an acceptable combination for this application.

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 wrought steel, and manufactured in accordance with the following standards or CRN approved equivalent 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 multiple unit trains 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 and location specified in Figure 2 below is common practice and is recommended.

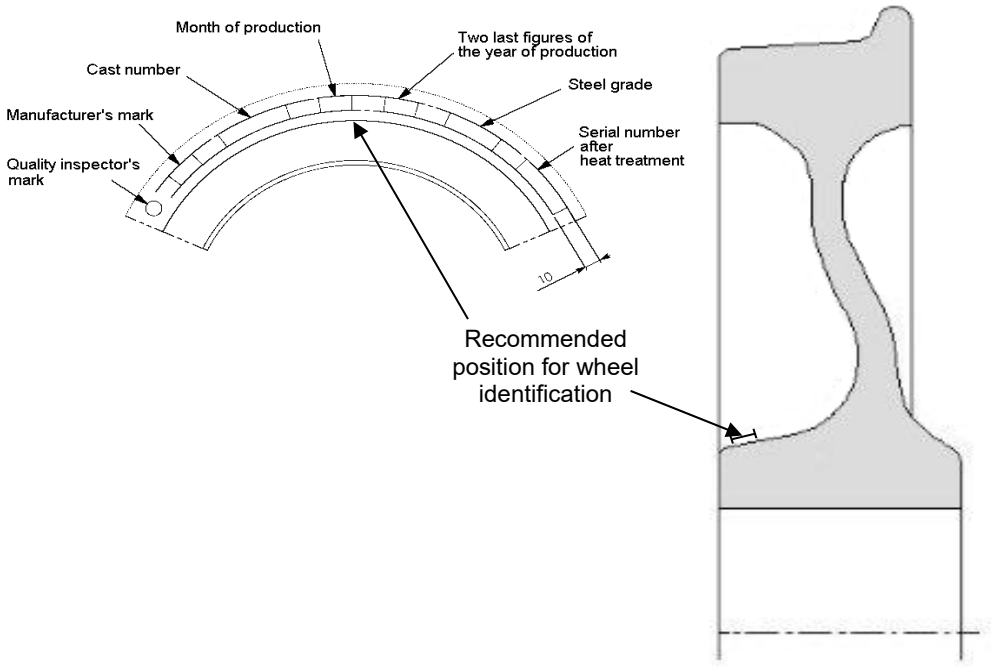


Figure 2 – Wheel identification

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 vehicles are sensitive to the higher conicity produced at the root radius resulting in bogie hunting instability. If vehicles are prone to hunting with the WPR 2000 profile, the ANZR1 profile may be used as a substitute.

3.8.2 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.

