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Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	07/12/2005	All	Reformatting to ARTC Standard and combining all 200 Series into one document
1.1	01/02/2018	3.4	Rebranding of document Wheel Profile Superseded

Table of Contents

WOS 01.200 - Wheels

1 General

1.1 This section contains vehicle interface information which is common to all vehicle types. For specific requirements refer to the applicable Rolling Stock Operation Standard covering that vehicle type.

1. 300 Series Locomotive specific interface requirements
2. 400 Series Freight vehicle specific interface requirements
3. 500 Series Locomotive hauled passenger vehicle specific interface requirements
4. 600 Series Multiple unit train specific interface requirements
5. 700 Series Track maintenance vehicle specific interface requirements.

WOS 01.210 - Wheels

1 General

1.1 This unit specifies the design, manufacture and minimum operational requirements for integral steel wheels and tyred wheels on vehicles operating on the Australian Rail Track Corporation network.

WOS 01.211 - Wheels, Design and Manufacture

1 Introduction

1.1 Sections 2 and 3 of this manual cover integral steel wheels only. For tyred wheels, refer to WOS 01.211, section 4.

1.2 Additional requirements, particular to certain types of rolling stock, can be found in the Series dealing with that rolling stock type

2 Wheel Design

2.1 Minimum Wheel Design Standards

All 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:

2.1.1 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 operating conditions, the Australian Rail Track Corporation will consider the maximum P/D ratio, (the ratio of maximum static wheel load to minimum [worn] wheel diameter).

Maximum allowable P/D ratio's for operation of **worn wheels** on the Australian Rail Track Corporation network are as follows:

Area of Operation	Maximum P/D Ratio (t/m)
Unlimited	12.66
Interstate Network (Class 1 Track)	15.13
Hunter Valley Coal Network (Class 1XC, 1C, 1X Track)	17.56

Where it is proposed to operate vehicles having P/D ratio's outside these limits, approval must be obtained from the Australian Rail Track Corporation.

The following table lists currently approved bogie/wheel load/wheel diameter combinations for **new wheels**.

Bogie Type	Wagon Type	Side Bearer Type	Max Axle Load Tonnes	New Wheel Diameter mm	Speed Km/h	Track Class	Comments
3 piece	Cartainer	CCSB	16	737	115	1 or better	19 tonne axle load approved for a limited number of services
	All types	Gap	19-20	840-920	80		Reduced speed over all lower class track
	Super freighter	CCSB	19		115		
			21	840	100		Reduced speed over some lower class track
			23		80		Reduced speed over some class 2 track. 2mm wheel tread hollowing limit
	Steel	Gap					Limited operation at reduced speed on some class 2 track. 2 mm wheel tread hollowing limit
	Coal traffic	CCSB					Ex-BHP vehicles used in the Hunter Valley
		Gap	25		60-65	1	BHP traffic in Port Kembla area – only for short sections of RIC track
				920	65	1 or 1C	Sydney and Hunter Valley areas
					80	1XC	Hunter Valley only
		Gap or CCSB	30		40	1 or better	
					60	1XC	
Dual Sprung WN type	Super freighter	Gap + large centre pivot	19.25	840	115	1 or better	Reduced speed over all lower class track
		CCSB		920			
			20		80		Reduced speed over some lower class track
	Grain		20.25				
Primary sprung	Super freighter		19.25	840	115		Reduced speed over all lower class track
	Coal traffic		25	920	80		Sydney and Hunter Valley areas
			30		40		Hunter Valley only
					60	1XC	

Table of Approved Bogie/Wheel Load/Wheel Diameter Combinations

Notes on Table:

All applications with axle loads exceeding 19 tonnes and/or wheel diameters with less than 840 mm are subject to traffic density considerations as part of the vehicle approval process.

Track Class 1XC = 60 kg/m head hardened rail on concrete sleepers

Track Class 1C = 53 kg/m standard rail on concrete sleepers

Track Class 1 = 53kg/m standard rail on timber sleepers

Track Class 2 to 5 are of lower quality

2.1.2 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, with 140 mm being mandatory for axleloads of 25 tonnes and above.

2.1.3 Wheel Web Shape

S-Plate, low stress wheels are preferred for all rolling stock where tread braking is performed, and shall be used for all AAR Class C wheel material applications where tread braking is performed. See WOS 01.211, section 3.2 for brake block compatibility.

Conventional curved plate wheels are acceptable for AAR Class A and B wheel material applications. See WOS 01.211, section 3.2 for brake block compatibility.

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

2.2 Alternate Designs

Alternate design methods may be used for integral steel wheels only, however, such proposals shall be subject to review by the Australian Rail Track Corporation.

This review will require submission of an analysis and the relevant technical information required by AAR Standard S 660 Procedure for Analytic Evaluation of Loco & Freight Car Wheel Designs.

In AAR Standard S 660, the following changes are applicable:

2.2.1 Application of Wheel Loads

The point of application of the vertical, lateral and thermal loads defined in AAR Standard S660 clauses 5.1, 5.2, and 5.3 shall relate to the relevant wheel profile as defined in section 3.4 of this Rolling Stock Operation Standard.

2.2.2 Condemning Limit Rim Thickness

The wheel condemning rim thickness, shall be in accordance with section 2 of WOS 01.212 in lieu of that specified in AAR Standard S660 clause 7.2.

2.2.3 Responsibility

The Australian Rail Track Corporation shall be substituted for AAR, in AAR Standard S660 clause 11.0.

3 Wheel Manufacture

3.1 Manufacturing Method

Wheels shall be either cast steel or wrought steel, and manufactured in accordance with the following standards or Australian Rail Track Corporation approved standards:

(For the purpose of clauses 3.1.1 and 3.1.2, the terms the “Secretary”, and the “Committee”, referred to in AAR specifications M107 and M 108, are to be taken to mean the Australian Rail Track Corporation, and “AAR Interchange Service” shall be taken to mean operation on the Australian Rail Track Corporation Network.)

3.1.1 Wrought Steel Wheels

All wrought steel wheels shall be manufactured to the requirements of AAR Specification M 107, with the exclusion of clauses 16.2 and 17.1.

3.1.2 Cast Steel Wheels

All cast steel wheels shall be manufactured to the requirements of AAR Specification M 208, with the exclusion of clauses 14.2 and 15.1.

3.2 Wheel Material and Brake Block Compatibility

Only the following combinations of wheel material and brake block type 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

Refer to WOS 01.272 for brake block friction characteristics.

3.3 Wheel Identification

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

The method specified in the ROA Manual of Engineering Standards and Practices, Section 13, Diagram 13-15 (See Appendix G [WOS 01.G] of this manual) is recommended.

THE FOLLOWING SECTION HAS BEEN GREYED OUT AND IS NOW COVERED BY ARTCs ROUTE ACCESS STANDARD (RAS) GENERAL INFORMATION SECTION 1.2 WHEEL PROFILES

3.4 Wheel Profiles

The following wheel profiles are approved for use on the Australian Rail Track Corporation network.

3.4.1 Standard ANZR Profile (also known as the ANZR-1 profile)

This profile is depicted on diagram 13.16 of the ROA Manual of Engineering Standards and Practices (See Appendix G [WOS 01.G] of this manual), and is the base standard profile for all rolling stock operating on the Australian Rail Track Corporation network.

See clause 3.4.3 for future recommended work.

3.4.2 Test Profile

The test profile is a generated field worn wheel profile installed on new or substantially modified rolling stock for the purpose of vehicle performance testing under worn wheel conditions. Refer to diagram 3-1 of the ROA Manual of Engineering Standards and Practices. (See Appendix G [WOS 01.G] of this manual).

3.4.3 Intersystem Profile

The profile depicted as WRP 2000 in Appendix G (WOS 01.G) of this manual is the recommended wheel profile for future wheel replacement and reprofiling on all rolling stock operating on the Australian Rail Track Corporation network.

Where it can be demonstrated that a vehicle experiences bogie instability, the standard ANZR-1 profile (see clause 3.4.1) may be used.

3.4.4 Alternate Profiles

Alternate profiles will be considered, however, such proposals must be compatible with the rail.

4 Wheel Profile Machining

4.1 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 can 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 type derailment.

The surface finish of the wheel tread and flange, after machining shall not exceed 6.3 µm (micrometres) RA (Roughness Average).

4.2 Undercutting

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

Localised undercutting, grooving or waviness of the flange profile between the wheel tread side of the flange root radius and the back face of the wheel, is permitted but shall not exceed 0.25 mm in depth below the true flange profile.

4.3 Witness Marks

Witness marks used for an indication of machining efficiency, are permitted on the flange face between the top of the flange root radius and the tip of the flange but shall not exceed 0.25 mm in depth below the true flange profile and 3 mm in width.

4.4 Machining Tolerance

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.

5 Tyred Wheels

5.1 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 vehicles must be equipped with integral steel wheels unless otherwise approved by the Australian Rail Track Corporation.

5.2 Brake Block Compatibility with Tyred Wheels

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

6 Wheel Generated Noise

6.1 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 noise emissions, including curve squeal.**

WOS 01.212 - Wheels, minimum operational requirements

1 Introduction

This standard describes the minimum allowable conditions under which integral stell wheels and tyred wheels may continue in service, and operating restrictions imposed for defective wheels found in service.

2 Wheel rim thickness limits

2.1 A rail vehicle shall not remain in service if it has a wheel rim thickness less than the limits specified below, with reference to Figure 1.

2.1.1 Freight vehicles up to 25 tonne axle load 20mm

2.1.2 Freight vehicles over 25 tonne axle load 22mm

2.1.3 Passenger vehicle 25mm

2.1.4 Locomotives 22mm (See Clause 2.2)

2.2 Locomotive wheel rim thickness may be dictated by bogie component clearances, such as gearboxes, above the rolling stock outline.

3 Permissible Variation in Wheel Diameter

3.1 3.1 On freight vehicles, the wheel diameter variation on wheelsets, bogies, and between bogies fitted to vehicles shall be as per the limits specified in the ROA Manual of Engineering Standards and Practices, section 24.2.1.3 (e), (f), (g), as stated below:

3.1.1 Maximum permissible variation in wheel tread diameter per axle (new or re-turned) 0.5mm

3.1.2 Maximum permissible variation in wheel tread diameter per axle (in service) 1mm

3.1.3 Maximum permissible variation in wheel tread diameter per bogie 25mm

3.1.4 Maximum permissible variation in wheel tread diameter per vehicle 60mm

3.2 On locomotives, locomotive hauled passenger cars and multiple unit rolling stock, the diameter variations on wheels shall be in accordance with vehicle manufacturer’s requirements, but they shall not exceed 3.1.1 and 3.1.2 above.

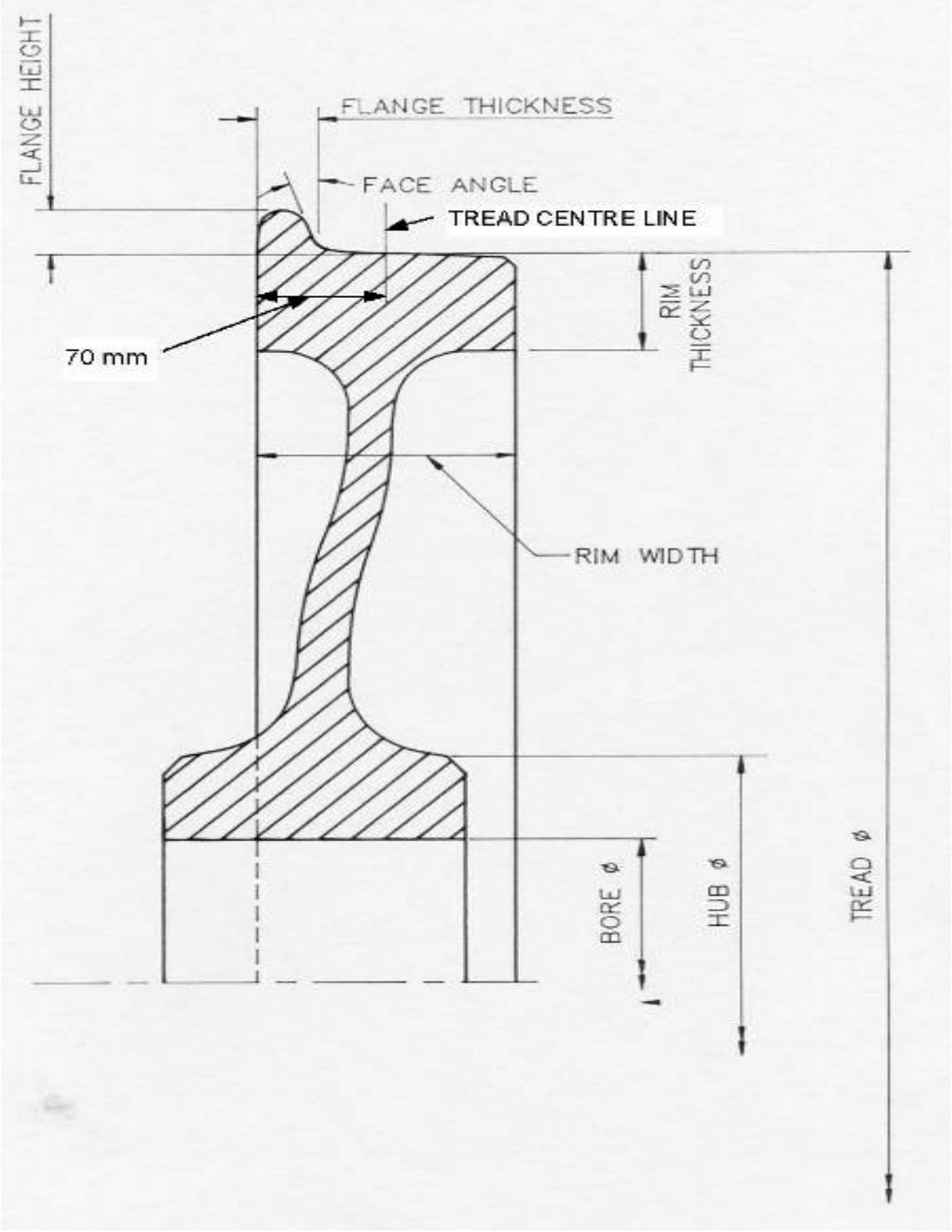


Figure 1 *- Wheels – Location of Limiting Dimensions*

4 Wheel Defects

This specification details the allowable limits for the inspection of all rail vehicle wheels for various tread and flange defects. The text outlines the action to be taken when defects are found.

Allowable speeds mentioned below are not to exceed the prevailing track speed limit.

The accompanying series of instructions and associated diagrams are included to indicate degrees of severity of wheel tread damage likely to be found and the appropriate action to be taken in each case.

4.1 Thermal Cracks

Thermal cracks are usually transverse, across the wheel tread, and, if allowed to grow without corrective action, can develop to the point where the wheel will fracture.

Many shallow thermal cracks can be removed by machining but extra care must be used to ensure that the crack has been completely eliminated in the operation.

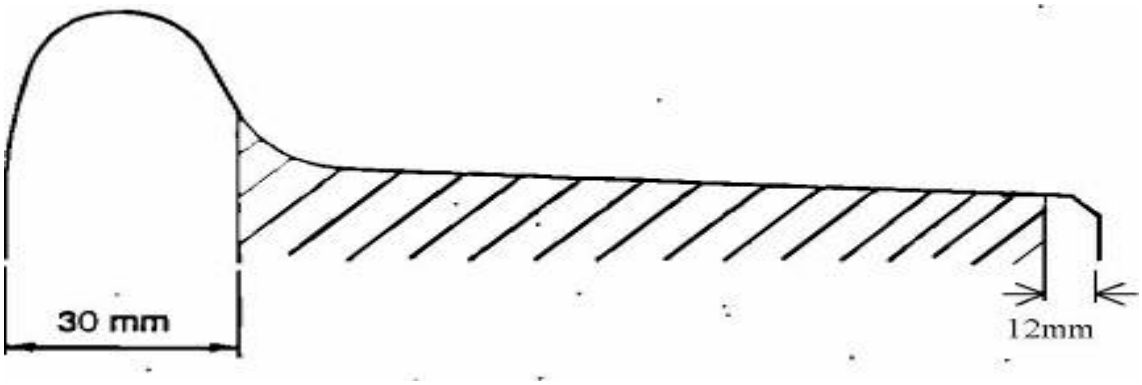
If thermal cracks are found on a wheel, then the vehicle's brake system should be checked for evidence of dragging brakes (sticking brakes).

IMPORTANT: If there is the slightest doubt as to the severity of the Thermal Crack, always report the higher classification. (For example, if the defect description falls between a Class 2 and 3 Thermal Crack, then a Class 3 Thermal Crack would be reported).

4.1.1 Class 1 Thermal Crack

Any thermal cracks up to 10 mm long on the tread surface within the zone shown in Figure 2 but not on or extending onto the Rim Face of the wheel (see Clause 4.1.4).

No action required.



Cracks up to 10 mm long within the shaded area

Figure 2 *- Class 1 thermal crack zone*

4.1.2 Class 2 Thermal Crack

Any thermal cracks between 10 mm and 30 mm long in the zone shown in Figure 3.

Locomotives and passenger vehicles: Any wheels with Class 2 Thermal Cracks must have inspection details recorded by the Operator to ensure that the wheel condition is identified as soon as it progresses to a Class 3 Thermal Crack.

Freight vehicles: If any Class 2 Thermal Cracks are found, the examining officer shall re-examine the wheel during vehicle examination/inspection and maintenance. No other action is required for Class 2 Thermal Cracks.

No speed restriction for a vehicle with Class 2 Thermal Cracks.

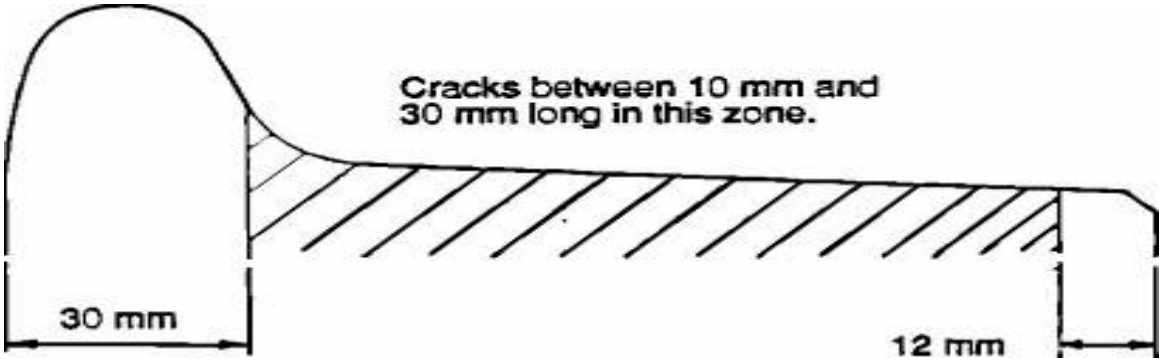


Figure 3 *- Class 2 thermal crack zone*

4.1.3 Class 3 Thermal Crack

Any thermal cracks over 30 mm and up to 40 mm long in the zone shown in Figure 4.

Note: Any vehicle found with a Class 3 Thermal Crack which has the wheel approaching the condemning diameter (i.e. less than 6 mm left on the tread above the condemning dimension), must be treated as if it had a Class 4 defect.

Locomotives and passenger vehicles with Class 3 Thermal Cracks must be scheduled for wheel turning within 14 days of detection.

Electric multiple unit vehicles with Class 3 Thermal Cracks may defer wheel turning provided the wheels are inspected and details recorded by the Operator every 14 days to ensure they have not progressed to a Class 4 thermal Crack.

Freight vehicles with Class 3 Thermal Cracks must be worked out of service for repairs.

No speed restriction for a vehicle with Class 3 Thermal Cracks.

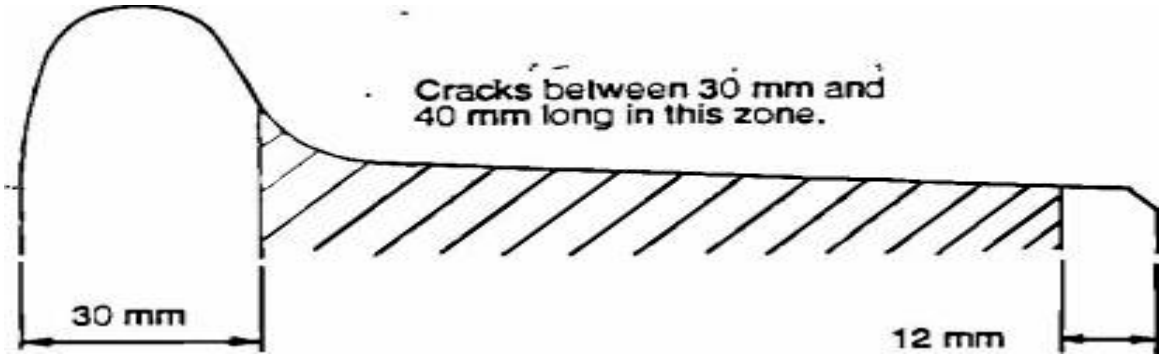


Figure 4 *- Class 3 thermal crack zone*

4.1.4 Class 4 Thermal Crack

Any thermal crack greater than 10 mm long in the shaded zone adjacent to the rim face, or any visible thermal crack on the flange shaded zone, as shown in Figure 5.

or

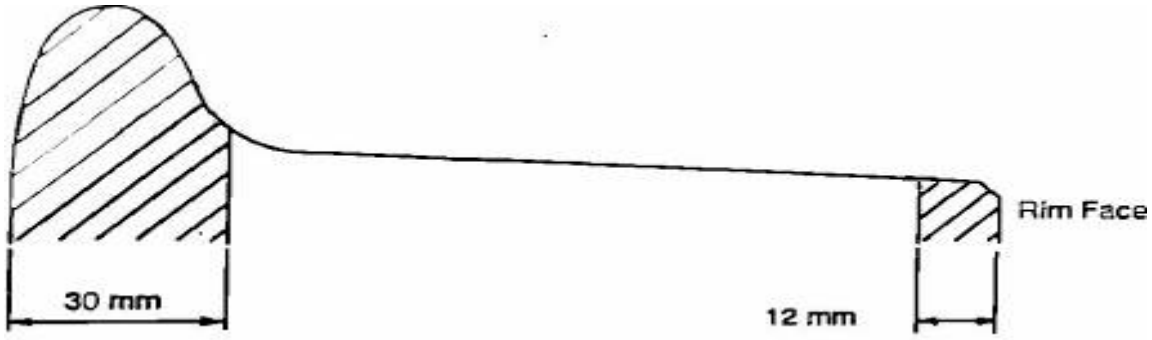
a thermal crack greater than 40 mm long anywhere on the wheel rim.

This is a serious defect which can result from extended heavy braking or periods of abnormal braking, for instance in the case of overhanging brake blocks.

NOTE: If there is any evidence of a crack on or extending onto the rim face, then this condition will be considered a Class 4 defect. Under no circumstances must a wheel with this defect be allowed to enter service if found at a pre-trip examination or at a depot.

If the defect is found en-route or at a location with no repair facility, the vehicle may continue through to the scheduled destination and/or be transferred to the nearest depot at a speed of not more than 40 km/h providing the brakes are isolated (passenger and freight) or the use of independent brake can be kept to an absolute minimum (locomotives).

If these restrictions unduly affect operations, the vehicle must be immediately removed from service. The vehicle may then be repaired (bogie/wheelset change) at the location where the defect was found.



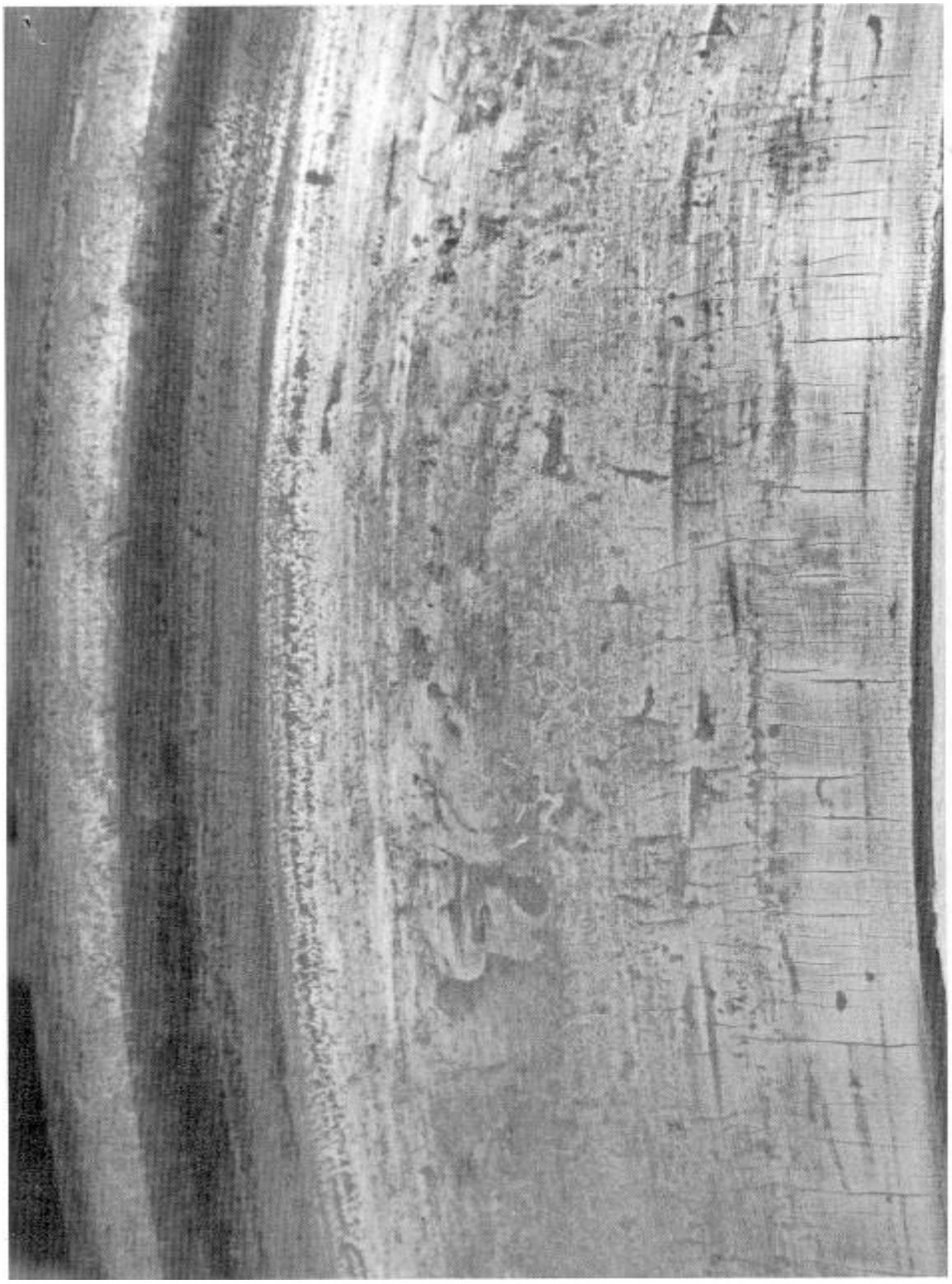
Any visible crack on Flange	**Cracks greater than 40 mm long anywhere**	**Cracks greater than 10 mm long**

Figure 5 *- Class 4 Thermal Crack Zone*

4.1.5 Photographs Showing Classes of Thermal Cracks

CLASS 2 THERMAL CRACK

CLASS 3 THERMAL CRACK



CLASS 4 THERMAL CRACK

4.2 Damaged or Fractured Wheels

4.2.1 Fatigue Cracks

Fatigue cracks generally originate from a defect in the wheel. These defects can be caused by either external damage or a manufacturing defect.