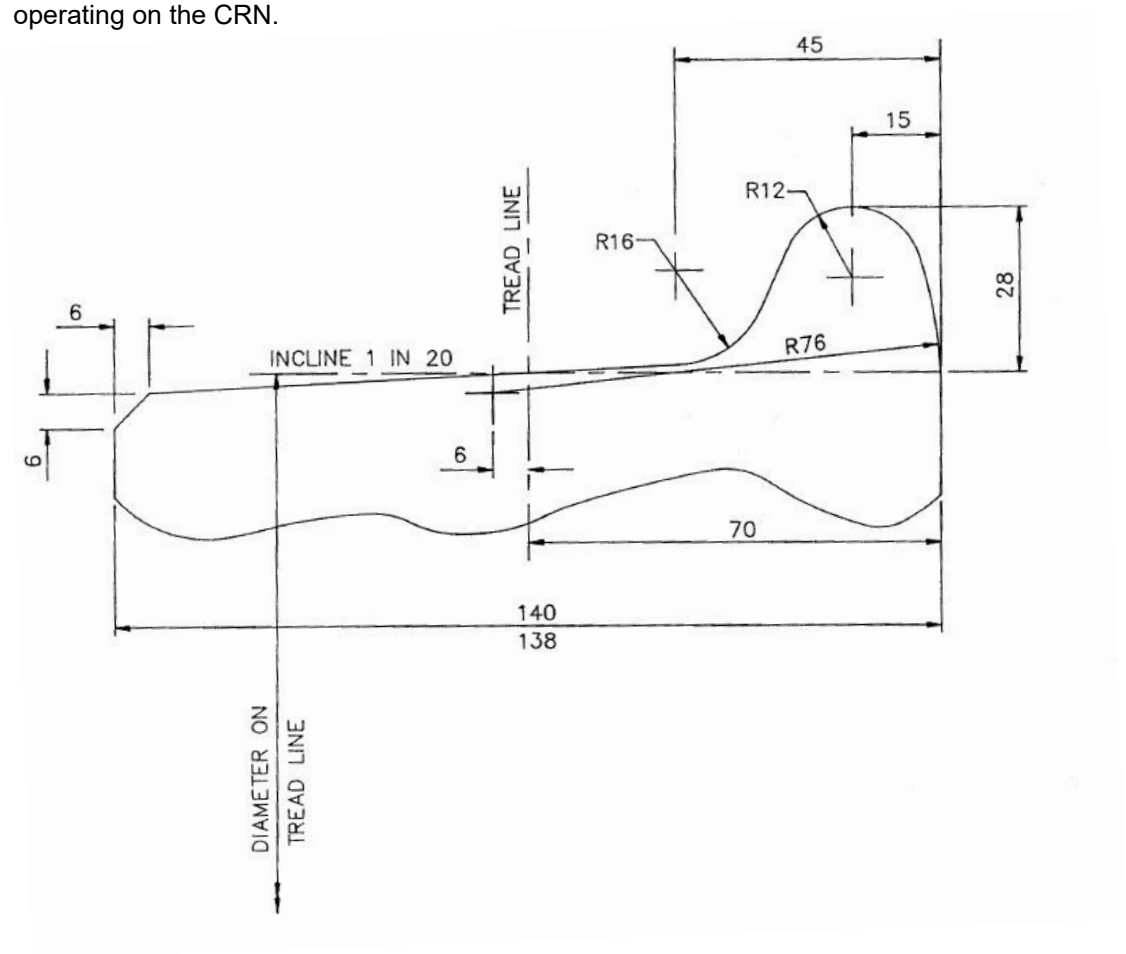


Figure 3 – ANZR1 Wheel Tread Profile

The 7/8 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 and 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.