Fatigue cracks usually appear as a solitary crack and must not be confused with thermal cracks.

Any fatigue crack found in a wheel must be classified as a Class 4 defect (see Clause 4.2.4) or a Class 5 defect (see Clause 4.2.5).

4.2.2 Manufacturing Defects

This type of defect generally occurs on the wheel web and can result in a fatigue crack which propagates circumferentially around the web. In other cases, defects have led to large pieces of the flange falling off in service.

W37 type freight wheels originating in New South Wales, (these are fitted with 18R or 9R axleboxes), are particularly prone to manufacturing defects and should be specifically examined for cracks. Although this type of wheel has essentially been phased out of service, some wheels may still be in service.

Any crack originating from a manufacturing defect shall be classified as a Class 4 or greater defect (see Clause 4.2.4).

4.2.3 External Wheel Damage

This type of damage generally occurs as the result of a heavy impact on the wheel and may show up as a chip or gouge in the wheel flange or a bruise on the wheel tread. A fatigue crack can start at this defect and propagate quickly through the entire wheel.

A close visual examination must be made of both flange surfaces and the wheel tread in order to detect the presence of any damage.

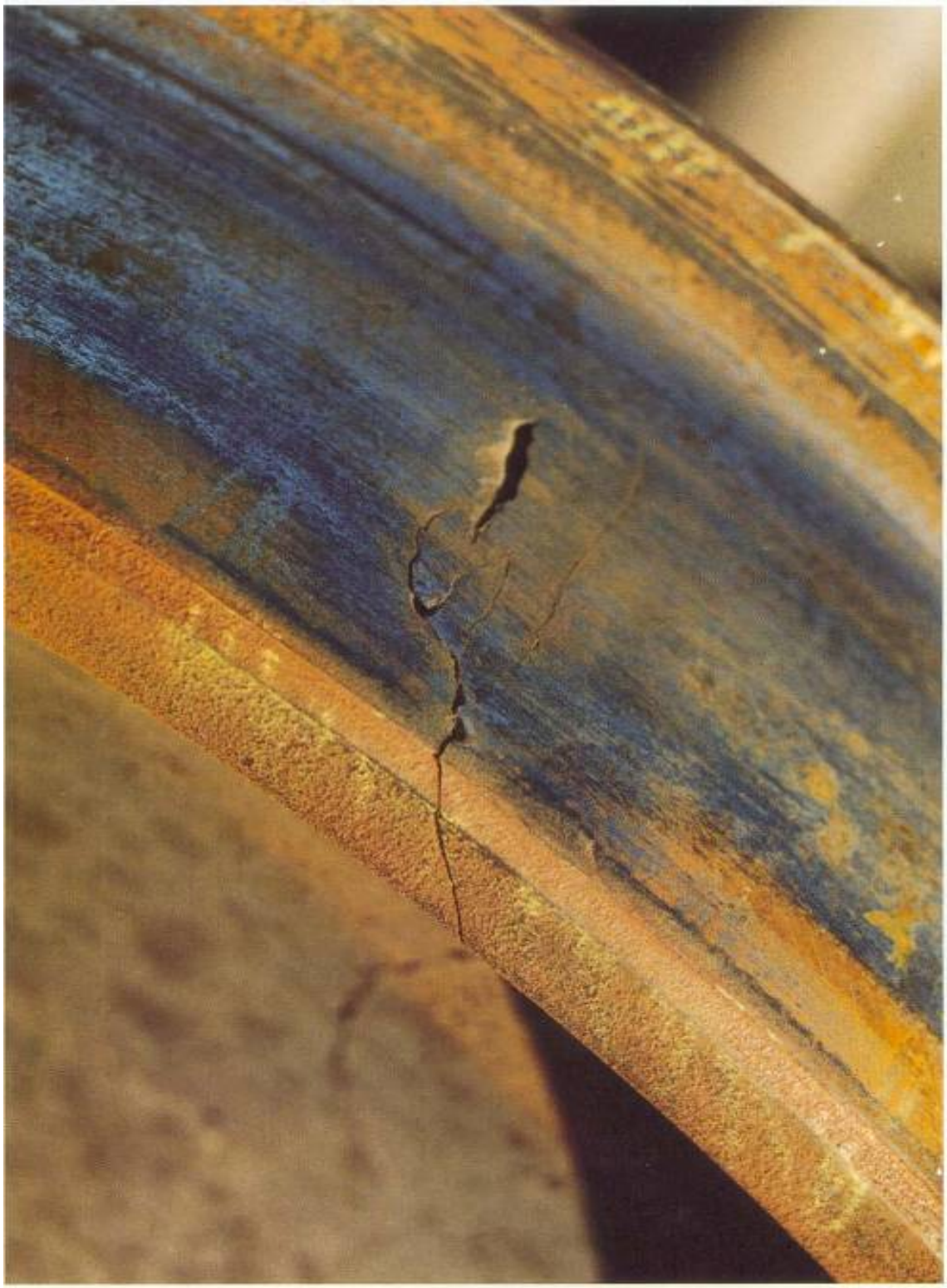
Any chip or gouge in a wheel which is more than 25 mm long and/or 12 mm wide shall be classified as a Class 4 defect (see Section 4.2.4).

4.2.4 Class 4 Fatigue Crack, Manufacturing Defect and External Wheel Damage

Under no circumstances shall a wheel with a Class 4 defect be allowed to enter service if found at a pre-trip examination or at a depot.

If the defect is found en-route, or at a location with no repair facility, the vehicle may continue through to the scheduled destination, and /or be transferred to the nearest depot at a speed of not more than 40 km/h, providing the brakes are isolated (passenger and freight) or the use of independent brake can be kept to an absolute minimum (locomotives).

If these restrictions unduly affect operations, the vehicle must be immediately removed from service. The vehicle may then be repaired (bogie/wheelset change) at the location where the defect was found.



CLASS 5 FATIGUE CRACK

4.2.5 Fractured Wheel - Class 5

Any crack running through the rim, web or boss of the wheel must be considered as a Class 5 defect.

A fractured wheel may be the result of either a thermal crack or a fatigue crack which has propagated or grown.

The vehicle shall not be moved until the damage has been examined and assessed by a qualified mechanical maintenance officer.

After examination, the vehicle may be allowed to clear the section at the speed nominated by the attending mechanical maintenance officer.

Once the vehicle is in a siding, it shall not be further moved until: the fitting of a pony bogie; OR a wheelset/bogie change. Once the vehicle has had a wheelset/bogie change, it may be returned to service.

4.2.5.1 Use of Pony Bogies

When a vehicle is fitted with a pony bogie it shall be transferred to the nearest depot as follows:

Defective locomotives, or loaded freight vehicles, supported by pony bogies must be accompanied by a suitably trained mechanical maintenance officer, who shall take every opportunity to examine the assembly and bearings.

The speed for locomotives and loaded freight vehicles when mounted on pony bogies shall not exceed 15 km/h, reduced to 8 km/h over points and crossings.

Empty freight and empty passenger type vehicles supported by pony bogies are permitted to travel unaccompanied at a maximum speed not exceeding 20 km/h, reduced to 10 km/h over points and crossings.

4.3 Spalling or Shelled Tread

Spalling or Shelled Tread occurs when pieces of metal break out of the tread surface.

Pitting can be the initial stages of spalling and in itself is not a concern.

IMPORTANT: If there is the slightest doubt as to the severity of Spalling, always report the higher classification.

4.3.1 Class 1 Spalling

The wheel tread is mostly smooth with minor visible flaws or a blotchy appearance. Pitting may also be noticed. Areas of spalling up to 12 mm diameter may be scattered on up to 10% of the total tread area.

No action required

4.3.2 Class 2 Spalling

The spalling has progressed such that the spalled areas are up to 25 mm diameter. The total coverage may be up to 20% of the total tread area and the edges of the spalls may be sharp and jagged.

Locomotives and passenger vehicles: Any wheels with Class 2 Spalling must have inspection details recorded by the operator to ensure that the wheel condition is identified as soon as it progresses to Class 3 Spalling.

Freight vehicles: If any Class 2 Spalls are found, the examining officer shall re-examine the wheel during vehicle examination/inspection or maintenance. No other action is required for Class 2 Spalling.

No speed restriction for any vehicle with Class 2 Spalling.

4.3.3 Class 3 Spalling

The spalling has progressed such that the spalled areas are larger than 25 mm diameter. These spalls may cover up to 50% of the total tread area and will be sharp edged and jagged.

Locomotives and passenger vehicles must have inspection details recorded by the operator and be scheduled for wheel turning within 14 days of detection.

Freight vehicles must be worked out of service for repairs.

No speed restriction for any vehicle with Class 3 Spalling.

4.3.4 Class 4 Spalling

Extensive spalling of greater than 50% of wheel surface area coverage or large spall areas 3 mm or more deep.

Spalling of any size on wheel flanges is a Class 4 defect. Any circular cracks associated with the early stages of spalling are also a Class 4 defect.

Under no circumstances must a wheel with this defect be allowed to enter service if found at a pre-trip examination or at a depot.

If the defect is found en-route or at a location with no repair facility, the vehicle may continue through to the scheduled destination and/or be transferred to the nearest depot at a speed of not more than 40 km/h providing the brakes are isolated (passenger and freight) or the use of independent brake can be kept to an absolute minimum (locomotives).

If these restrictions unduly affect operations, the vehicle must be immediately removed from service. The vehicle may then be repaired (bogie/wheelset change) at the location where the defect was found.

Bogies which have had wheels in this condition shall have their running gear thoroughly examined for evidence of loose or adrift components particularly in the axlebox and traction motor areas. Bearings shall be rumble tested and visually inspected with the removal of the front cover or gas plug.

4.3.5 Photographs Showing Classes of Spalling

CLASS 1 SPALLING

CLASS 2 SPALLING

CLASS 3 SPALLING

CLASS 4 SPALLING

4.4 Skidded Wheels (flats)

Skids occur when a wheel "locks up" while the vehicle is moving. All skids eventually lead to further wheel damage such as spalling and reduce the life of bogie components such as bearings. Impact forces produced by a skid are also detrimental to the track structure.

IMPORTANT: If there is the slightest doubt as to the severity of skidding, always report the higher classification.

Skids may be ground to reduce the severity to the next lower category.

Refer to WOS 01.810 for single car air testing of vehicles with skidded wheels.

4.4.1 Class 1 Skidded Wheels

A single skid with length less than 25 mm.

No action required.

4.4.2 Class 2 Skidded Wheels

Single skid length between 25 mm and 40 mm or multiple Class 1 Skids

Locomotives and passenger vehicles: Any wheels with Class 2 Skids must have inspection details recorded by the operator to ensure that the wheel condition is identified as soon as it progresses to a Class 3 Skid.

Freight vehicles: If any Class 2 Skids are found the examining officer shall reexamine the wheel during vehicle examination/inspection or maintenance. No other action is required for Class 2 Skids.

A speed restriction of 80 km/h must be placed on any vehicle with Class 2 Skids.

4.4.3 Class 3 Skidded Wheels

Single skid length between 40 mm and 60 mm or multiple Class 2 Skids.

Locomotives and passenger vehicles must have inspection details recorded by the perator and be scheduled for wheel turning within 14 days.

Freight vehicles must be worked out of service for repairs.

A speed restriction of 40 km/h must be placed on any vehicle with Class 3 Skids.

4.4.4 Class 4 Skidded Wheels

Single skid length between 60 mm and 100 mm.

Under no circumstances must a wheel with this defect be allowed to enter service if found at a pre-trip examination or at a depot.

If the defect is found en-route or at a location with no repair facility, the vehicle may continue through to the scheduled destination and/or be transferred to the nearest depot at a speed of not more than 25 km/h providing the brakes are isolated (passenger and freight) or the use of independent brake can be kept to an absolute minimum (locomotives).

If these restrictions unduly affect operations, the vehicle must be immediately removed from service. The vehicle may then be repaired (bogie/wheelset change) at the location where the defect was found.

4.4.5 Class 5 Skidded Wheels

Single skid greater than 100 mm in length.

This vehicle shall not be moved until the tread surface defect is adequately rectified.