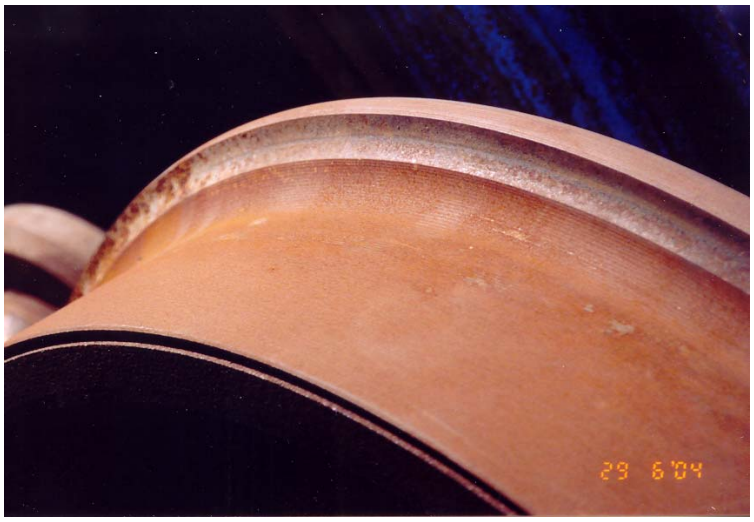


Figure 4 - An unacceptable witness mark

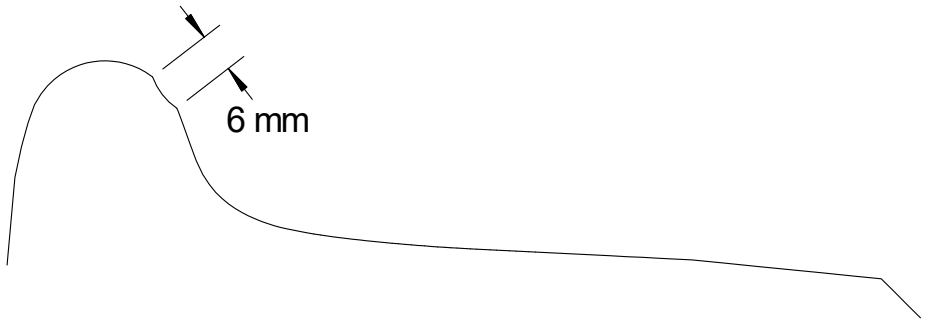


Figure 5 – Witness mark dimensional limit

3.10 Tyred wheels

3.10.1 Multiple unit trains fitted with tyred wheels

The use of tyred wheels will only be permitted on multiple unit trains where such trains have a historical background and the original wheel design incorporated 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 rail 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 multiple unit train integral steel wheels may continue in service. For wheel defects and operating restrictions imposed for defective wheels found in service refer to CRN Standard CRN RS 015.

3.12.1 Wheel rim thickness limits

A multiple unit train shall not remain in service if it has a wheel rim thickness less than the limit specified below, with reference to Figure 1

Vehicle Type	Minimum wheel rim thickness
Passenger vehicles	25 mm (See Note)

Table 2 - Minimum wheel rim thickness

Note: The minimum wheel rim thickness on multiple unit trains may be dictated by bogie component clearances, such as gearboxes, above the rolling stock outline.

3.12.2 Permissible Variation in Wheel Diameter

On multiple unit trains, the diameter variation between wheels on the same axle shall be in accordance with multiple unit train manufacturer's requirements, but they shall not exceed the following:

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

Table 3 - Permitted variations in wheel diameter

For multiple unit rolling stock, the diameter variations between wheels shall be in accordance with vehicle manufacturers requirements, but shall not exceed the values in Table 3 above

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

Multiple unit train 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, such as hollow axles, may be used, however such proposals shall be subject to approval by the CRN Manager.

4.1 Axle manufacture

Multiple unit train axles shall be of forged steel and be manufactured in accordance with AAR Specification M-101, or an approved equivalent.

4.2 Axle remanufacture

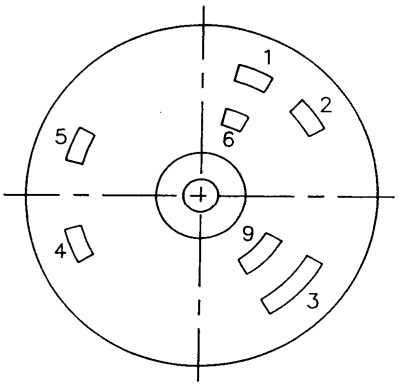
All reclamation and/or modification of axles shall be in accordance with AAR M-101, Section G part 2, rules 2A4 and 2A5. Multiple unit train axles that are unable to be reused for their normal application due to dimensional limits may be cascaded to a lesser duty for an alternate axle application provided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

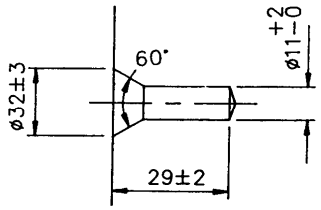
Any other proposal for the reclamation of axles must first be approved by the CRN Manager.

4.3 Axle identification

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.





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

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

Multiple unit train 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 multiple unit train 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.

Whilst a portion of a diesel power car axle is protected by the final drive unit there are portions of the axle outside final drive and the wheel boss which can be damaged. Also multiple unit trailer cars have unprotected axles. Therefore in cases where the following defect is detected on an operational multiple unit train axle, the multiple unit train is to be worked out of service for repairs:

- Any multiple unit train 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 multiple unit train 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

Multiple unit train owner/operators/manufacturers shall follow proven industry standards for the assembly of multiple unit 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:

- Assembly location (facility)
- Date of assembly
- Individual wheel and axle identification.
- Wheelset assembly number
- 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 a 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 multiple unit 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 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 affected 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 affected vehicle being immediately removed from service.