This can be achieved by in situ welding and build up of the tread defect area followed by grinding to restore a uniform profile. Refer to section [5] of this Rolling Stock Operation Standard

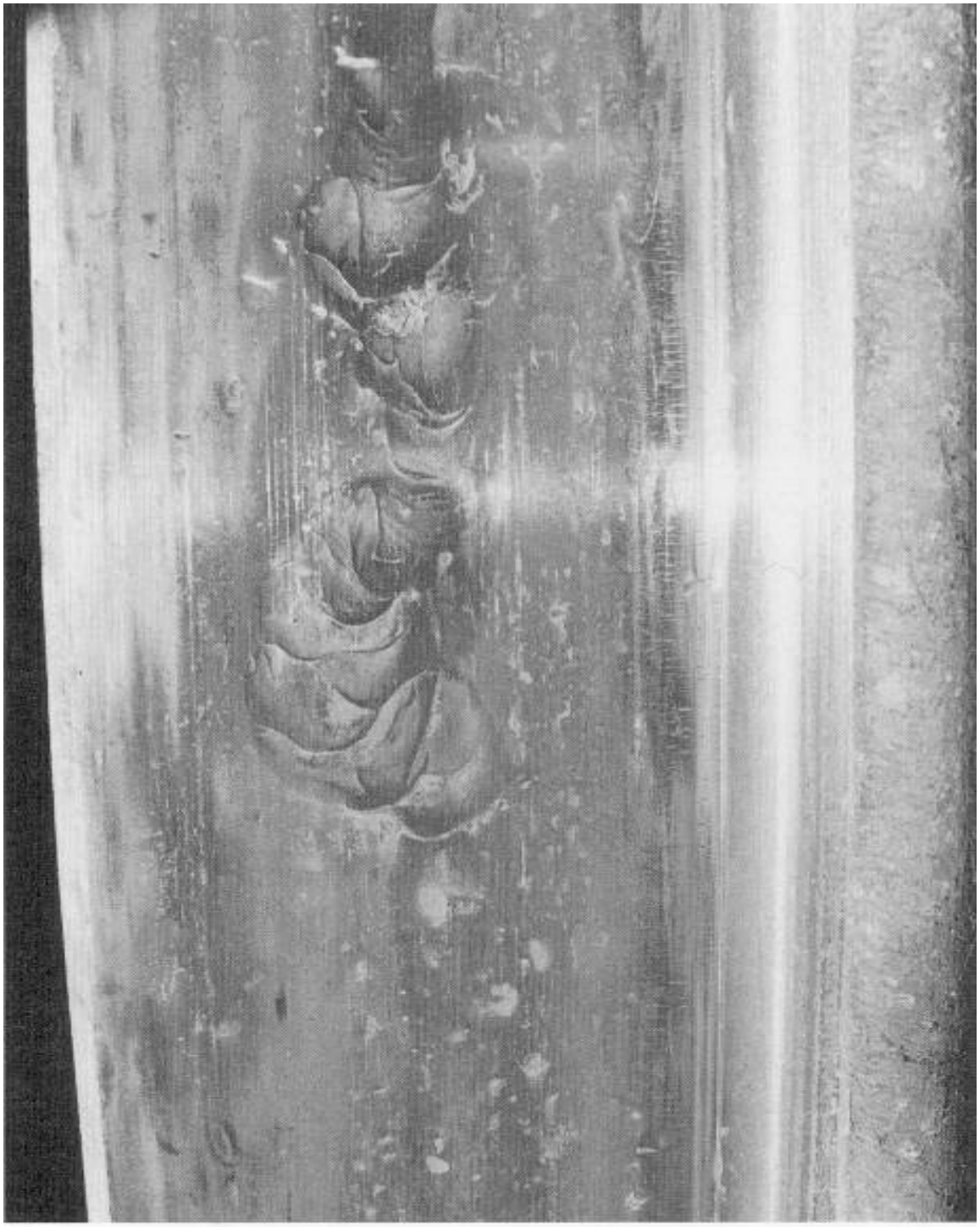
After rectifying the defect in the section, ensure that the vehicle movement is to the nearest siding at the speed which the attending mechanical maintenance officer nominates.

Once the vehicle is in the siding, it shall not be further moved until: the wheel profile has been completely restored; OR a wheelset/bogie change; OR the fitting of a pony bogie. If a pony bogie is fitted, the vehicle shall then be transferred to the nearest wheel lathe in accordance with section 4.2.5.1 of this Rolling Stock Operation Standard.

Upon reaching the wheel lathe the defective wheel is to be reprofiled to ensure all weld metal and the heat affected zone is removed. In practice this can be achieved by machining the wheel such that the radius is reduced by an amount no less than the skid length divided by eight (8).

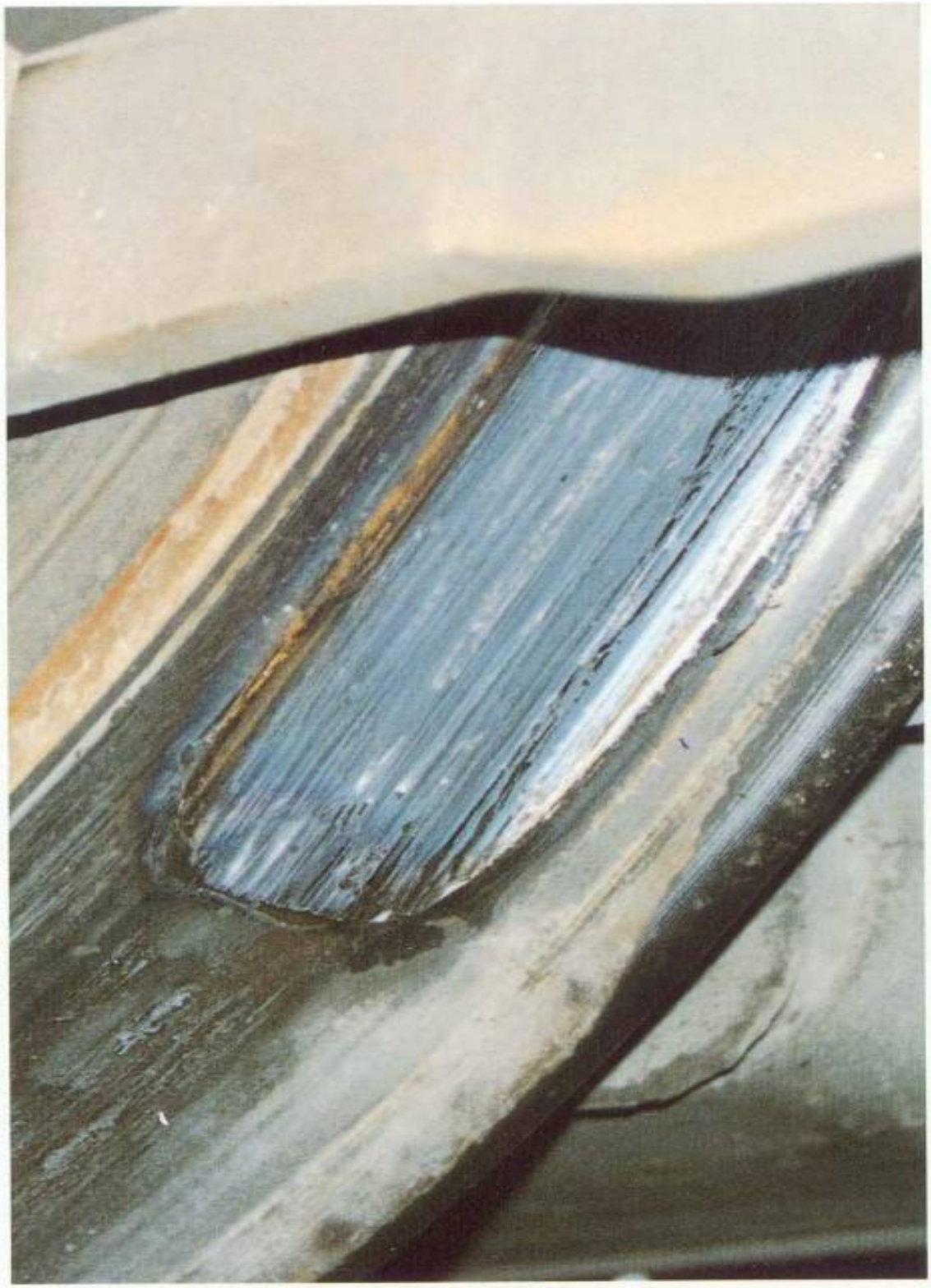
Bogies which have had wheels in this condition shall have their running gear thoroughly examined for evidence of loose or adrift components particularly in the axlebox and traction motor areas. Bearings shall be rumble tested and visually inspected with the removal of the front cover or gas plug. The vehicle brake system shall also be tested for correct operation and sensitivity.

4.4.6 Photographs Showing Classes of Skids



CLASS 3 SKIDDED WHEEL
(MULTIPLE CLASS 2 SINGLE SKIDS)

CLASS 4 SKIDDED WHEEL



CLASS 5 SKIDDED WHEEL

4.5 Scaled Wheels

Scaling is the build up of metallic material on the surface of the wheel tread.

Scaling may cover the entire wheel surface or any part of it. The method used to determine the severity of any given scaling is to measure its height from the normal wheel surface.

Refer to WOS 01.286 for single car air testing of vehicles with scaled wheels.

IMPORTANT: If there is the slightest doubt as to the severity of scaling, always report the higher classification.

NOTE: CLASS 1 SCALED WHEEL and CLASS 2 SCALED WHEEL classifications are not relevant.

4.5.1 Class 3 Scaled Wheels

Light surface smearing, very light scale may be present. Scale height too small to measure with a standard rule (less than 0.5 mm). This smearing effect is caused by the wheel sliding, but not completely stopping, for a very short time.

No action is required at this stage although the brake system should be examined for defects which could cause the wheels to over-brake.

No speed restriction for any vehicle with Class 3 Scale.

4.5.2 Class 4 Scaled Wheel

Measurable scale height not exceeding 15 mm.

Under no circumstances must a wheel with this defect be allowed to enter service if found at a pre-trip examination or at a depot.

If the defect is found en-route or at a location with no repair facility, the vehicle must clear the section subject to the following speed restrictions:

i. scale height up to 5 mm:- 25 km/h maximum

ii. scale height up to 10 mm:- 15 km/h maximum

iii. scale height up to 15 mm:- 5 km/h maximum

providing the brakes are isolated (passenger and freight) or the use of independent brake can be kept to an absolute minimum (locomotives).

Once the section has been cleared, the vehicle shall not be further moved until: the scale build-up has been completely removed by grinding, chiselling, etc.; OR a wheelset/bogie change; OR the fitting of a pony bogie. If a pony bogie is fitted, the vehicle shall then be transferred to the nearest depot in accordance with section 4.2.5.1 of this Rolling Stock Operation Standard.

Upon reaching the depot/workshop, an abrasive brake block may be used to clean the tread and restore it to unrestricted operation as per WOS 01.280. Bogies which have had wheels with Class 4 Scale must have their running gear thoroughly examined for evidence of loose or adrift components particularly in the axlebox and traction motor areas. The vehicle brake system shall also be checked for correct operation and sensitivity.

4.5.3 Class 5 Scaled Wheels

Scale height greater than 15 mm.

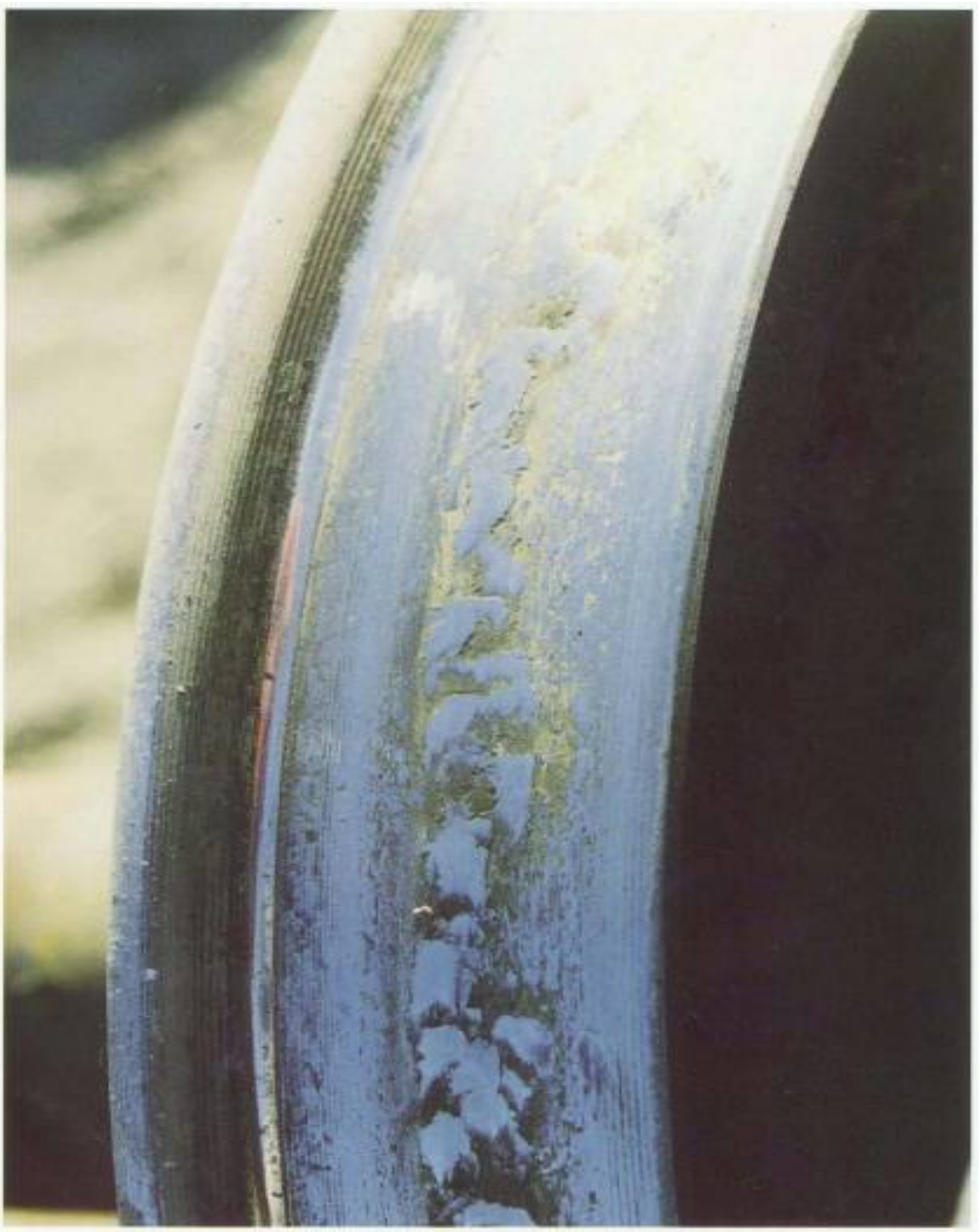
The vehicle is not to be moved until the tread surface defect is adequately rectified. This can be achieved by in-situ grinding or chiselling. After rectifying the defect in the section, ensure that the vehicle is moved to the nearest siding at a speed which is applicable for class 4 scaled wheels.