5.6 Plain bearing axlebox assemblies

Multiple unit vehicles with plain bearing axlebox assemblies shall not operate on the CRN without the approval of the CRN Manager.

5.6.1 Plain bearing maintenance

The owner/operator shall follow proven industry standards and have procedures in place for the maintenance of plain bearing equipment.

6 Bogie frame components

Bogie frame components include, but are not limited to side frames, bolsters, spring planks, swing links, control rods, frame adaptors, swing arm axleboxes, equaliser beams 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 and fatigue 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 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 multiple unit vehicle suspension systems, including steel helical and flexicoil springs, hydraulic and 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 multiple unit 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 multiple unit vehicles with missing, broken springs or incorrectly fitted springs.

Possible multiple unit 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 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 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 of 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.

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

Multiple unit 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 multiple unit 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.

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

All multiple unit vehicles shall be fitted with a parking brake system capable of securing the multiple unit train on a 1 in 30 gradient, indefinitely.

There should be detection on the spring parking or handbrake system to indicate that the brake is applied or released. This indication shall be train lined, to ensure the leading drivers cab has indication covering all parking brakes in the train consist.

9.3 Multiple unit vehicle brake forces

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

Brake block/pad forces shall be such as to provide sufficient braking effort to meet the stopping distances specified in in Section 12.5.2, Table 6

Refer to CRN Standard CRN RS 010, Section 18 for brake performance test method.

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

9.4 Disc brakes

For multiple unit train braking performance the vehicles shall be tested in a train consist for stopping distance in Section 12.5.2, Table 6.

10 Brakes and pneumatic equipment

Multiple unit trains generally operate in sets consisting of two or more similar type vehicles.

The braking system shall be suitable to allow for the operation of multiple sets joined together to form a larger train consist.

All multiple unit vehicles operating on the CRN operating as a train shall be fitted with a fail safe automatic brake system that can be operated from a hauling vehicle with a brake pipe pressure set at 500 kPa, in the event of train failure.

When the vehicle/train is being rescued by a locomotive/train, the automatic air brake must be fully operational when only the brake pipe air is connected, that is the main reservoir air supply is not connected.

10.1 General requirements

In general, multiple unit train brake systems shall consist of pneumatic control equipment to provide for an automatic air brake system. Because the multiple unit train is normally a dedicated consist it is possible for such trains to also have an electro-pneumatic brake system installed.

The driver's automatic brake valve shall:-

- charge the brake pipe when the driver's brake valve handle is placed in the release position.
- reduce the brake pipe pressure when the driver's brake valve handle is placed in the application position
- fully exhaust the brake pipe when in the driver's brake valve handle is placed in the emergency position.

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

10.2 Air reservoirs

Air reservoirs shall be designed and tested in accordance with Australian Standard AS1210 for unfired pressure vessels.

There shall be procedures in place covering the regular inspection, maintenance and testing of vehicle air reservoirs and drain valves.

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 7.