Once the vehicle is in the siding, it shall not be further moved until: the scale build-up has been completely removed by grinding, chiselling, etc.; OR a wheelset/bogie change; OR the fitting of a pony bogie. If a pony bogie is fitted, the vehicle shall then be transferred to the nearest depot in accordance with Clause 4.2.5.1 of this Rolling Stock Operation Standard.

Bogies which have had wheels with Class 5 Scale must have their running gear thoroughly examined for evidence of loose or adrift components particularly in the axlebox and traction motor areas. Bearings shall be rumble tested and visually inspected with the removal of the front cover or gas plug. The vehicle brake system shall also be checked for correct operation and sensitivity.

Wheel treads shall be examined for any evidence of thermal cracking.

4.5.4 Photographs Showing Classes of Scaled Wheels



CLASS 3 SCALED WHEEL

CLASS 4 SCALED WHEEL

4.6 Arrises

4.6.1 Class 1 Arris

This classification is not relevant.

4.6.2 Class 2 Arris

A Class 2 Arris is less than or equal to 1.5 mm high.

No action required for a wheel with a Class 2 Arris.

Up to 1mm high above the tip of the flange and where the arris is rolled slightly back towards the flange tip

Up to 1.5mm high above the tip of the flange and where the arris is rolled back towards the flange tip.

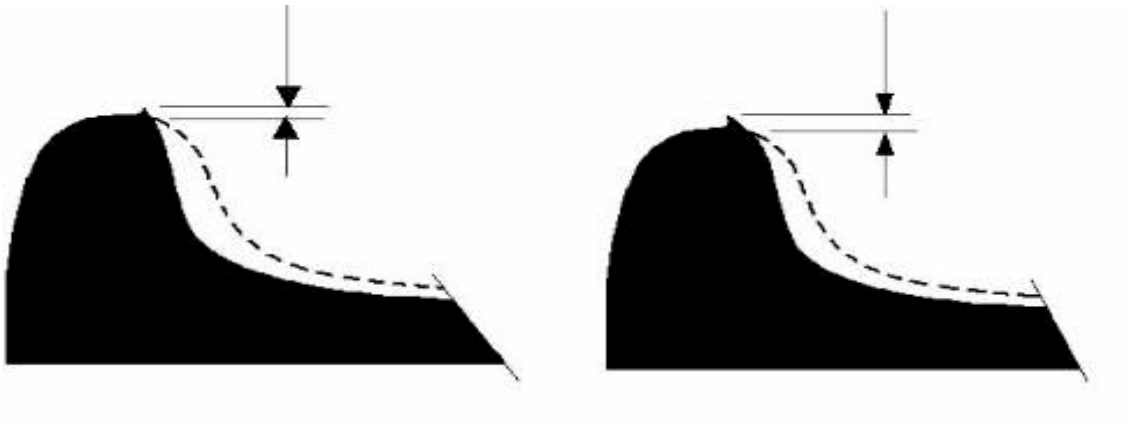


Figure 6 *- Class 2 Arris*

4.6.3 Class 3 Arris

A Class 3 Arris is greater than 1.5 mm high. Wheel flange tips such as these should be removed either by wheel turning, the use of an abrasive block or by some suitable grinding operation.

Locomotives and passenger vehicles must have inspection details recorded by the operator and be scheduled for wheel turning within 14 days of detection.

Freight vehicles must be worked out of service for repairs.

As a temporary measure the arris may be hammered down or ground off at the location to allow vehicle movement as per a lower classification of defect.

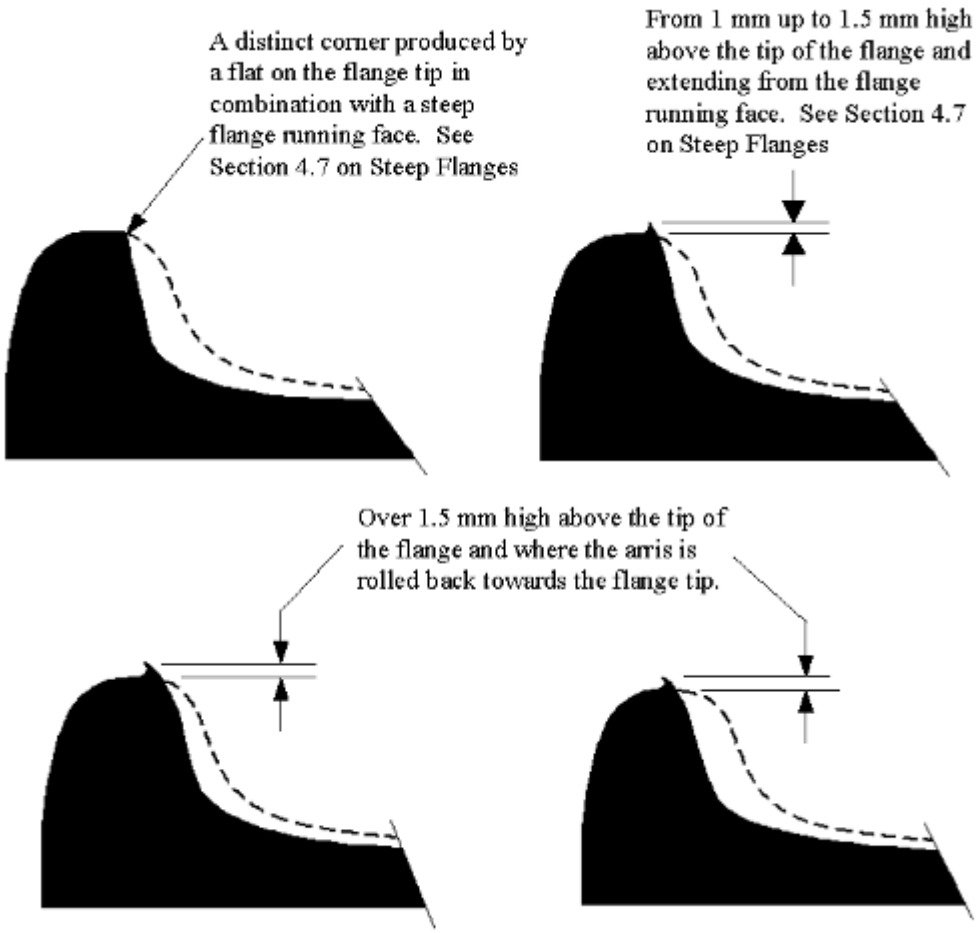


Figure 7 *- Class 3 Arris*

4.6.4 Class 4 Arris

The combination of a near vertical flange running face and an arris greater than 1.0 mm high can split incorrectly housed points and result in a derailment.

Under no circumstances must a wheel with this defect be allowed to enter service if found at a pre-trip examination or at a depot.

If the defect is found en-route or at a location with no repair facility, the vehicle may continue through to the scheduled destination and/or be transferred to the nearest depot at a speed of not more than 40 km/h over normal track and at not more than 25 km/h over points, turnouts or crossings.

If these restrictions unduly affect operations, the vehicle must be immediately removed from service. The vehicle must then be repaired (bogie/wheelset change) at the location where the defect was found.

As a temporary measure the arris may be hammered down or ground off at the location to allow vehicle movement as per a lower classification of defect.

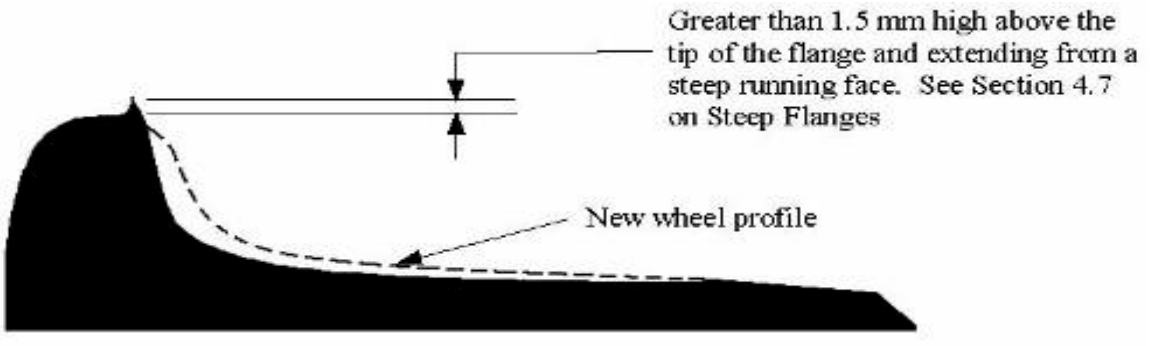


Figure 8 *- Class 4 Arris*

4.7 Steep Flanges

A Steep Flange in conjunction with a Class 2 Arris is a Class 4 defect as per Section 4.6.4.

A visual examination of the wheel will be necessary to determine if it has a steep flange.

No speed restriction for any vehicle with Steep Flanges where not associated with an Arris.

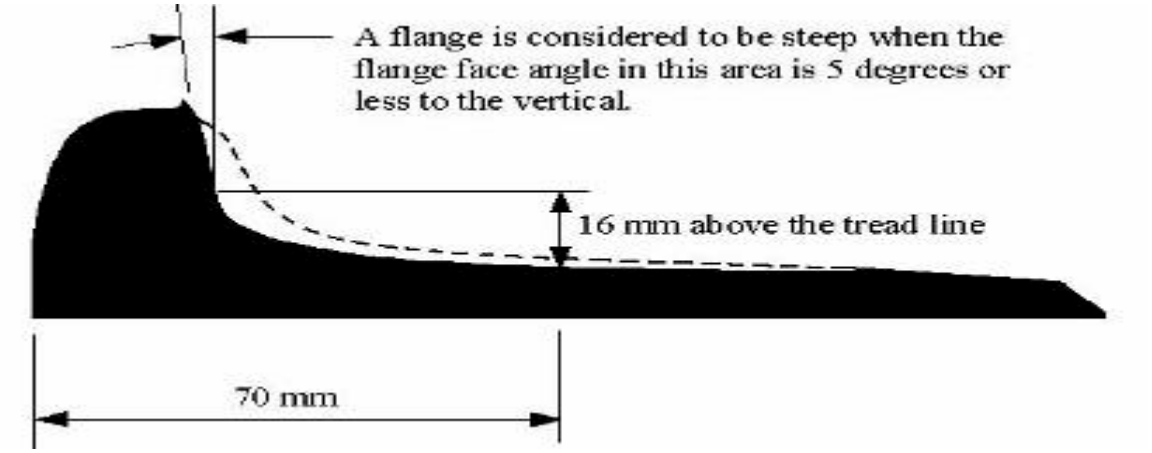


Figure 9 *- Steep Flange*

4.8 High Flanges

High flanges exceed a height of 35 mm.

Vehicles found with a high flange at a depot or pre trip shall not be permitted to enter service.

Where the flange height exceeds 35 mm the following action applies:

Locomotives and passenger vehicles must have inspection details recorded by the operator and be scheduled for wheel turning within 14 days of detection.

Freight vehicles must be worked out of service for repairs.

No speed restriction for any vehicle with High Flanges.

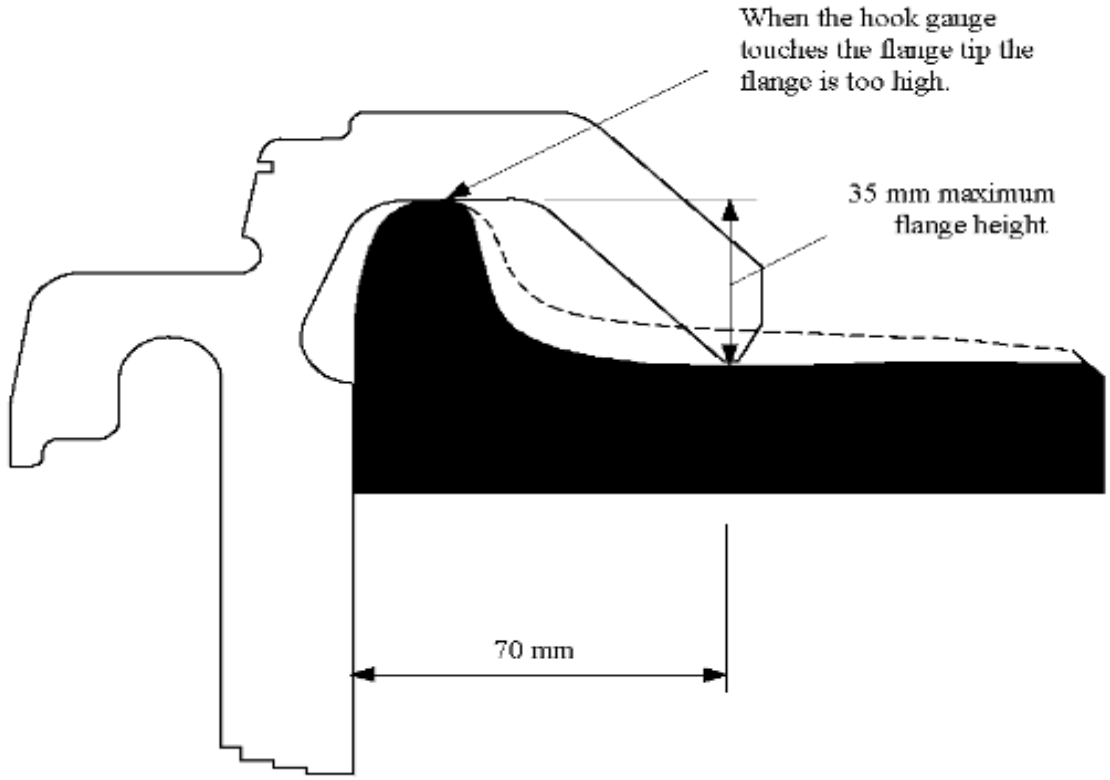


Figure 10 *- Application of High Flange Gauge*

4.9 Hollow Tread

Visual examination of wheels is necessary to determine if a hollow tread is evident. The maximum permissible tread hollowing is 3 mm nominal, as determined using the wheel gauge as shown in Figure 11. Refer to Appendix G for wheel gauge drawing.