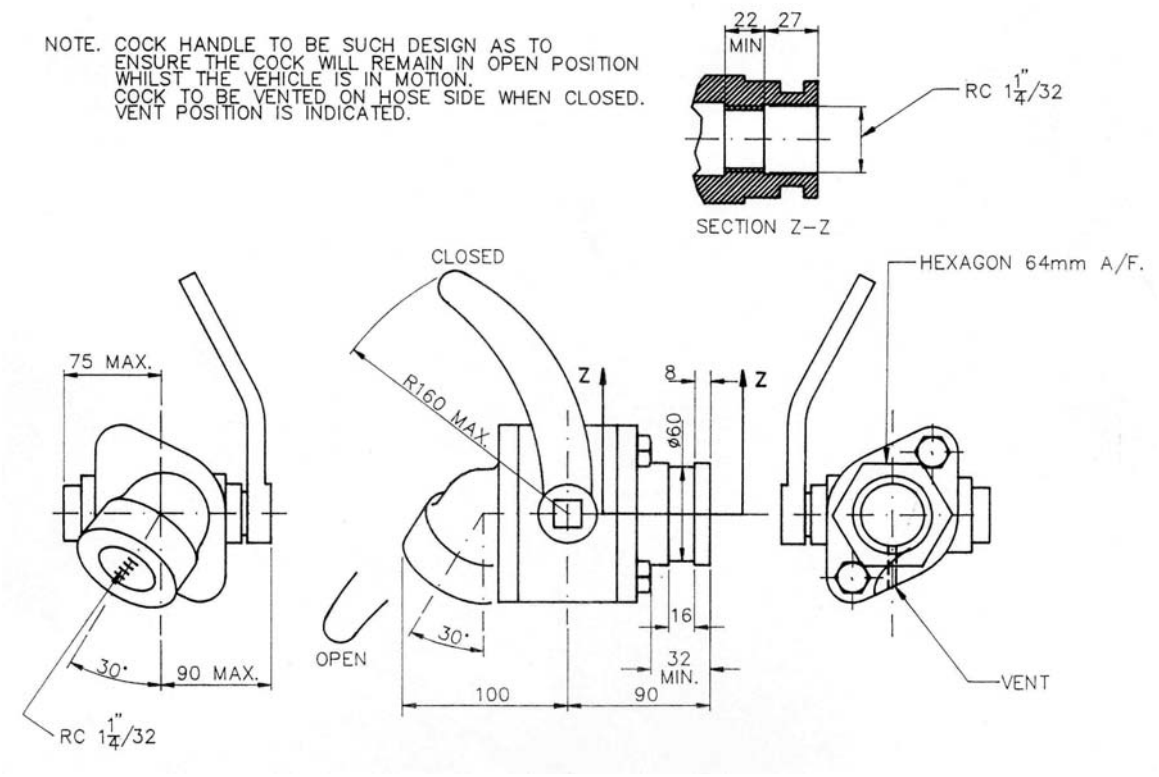


Figure 7 - Brake pipe coupling cock

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

Coupling heads shall be:

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

Brake hose coupling heads shall be in accordance with Figure 7

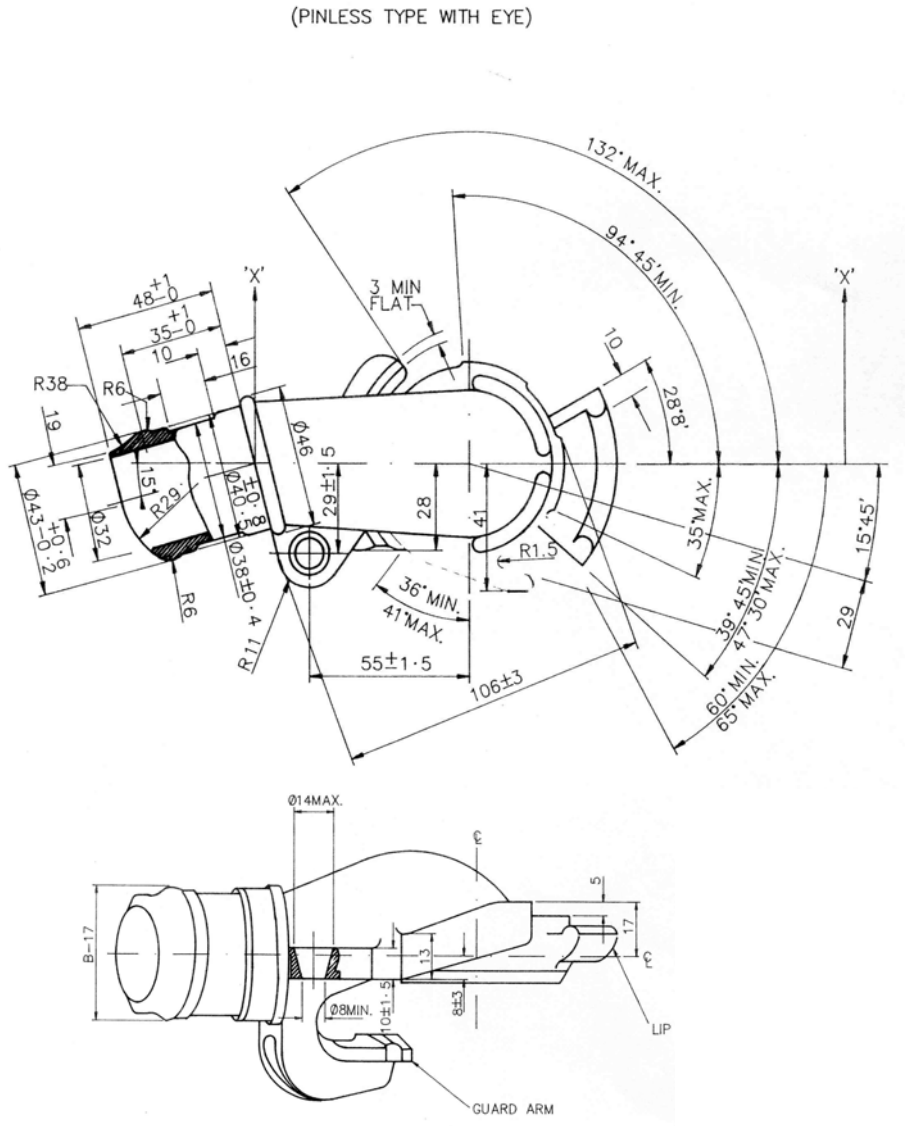


Figure 7 - Air brake coupling hose head

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

All equipment cut-out, isolation and end cocks shall be clearly identified and have their handles painted white.

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 Trip gear

Multiple unit trains shall be fitted with a trip valve on the front left hand axlebox. The trip valve arm shall be retractable and retracted when operating on the CRN.

10.9 Air dryers

It is recommended that air dryers be fitted to reduce the damage caused by water on brake equipment.

It is recommended that silencers be fitted to the air exhaust of air dryers and that the exhaust is directed such that dust is not blown up around the vehicle.

10.10 Electro-pneumatic brakes

Alternate brake systems, such as electro-pneumatic (EP) brakes, will be permitted to operate on the CRN provided the vehicles are pneumatically compatible to operate in conjunction with trains/locomotives used for rescue purposes.

In cases where EP brake is installed, it is preferred that the automatic brake be a shadowing system that automatically takes over the braking function if the EP brake fails.

10.11 Hydro-dynamic brake

Modern diesel rail cars use a hydro-dynamic drive system through a torque converter and thus they have the ability to use the drive system as retarding brake.

11 Body, underframe and appointments

The multiple unit 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 Shock loads:

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 5 – 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 be designed to act in conjunction with the body structure in resisting the forces listed above.

Vertical anti-collision members shall be provided at each end of the vehicle body structure. 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.

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 Collision protection and energy absorption

All multiple unit 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 multiple unit trains 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. The multi-function couplers on Xplorer/Endeavour diesel vehicles shall be generally as follows:

Xplorer/Endeavour type diesel powered vehicles	905 +/- 1 mm.

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

The height of the knuckle coupling end of emergency adapters must be such that the height is compatible with that of locomotives.

11.3 Towing fixtures, jacking and lifting points

Multiple unit 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 Cowcatcher or pilot

The terminal ends of multiple unit trains shall be fitted with a cowcatcher, pilot and/or wheel guard irons to deflect and prevent beasts or other objects on the track from passing under the train.

The minimum height of the cowcatcher or pilot shall be 80 mm above rail with solid springs and wheels at condemn diameter. If spring packing is proposed at wheel turnings to compensate for reduced wheel diameter, then the minimum height shall be 80 mm with solid springs.