For wheels found with hollow tread, the following applies:

Locomotives and passenger vehicles must have inspection details recorded by the operator and be scheduled for wheel turning within 14 days of detection.

Freight vehicles must be worked out of service for repairs.

No speed restriction for any vehicle with a Hollow Tread.

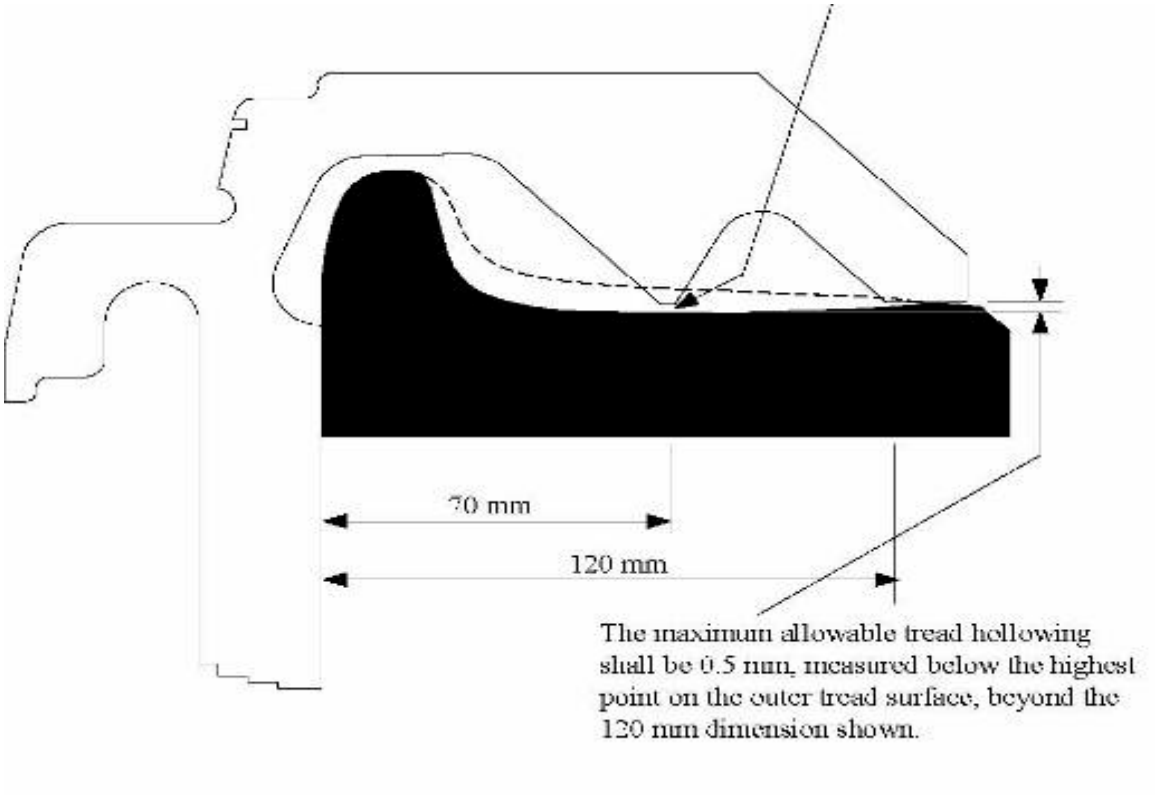


Figure 11 *- Application of Hollow Tread Gauge*

4.10 Thin Flanges

The minimum allowable flange thickness is 19 mm.

The recommended method for detecting a thin flange is using a "hook gauge". (see ROA Manual of Engineering Standards and Practices, Figure 24-21) A thin flange will be detected when the end of the gauge touches the tread surface of the wheel.

Under no circumstances must a wheel with a flange thickness of 19 mm or less be allowed to enter service if found at a pre-trip examination or at a depot.

If a vehicle is found with a wheel flange thickness of less than 19 mm, up to a minimum of 18 mm, en-route or at a location with no repair facility, the vehicle may continue through to the scheduled destination and/or transferred to the nearest depot at a speed of not more than 40 km/h. **Note:** In this case any arris present on the flange must be removed completely.

If a vehicle is found with a wheel flange thickness of less than 18 mm the vehicle must be immediately removed from service.

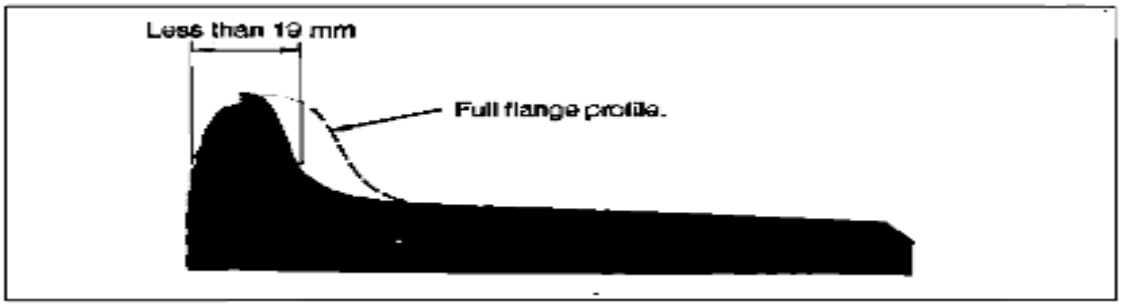


Figure 12 *- Thin Flange*

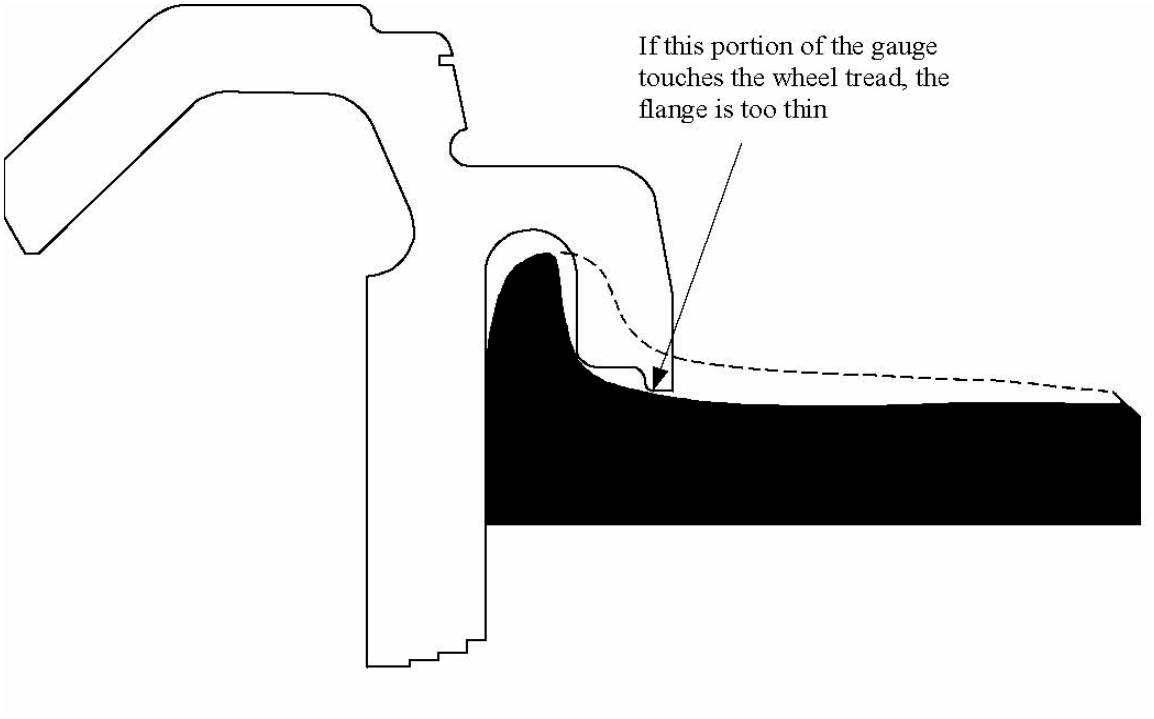


Figure 13 *- Application of Thin Flange Gauge*

4.11 Short Flange

In some cases where rapid flange wear takes place, without significant tread wear, a worn wheel profile is produced having a ramp at the root of the flange. This ramp effectively shortens the flange thereby allowing the gauge corner of the rail to work closer to the flange tip. This arrangement reduces the safety margin for wheel climb derailments. The short flange gauge is designed to arrest this phenomenon before it becomes critical.

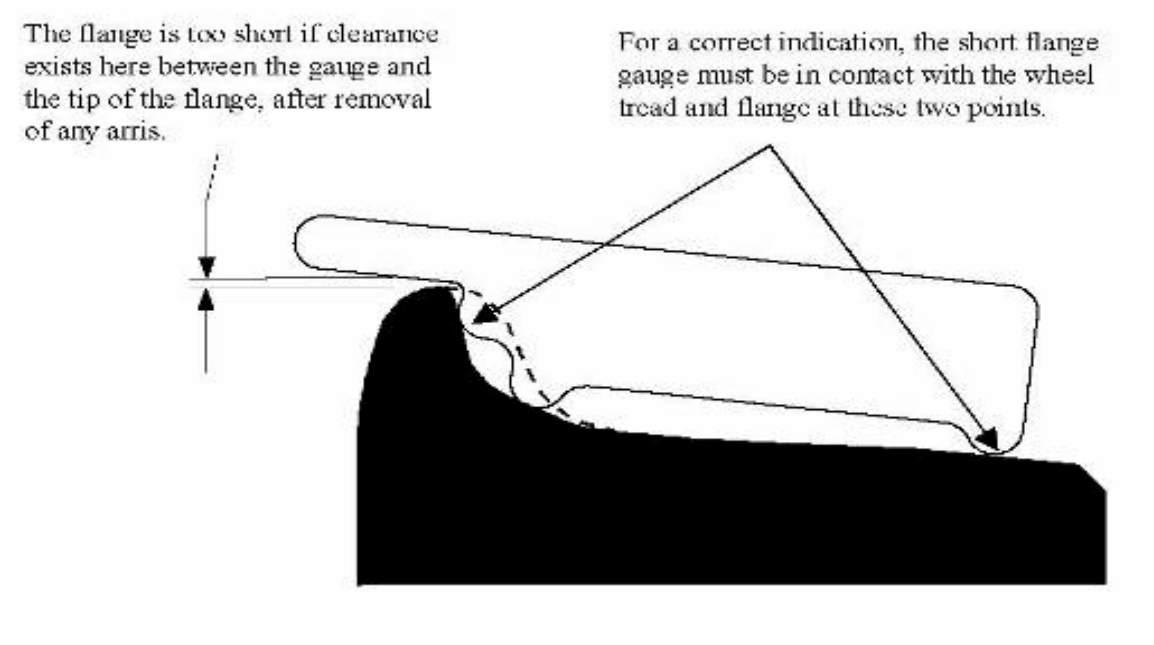


Figure 14 *- Application of Short Flange Gauge*

4.12 Misaligned Brake Gear

Inspection for overhanging brake blocks or misaligned brake gear must be carried out with the brakes applied.

4.12.1 Temporary Brake Block Overhang.

In the case where an overhanging brake block is found and there is no evidence of shouldering on the brake block or wheel tread and no evidence of Class 4 Thermal Cracks, then the overhanging brake block may be a temporary condition.

Consideration must be given to the lateral float of the wheelset together with brake rigging clearances to determine if the brake block is overhanging temporarily.

If evidence suggests that the brake block overhang is temporary then the vehicle is suitable for service subject to regular inspections of the brake block(s) in question.

Locomotive and Passenger vehicles with brake gear in this condition are to have the defect recorded and be inspected at the next routine inspection.

On vehicles where brake rigging is tied together laterally there should be no excuse for overhanging brake blocks, and if found corrective action must be taken to adjust the rigging or replace worn components such as brake heads, pins and/or bushes.

If there is evidence of any other wheel tread surface defect the vehicle shall be attended to as per the relevant Section of this Rolling Stock Operation Standard.

Where non-metallic and/or segmented brake blocks are used, particular attention shall be paid to the presence of thermals and skids.

If a shoulder has worn on the edge of the brake block face, then action shall be as per Clause 4.11.2. IMPORTANT: Non-metallic blocks will not exhibit a pronounced shoulder as the overhanging area tends to break away before achieving any noticeable size unless the overhang is excessive.