The height for wheel guard irons above rail under any condition of wear and dynamics shall not be less than 30 mm.

11.6 Crew cab security

All multiple unit trains should be fitted with a positive means of locking the crew cab/s when the cabs are unattended. This is mandatory for trains used or proposed for driver only operation.

11.7 Multiple unit train toilets

Toilets installed on multiple uni trains 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.

11.8 Wooden bodied vehicles

All self propelled wooden-bodied vehicles shall be fitted with approved hazard warning lights at each terminal end and approved impact resistant barriers on the front and rear windows. The use of an appropriate film applied to the windscreens of these vehicles will be assessed for suitability as an impact resistant barrier.

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

Any self propelled wooden bodied 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.

11.9 Gas heating and cooking facilities

Gas heating is prohibited on passenger rolling stock operating on the CRN.

Gas cooking facilities are permitted but only in specifically design rolling stock galleys, and provided there is adequate safety equipment such as fire blankets, fire extinguishers, isolating valves and automatic flow shut off valves installed.

11.10 Fire and smoke control

All materials used in the construction of passenger vehicles shall be selected so as to minimise the risk of fire and retard the spread fire by limiting the effect of the materials in supporting combustion.

Particular attention shall be given to the fire resistance, flammability and toxicity properties of materials used in the construction of rolling stock.

The vehicle design and construction shall minimise the potential for a fire to spread rapidly throughout the vehicle, into the roof space, or to adjoining vehicles or buildings and structures

11.11 Marking and identification

11.11.1 Code and number

Each vehicle of a multiple unit train shall have a unique identification code/number clearly marked on each side the vehicle.

The minimum height of 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.

11.11.2 Markings

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.

11.11.3 Terminal end colours

For on-track visual safety, the terminal end frontal area of multiple unit trains shall have an area of high visibility colour preferably with the colour yellow, orange, orange-red, white or an approved combination of those colours. There shall be sufficient colour and contrast to enable the approaching train to be seen from a safe distance.

11.11.4 Reflective delineators

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

11.11.5 Maintaining visibility

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

11.11.6 AEI Tags

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

12 Multiple unit train performance

The performance of a multiple unit train 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 multiple unit trains on the CRN. For performance testing refer to CRN Standard CRN RS 010.

12.1 Multiple unit train ride performance

Refer to CRN Standard CRN RS 008, Section 20, for ride performance requirements.

12.2 Multiple unit train noise

Multiple unit train noise is an important performance consideration as it requires endorsement by the EPA before the multiple unit train will be approved to operate on the CRN. For noise requirements refer to CRN Standard CRN RS 008.

12.3 Multiple unit train mass and mass distribution

Multiple unit trains shall be type tested to determine the fully provisioned mass, as well as the loads on individual axles.

It is in the interest of multiple unit train owner/operators that their power vehicles' mass, axle and wheel load distribution be within acceptable limits for optimum adhesive tractive effort. The axle and wheel load distribution shall therefore be within the limits specified in CRN Standard CRN RS 012.

The maximum axle load of multiple unit vehicles for unlimited operation on the CRN is 19 tonnes. Multiple unit trains with a higher axle loads may be considered but they will be subject to restricted operations.

12.4 Traction performance

Traction performance type tests shall be carried out on multiple unit trains to confirm the acceleration and wheel slip control system meets the design requirements.

Traction tests shall be conducted in accordance with CRN Standard CRN RS 010. The fuel level shall be recorded before conducting traction performance tests.

12.4.1 Wheelslip control

Multiple unit power vehicles shall be fitted with a suitable traction control system to prevent uncontrolled wheelslip.

Wheelslip detection shall be train lined to ensure that wheelslip on any or all power vehicles in a multiple unit train is capable of being monitored by the driver.

12.5 Braking performance

Braking performance is specified to ensure that a multiple unit train is compatible with current CRN signalling systems and can safely stop within the distances specified in Table 6.

12.5.1 Static brake performance

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

12.5.2 On-track brake performance

Braking performance is specified to ensure that multiple unit trains 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

	Maximum stopping distance (Cont'd) (metres)	
Speed (km/h)	Full service brake application	Emergency brake application
80	278	265
90	349	330
100	516	480
115	565	521
120	620	565
130	720	657

Table 6 - Maximum stopping distances for new multiple unit trains

For all new multiple unit trains, the braking performance on clean dry level track must be better than the stopping distances in Table 6 to ensure a consistency of train handling across the new generation of rolling stock and a high level of braking performance to ensure timetable margins are maintained.

12.5.3 Multiple unit vehicles hauled dead attached

Multiple unit diesel hydraulic vehicles that are to be hauled dead attached on the rear of a train or by a locomotive shall have coupling and air brake compatibility. The owner/operator shall have procedures covering the movement of such trains and the security of cardan shafts and final drives.

13 Multiple unit train safety equipment

13.1 Driver's safety system

Each multiple unit train shall be fitted with driver's safety systems as specified in CRN Standard CRN RS 013.

Some heritage diesel multiple unit trains/vehicles may be exempt from this requirement and therefore will be required to operate under special conditions as determined by the CRN Manager.

13.2 Speed indicating device

Each multiple unit train driving position shall have an operating speed indicating device.

Speed indicating devices which are displayed digitally on a VDU (Visual Display Unit) shall display the speed to an accuracy of +/- 0.5 km/h or better, when compared to the true vehicle speed, at all times.

Analogue (gauge type) speed indicating devices shall display speed to an accuracy of +/-2.5 km/h or better, when compared to the true vehicle speed, at all times.

Verification of the speed indicating devices on a new or substantially modified multiple unit train compared to the true vehicle speed shall be measured by suitably accurate equipment. Verification shall be carried out at 10 km/h intervals up to the maximum design speed.

The design of any speed indicating devices shall take into account variation in wheel diameters and wheel slip / slide events.

13.3 Data logger/recorder

Each multiple unit train, except those specified below, shall be fitted with a functioning, reliable and accurate data recording/logger system.

The system shall meet the requirements of the Office of National Rail Safety Regulator, Rail Safety Compliance Code for Data Loggers. This Guidance Material is available via the ONRSR website at:

http://www.onrsr.com.au/__data/assets/pdf_file/0013/5260/Data_loggers_rail_safety_compliance_code_2011-3-May-2013-2.pdf

The system shall record the information as specified in the ONRSR Guidance for Train Data Loggers.

Some multiple unit trains/vehicles have a heritage background and thus may be exempt from this requirement and therefore will be required to operate under special conditions as determined by the CRN Manager.

13.4 Driver's emergency cock

Multiple unit trains shall be fitted with an emergency cock or failsafe emergency brake pipe dump control near each driving position. The cock when opened shall directly vent the brake pipe to a position outside the cab.

13.5 Emergency equipment

Each multiple unit train, except those specified below, shall be supplied with the emergency equipment as specified in the CRN Train Operating Conditions Manual, General Instruction Pages, Section 3, Train Operations, Emergency Equipment.

Some multiple unit trains/vehicles have a heritage background and thus may be exempt from this requirement and therefore will be required to operate under special conditions as determined by the CRN Manager.

13.6 Communications

Multiple unit trains, except those specified below, shall be fitted with a train radio system. Radio frequencies shall be approved by the CRN Manager. Refer to CRN Standard CRN RS 018.

Some multiple unit trains/vehicles have a heritage background and thus may be exempt from this requirement and therefore will be required to operate under special conditions as determined by the CRN Manager.

13.7 Lights

Each multiple unit train shall be fitted with headlights, tail lights, marker lights, visibility lights in accordance with CRN Standard CRN RS 008.

Some multiple unit trains/vehicles have a heritage background and thus may be exempt from this requirement and therefore will be required to operate under special conditions as determined by the CRN Manager.

13.8 Horns

Refer to CRN Standard CRN RS 008 for horn noise level requirements.

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