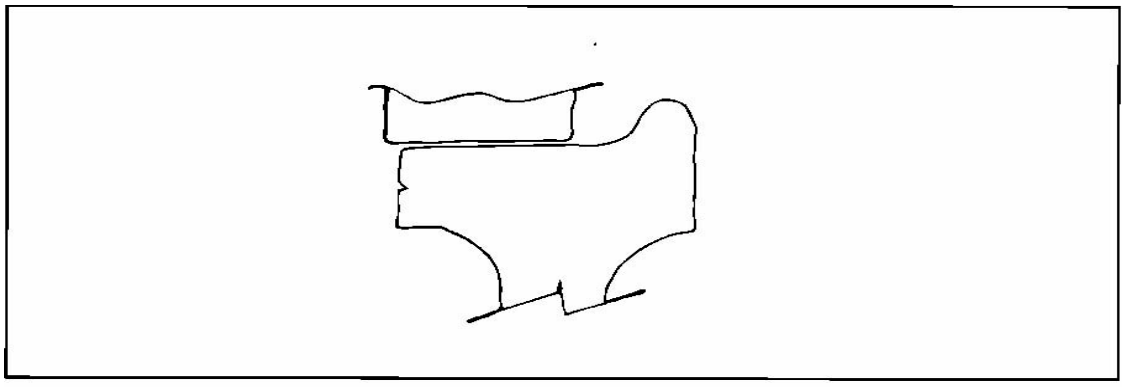


Figure 15 *- Example of Temporary Overhanging Brake Block*

4.12.2 Permanent Brake Block Overhang.

In the case where an overhanging brake block is found and determined to be a permanent fault by evidence of a shoulder on the wheel tread, a shoulder on the brake block face and/or Class 4 Thermal Cracking at the edge of the wheel tread, then that vehicle shall not be permitted to enter service until the matter is rectified

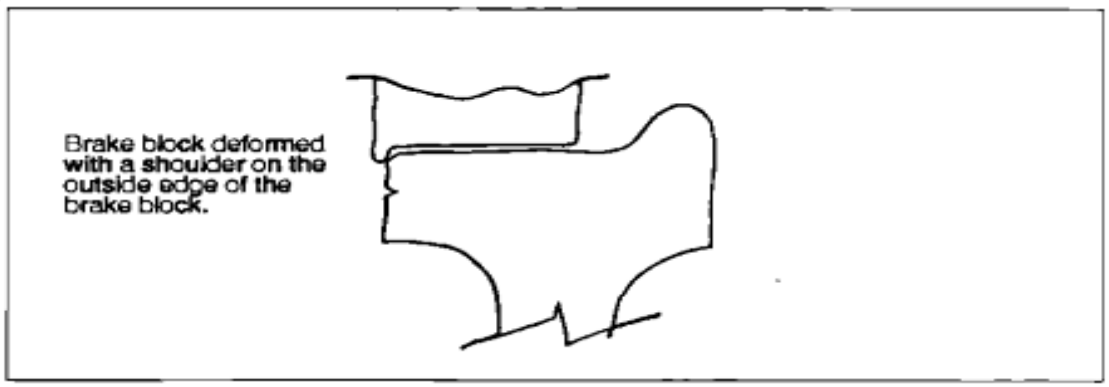


Figure 16 *- Example of Permanent Overhanging Brake Block*

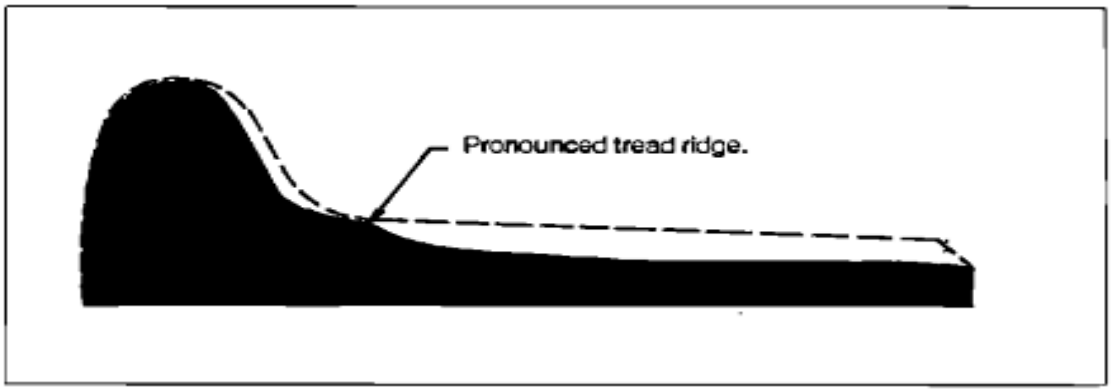


Figure 17 *- False Flange Due to Brake Block Overhang*

5 Weld Repairs of Wheels Skids

5.1 The repair of wheel skids by welding is a temporary measure to allow recovery of a vehicle with class 5 wheel skids, as outlined in WOS 01.212 section 4.4.5. After weld repair the vehicle must proceed directly to the nearest repair facility for wheelset change or reprofiling.

5.2 A suitable weld procedure must be developed for the repair.

5.3 Notwithstanding this, welding shall be carried out circumferentially, not transversely across the tread. All surface irregularities and deposited weld metal shall be ground smooth to the contour of the wheel after the welded area has cooled to ambient temperature. The surface of the weld, and adjacent area shall be inspected for flaws prior to movement of the vehicle.

5.4 Once the vehicle has been moved to a suitable repair location for wheel turning, all weld metal, including the heat effected zone, must be removed, and the wheel surface inspected for possible flaws, prior to replacing the vehicle into service.

6 Wheel Tread Profile Remachining

6.1 It is important when remachining the wheel tread and flange profile that the surface finish be maintained within acceptable limits. This is to ensure that surfaces which can 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 type derailment.

The surface finish of the wheel tread and flange, after machining shall not exceed 6.3 µm (micrometres) RA (Roughness Average).

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

Localised undercutting, grooving or waviness of the flange profile between the wheel tread side of the flange root radius and the back face of the wheel, is permitted but shall not exceed 0.25 mm in depth below the true flange profile.

6.3 Witness marks used for an indication of machining efficiency, are permitted on the flange face between the top of the flange root radius and the tip of the flange but shall not exceed 0.25 mm in depth below the true flange profile and 3 mm in width.

6.4 The tolerance of a remachined wheel tread and flange profile 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.

7 Examination of Tyred wheels in Service

7.1 Tyred wheels must be inspected prior to each trip for relative movement between the tyre and wheel centre.

7.2 If any relative movement is detected between the tyre and wheel centre, the vehicle must be immediately removed from service.

8 Overheated Wheels

8.1 Any wheel which has become severely overheated due to excessive braking or dragging brakes is a Class 4 defect. An overheated wheel can be identified by a blueing discolouration, and may be evident after a skidded wheel or dragging brake incident.

8.2 Under no circumstances shall a wheel with a Class 4 defect be allowed to enter service if found at a pre-trip examination or at a depot.

8.3 If the defect is found en-route, or at a location with no repair facility, the vehicle may continue through to the scheduled destination, and /or be transferred to the nearest depot at a speed of not more than 40 km/h, providing the brakes are isolated (passenger and freight) or the use of independent brake can be kept to an absolute minimum (locomotives).

8.4 If these restrictions unduly affect operations, the vehicle must be immediately removed from service. The vehicle shall then be repaired (bogie/wheelset change) at the location where the defect was found.

8.5 Wheels which have been severely overheated must be thoroughly inspected for possible thermal defects and checked for changes in metallurgical structure. If there is any doubt as to the structural integrity of the wheel, and the heat affected area cannot be removed by machining, then the wheel must be scrapped.

8.6 Overheated tyred wheels must be removed from service and replaced immediately.

WOS 01.220 - Wheels

1 General

1.1 This unit covers the design, manufacture and minimum operational requirements for conventional solid forged steel axles only.

WOS 01.221 - Axles, Design and Manufacture

1 Axle Design

1.1 Minimum Axle Design Standards

1.1.1 All 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.

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

1.1.3 Alternate design methods may be used, however such proposals shall be subject to approval by the Australian Rail Track Corporation.

2 Axle Manufacture

2.1 All axles must be manufactured in accordance with AAR Specification M-101, or approved equivalent.

3 Axle Identification

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

3.2 The methods specified in the ROA Manual of Engineering Standards and Practices, Section 6, Diagram 6-2 (See Appendix G [WOS 01.G] of this manual), or alternatively AAR Specification M-101, Figure 2 are recommended.

4 Axle Remanufacture

4.1 All reclamation and/or modification of axles must be in accordance with AAR M-101, Section G part 2, rules 2A4 and 2A5. Any other proposal for the reclamation of axles must first be approved by the Australian Rail Track Corporation.

WOS 01.222 - Axles, Minimum Operational Requirements

1 Introduction

1.1 This unit describes the minimum allowable conditions under which solid forged steel axles may continue in service.

2 Axle Condemning Diameters

2.1 Operators shall have proven industry standards clearly specifying the condemning diameters for the axle component parts.

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

3 Welding on Axles

3.1 Under no circumstances is welding permitted on any part of any axle.

4 Axle Defects

4.1 The following axle defects, will require the vehicle to be removed from service. Defects consist of scoring, grooves, scratches, flame cutting marks, welding, grinding, chisel marks or similar indentations.

4.1.1 Any vehicle with an 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.

4.1.2 Any vehicle with an axle defect greater than 5 mm deep.

4.1.3 Any vehicle with visible cracks in the axle body, either between the wheel seats or adjacent to the wheel hub.

4.1.4 4.1.4 Any vehicle with an axle which is bent, damaged due to overheating or bearing failure, or otherwise distorted.

4.2 The following defects require the vehicle to be worked out of service for repairs:

4.2.1 Any 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, it shall be treated as per 4.1.1.

WOS 01.230 - Wheel and Axle Assembly

This unit applies to wheel sets comprising both integral steel wheels and tyred steel wheels.

1 Assembly Procedure

1.1 The operator shall follow proven industry standards for the assembly of wheels onto axles. These standards may allow either conventional pressing using a suitable lubricant, or shrink fitting, to the required interference.

2 Lubricant for Pressing Wheels onto Axles

2.1 The owner/operator shall use a proven wheelmount lubricant for wheelset assembly. Where a lubricant is proposed which is unproven under Australian conditions the application shall be subject to the approval of the Australian Rail Track Corporation.

WARNING: Some lubricants are affected by increased wheel temperatures due to braking, allowing relative movement between wheel and axle.

Some lubricants may affect electrical conductivity for signal shunting.

2.2 A recommended lubricant is Rocol Wheelmount Compound.

3 Information to be recorded

For the assembly of all wheelsets, the following information shall be recorded, and retained for the life of the wheelset assembly for audit purposes, and for the purposes of investigation in the event of a failure in service:

3.1 Axle wheelseat diameter, measured at 90 degree intervals around the circumference, and in two planes on the wheelseat.

3.2 Wheel bore diameter, measured at 90 degree intervals around the circumference, and in two planes of the wheel bore.

3.3 Press-on tonnage achieved for each wheel pressed on, where applicable.

3.4 Wheelset back to back dimension, measured at three points equidistant around the outer wheel circumference 40 mm below the outer circumference of the wheel flange.

3.5 Individual wheel and axle identification.

4 Wheelset Back To Back Dimension

4.1 Wheelset Assembly Dimension

For the assembly of all wheelsets, the wheelset back to back dimension shall be in the following range, as measured at three points equidistant around wheels at a point 40 mm below the outer circumference of the wheel flange.

Minimum 1357 mm

Maximum 1360 mm

* The difference between any two dimensions shall not exceed 1 mm.

4.2 In service dimension

For measurement of wheelset back to back in service, the wheelset back to back shall be measured at four 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. When the wheelset is rotated 180 degrees, and the back to back is measured again at four new points representing 3 o'clock, 6 o'clock, 9 o'clock and 12 o'clock, there shall be not more than 3 mm variation between the 6 o'clock and 12 o'clock dimensions.

(Note: The allowable variation is because of axle bending, when the wheelset is installed beneath a vehicle.)

4.3 AAR Wheelsets with Reduced Back to Back

AAR Wheelsets with the wide flange profile and reduced back to back dimension will not be permitted to operate on the Australian Rail Track Corporation network.

WOS 01.240 - Axle Bearing Assemblies

1 Axle Roller Bearing Design and Application

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

1.2 In the selection of roller bearing assemblies, due regard shall be given to the fatigue life of the bearing assembly, taking into account all the factors relevant to the application.

2 Approved Axle Roller Bearings

2.1 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.

2.2 Where bearings are proposed which fall outside that specified in 2.1 above, the owner/operator shall advise the Australian Rail Track Corporation and indicate the proposed method of testing / evaluation of such bearings to substantiate their reliability and suitability for the application.

3 Axle Roller Bearing Maintenance

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

3.1 Installation and removal of roller bearing assemblies to and from axles.

3.2 Lubrication of axle roller bearing assemblies.

3.3 Remanufacture of axle roller bearing assemblies, where applicable.

3.4 Requalification of axle journals, axle boxes and bearing adaptors.

3.5 Regular field inspection of axle roller bearing assemblies for defects.

3.6 Field adjustment of axle roller bearing assemblies.

4 Axle Roller Bearing Defects Detected In the Field

4.1 4.1 Axle roller bearing assemblies with defects as listed in the ROA Manual of Engineering Standards and Practices, Section 24.2.11.1.1, and 24.2.11.2.1 shall not enter service or remain in service.

5 Action Required Following Derailments for Axle Roller Bearings

5.1 5.1 The owner/operator shall have procedures in place for bearing inspection and requalification following any derailment, in order to mitigate the risk of premature inservice failure of bearing components.

6 Axle Package Unit Bearing Adaptors

6.1 Adaptor design

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

6.2 Adaptor Defects

Any adaptor defects listed in Section 24.2.11.1.2, of the ROA Manual of Engineering Standards and Practices, or any distortion of the adaptor seating radius, shall be cause for adaptor replacement or the vehicle being immediately removed from service.

6.3 6.3 Incorrect Adaptor Size

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

7 Axlebox Plain Bearing Assemblies

7.1 Application of Plain Bearing Assemblies

Plain bearing assemblies shall be operated within their design capacity.

7.2 Plain Bearing Maintenance

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

7.2.1 Installation of plain bearing assembly and axlebox.

7.2.2 Lubrication of plain bearing assembly, including maintenance of oil at the correct level, and prevention of water ingress.

7.2.3 Operational life, and replacement of bearing brass.

7.2.4 Operational life, preparation and replacement of lubricator or wick.

7.2.5 Operational life of wedge.

7.2.6 Operational life of axle journal.

7.2.7 The regular inspection of plain bearing axlebox assemblies for defects.

7.3 Plain bearing axlebox assembly defects

The owner/operator shall not place or continue in service vehicles with the following defects:

7.3.1 A plain bearing axlebox containing no visible free oil.

7.3.2 A plain bearing axlebox which has a lid missing, broken or open, except to receive servicing.

7.3.3 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.

7.4 Plain Bearing Journal Lubrication System Defects

The owner/operator shall not place or continue in service vehicles with the following defects:

7.4.1 Lubricating pads with a tear extending half the length or width of the pad or more.

7.4.2 Lubricating pads showing evidence of being scorched, burned or glazed.

7.4.3 Lubricating pads which contain decaying or deteriorated fabric impairing proper lubrication of the pad.

7.4.4 Lubrication pads contaminated by grease.

7.4.5 Lubricator pads with an exposed centre core, except by design.

7.4.6 Lubricator pads with metal parts contacting the journal.

7.4.7 Lubricator pads which are missing or not in contact with the journal.

7.5 Plain Bearing Defects

The owner/operator shall not place or continue in service vehicles with the following defects:

7.5.1 A plain bearing which is missing, cracked or broken.

7.5.2 A plain bearing liner which is loose, or has a piece broken out.

7.5.3 A plain bearing showing signs of having been overheated, as evidenced by melted babbitt, smoke from hot oil, or journal surface damage.

7.6 Plain Bearing Wedge Defects

The owner/operator shall not place or continue in service vehicles with the following defects:

7.6.1 A plain bearing wedge that is missing, cracked or broken.

7.6.2 A plain bearing wedge that is not located in its designed position.

WOS 01.250 - Bogie Frames and Associated Componentry

1 Bogie Frames and Associated Componentry, Design and Manufacture

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:

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

NOTE: *Associated componentry includes but is not limited to sideframes, bolsters, spring planks, swing links, control rods, frame adaptors, swing arm axleboxes, equaliser beams and other structural bogie components.*

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 load cases shall have due regard for the track condition and geometry, intended bogie service life, operating speed, vehicle mass, and any other factors considered relevant.

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 requirements for the intended service life of the bogie.

1.2.1 Safe Working Stress

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

i. 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, which ever is the lesser.

ii. The maximum uniaxial 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, which ever is the lesser.

iii. The fatigue limit stress is the endurance limit stress for the specific component or joint being considered.

1.2.2 Fatigue Analysis

Fatigue analysis may be carried out in accordance with the following guideline:

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 (WOS 01.A10) in the AAR Manual.

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

1.3 Load Testing

Load testing on a test rig shall 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.

2 Bogie Frames, Operational Requirements

2.1 Bogie Frame and Associated Components Capacity

Bogies shall be operated within their design capacity.

2.2 Bogie Frame and Associated Components Maintenance

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

2.2.1 Trammelling of bogie frames (where applicable)

2.2.2 Non destructive testing

2.2.3 Repair of bogie frames and associated componentry including welding, straightening and heat treatment.

2.2.4 Maintenance of pedestal opening and other component interface dimensions (where applicable)

2.3 Bogie Frame Defects

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

2.3.1 Critically cracked bogie frames and associated components.

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

2.3.2 Bogie frames and associated components which are bent or distorted causing an imbalance in wheel loads, and/or incorrect tracking of the bogie.

2.3.3 Loose, missing, or broken, rivets or huck bolts, locating bolsters, transoms, headstocks, W-guards or other major bogie frame components, where applicable.

2.3.4 Timber bogie components which have split, or are rotted, compromising their integrity.

2.4 Bogie Frames, Action Required Following Derailments

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

WOS 01.260 – Vehicle Suspension

1 Introduction

1.1 This unit governs the requirements applicable to vehicle suspension systems, including steel helical and flexicoil springs, air springs, friction snubbers and other damping devices. It specifies the design, manufacture, maintenance and operating conditions where appropriate.

WOS 01.261 - Suspension Springs

1 Suspension Springs Design and Manufacture

1.1 Springs shall be designed and manufactured in accordance with accepted industry standards.

2 Suspension Spring Defects

2.1 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 results in the vehicle failing to meet the requirements for track twist negotiation. Refer to WOS 01.283.

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

2.3 For all rolling stock refer to clause 24.2.8 of the ROA Manual of Engineering Standards and Practices for recommended limits.

3 Air Spring Defects

3.1 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. Refer to WOS 01.283.

3.2 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.

4 Operation of Vehicles with Deflated Air Springs

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

WOS 01.262 - Suspension Damping

1 Suspension Damping Design

1.1 The owner/operator shall follow accepted industry standards for the design and selection of damping devices to ensure compliance with track twist negotiation requirements, WOS 01.283, for all conditions of loading and all serviceable states of wear of the vehicle.

1.2 Damping devices include but are not limited to friction snubbers/wedges, hydraulic dampers, axlebox/pedestal guides (Coulomb damping), and hydraulic stabiliser units.

2 Suspension Damping Defects

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

2.2 It is recommended that hydraulic damper units exhibiting signs of fluid leakage or physical damage to body or ends be requalified for correct operation.

2.3 Friction type damping devices shall not be permitted to enter service, and shall be removed from service for the following defects.

2.3.1 Wear plates which are loose, missing (except by design), or worn beyond their condemning limit.

2.3.2 Broken or missing snubber/damper activating spring.

2.3.3 Broken snubber/damper unit.

2.3.4 Seized friction wedge assembly.

2.3.5 For axlebox / pedestal guide assemblies, loose wear plates that will allow foreign matter to lodge behind the wear plate, or missing wear plates on either the axlebox or the bogie pedestal.

WOS 01.263 - Resilient Suspension Components

1 Design and Manufacture

1.1 Resilient suspension components, including axlebox pivot bushes, alsthom links, lateral control rod bushes, traction rod bushes, and suspension units 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 WOS 01.283.

2 Maintenance

2.1 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 the required performance.

3 Defects

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

3.1.1 Delamination between resilient material and any backing plate which is likely to effect suspension performance or operating safety.

3.1.2 Distortion of resilient material due to the application of excessive heat or contact with detrimental chemical or other substances which is likely to effect suspension performance or operating safety.

3.1.3 Resilient material which is cracked or perished which is likely to affect suspension performance or operating safety.

3.1.4 Resilient material which has incorrect characteristics for the application.

WOS 01.270 - Brakes and Pneumatic Equipment

1 Introduction

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

1.2 The fail safe automatic brake system/s fitted to vehicles operating on the Australian Rail Track Corporation network shall be compatible to allow disabled vehicles to be moved safely.

2 General Requirements

2.1 In general, vehicles shall comply with the requirements of the ROA Manual of Engineering Standards and Practices Sections 7 or 12.

2.2 Early vehicle designs and some special purpose vehicles may not fully comply with these requirements but will be assessed considering the brake equipment fitted and the proposed use of the vehicle.

3 Maintenance

3.1 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.

WOS 01.271 - Brake Equipment Compatabiity

1 Introduction

1.1 For vehicle to vehicle compatibility, it is necessary that some items of equipment be standard across the vehicles operating on the Australian Rail Track Corporation network

2 Brake Blocks and Disc Pads

2.1 Refer to WOS 01.272 for the requirements for brake blocks and brake disc pads.

3 Location of End Equipment

3.1 The location of end equipment, brake pipe, main reservoir and other hoses shall be as detailed in the vehicle specific sections of this manual..

4 Coupling Cocks

4.1 Brake pipe coupling cocks shall comply with the requirements of the ROA Manual of Engineering Standards and Practices, Section 7.3.12.

4.2 Main reservoir, No. 3 independent brake control pipe and No. 4 independent brake release pipe cocks shall comply with the requirements of the ROA Manual of Engineering Standards and Practices, Section 13.10.2.5.2 and Diagrams 13-12 & 13-13 (See Appendix G [WOS 01.G] of this manual).

5 Coupling Hoses

5.1 Coupling hoses shall comply with the requirements of the ROA Manual of Engineering Standards and Practices, Sections 7.3.13 and 13.5.6.6.

6 Parking Brake/Handbrake

6.1 Refer to the appropriate Rolling Stock Operation Standard for parking/handbrake requirements for specific vehicle types.

7 Securing of Brake Gear

7.1 All brake gear shall be securely mounted or supported.

7.2 Brake blocks shall be centred laterally on the wheel tread.

7.3 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.

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

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

WOS 01.272 - Brake Blocks and Disc Pads

1 General

1.1 Vehicles fitted with brake blocks or disc pads shall comply with the following requirements.

1.2 Due to the variation in friction characteristics between the different types of wheel tread brake blocks, they shall be designed such that they are not interchangeable.

1.3 The brake block type shall be compatible with the vehicle wheel design/material. Refer to WOS 01.211 clause 3.2.

1.4 Brake blocks and disc pads shall not contain asbestos fibre or any other asbestos product.

2 Composite Brake Blocks

2.1 The following table showing the coefficient of friction of composite brake blocks and disc pads is provided as a guide:-

Composition brake block/pad type	Dynamic coefficient of friction
Low friction	0.2 maximum
Medium friction	0.2 to 0.25
High friction	0.25 minimum

2.2 High friction brake blocks shall comply with the latest revision of AAR Manual of Standards, specification M-926.

3 Cast Iron Insert Composite Brake Blocks

3.1 Cast iron insert composition brake blocks may be used on locomotives.

3.2 The application of cast iron insert composition brake blocks to other vehicles shall be subject to the approval of the Australian Rail Track Corporation.

4 Cast Iron Brake Blocks

4.1 Cast iron brake blocks are commonly used on locomotives and some other vehicles such as XPT power cars, some Indian Pacific cars and vehicles with tyred wheels.

4.2 Cast iron brake blocks may be used for wheel conditioning and should be replaced by a composition brake block as soon as practical. Cast iron brake blocks may be used to remove minor tread defects such as class 1 skids and class 1 scale.

4.3 Composition brake blocks are preferred to that of cast iron.

5 Abrasive Brake Blocks

5.1 Abrasive brake blocks shall only be used to remove minor wheel and tread irregularities.

5.2 Full thickness abrasive brake blocks shall not be used on a vehicle in service.

5.3 Brake blocks with a thin layer of abrasive material may be fitted to a vehicle and enter normal service.

6 Noise Limits

6.1 Noise emitted during braking, usually caused by the wheel or any other associated component resonating shall not exceed the limits specified in WOS 01.150 [2].

6.2 Noise emission tests shall be conducted on a complete train consist, braking at various normal running speeds.

6.3 Noise tests shall be conducted:

- on new trains with different combinations of brake rigging and brake block or disc pad material to that already in service.
- when the material composition of brake blocks or disc pads is altered.

6.4 The Australian Rail Track Corporation reserves the right to request and have noise emission tests carried out by the owner/operator where, in the Australian Rail Track Corporation's opinion, there is doubt to the vehicle/train complying with the noise limits specified in WOS 01.150 [2].

WOS 01.273 - Pneumatic Equipment

1 General

1.1 This unit covers pneumatic equipment that is not specifically part of the brake equipment.

2 Pressure Vessels

2.1 Pressure vessels shall comply with the requirements of Australian Standard AS1210 Unfired Pressure Vessels and AS 3788 Pressure Equipment In-Service Inspections.

WOS 01.280 - Vehicle Compatibility Tests

1 Introduction

1.1 This section covers the common test requirements for vehicle compatibility with the Australian Rail Track Corporation network.

1.2 The following table outlines the test required and the reference to the appropriate Rolling Stock Operation Standard containing common requirements for each test.

Compatibility test	**Reference**
Static rolling stock outline test	WOS 01.281
Static vehicle weigh test	WOS 01.282
Static vehicle twist test	WOS 01.283
Static vehicle/bogie swing test	WOS 01.284
Static vehicle/vehicle swing test	WOS 01.285
Static brake test	WOS 01.286
Brake performance test	WOS 01.287
Ride performance test	WOS 01.288
Kinematic rolling stock outline test	WOS 01.289
Pitch & bounce performance test	WOS 01.290
Rock and roll test	WOS 01.291
Environmental tests	WOS 01.292
Signal visibility test	WOS 01.293
Electrical safety inspection	WOS 01.294
Signal compatibility test	WOS 01.295
Signal interference test	WOS 01.296
Traction performance test	WOS 01.341

1.3 For specific/recommended test limits refer to the vehicle specific sections.

WOS 01.281 - Static Rolling Stock Outline Test

1 Introduction

1.1 This test is required to ensure that the vehicle is constructed within the confines of the particular static rolling stock outline specified for that vehicle type and the corridor/s along which the vehicle is to operate.

1.2 No part of the vehicle shall infringe the static rolling stock outline, for unrestricted operation, under any condition of loading and wear.

1.3 Where an infringement to the rolling stock outline exists or is proposed approval shall be obtained from the Australian Rail Track Corporation prior to operation.

1.4 Where a vehicle has been modified such that the modification impacts on the rolling stock outline, the vehicle shall be reassessed.

2 Test Configuration

2.1 The vehicle shall first be measured in the free standing tare condition on level straight track with new wheels. Vehicles which carry provisions such as fuel, sand and water shall be measured in the unprovisioned state.

2.2 The vehicle shall then be assessed with simulated solid load bearing springs, fully worn wheels and any other fully worn wear surfaces that could result in reduced vehicle height.

2.3 All measurements shall be taken in relation to the track centreline and rail head level.

2.4 Vehicles with attachments such as cranes and elevated platforms shall be measured in the travelling condition.

2.5 Vehicle length and bogie centres shall also be measured.

WOS 01.282 - Static Vehicle Weigh Test

1 Introduction

1.1 This test is designed to ensure that the vehicle is constructed within the allowable axle load limits for the particular type of rolling stock and the corridor/s along which the vehicle is to operate.

2 When the Weigh Test Must Be Performed

A weigh test shall be performed on each of the following occasions:

2.1 Acceptance Testing Of New or Substantially Modified Vehicles

Substantially modified vehicles include any vehicle modified such that the total vehicle mass has been altered, or the vehicle mass distribution has changed.

All vehicle types shall be weighed in the service tare condition. In the case of locomotives, passenger cars or track maintenance vehicles, the tare condition shall include full supplies.

In the case of bulk commodity vehicles, the vehicle shall also be loaded to the full volumetric capacity with the highest density commodity proposed to be carried in the vehicle, to ensure that the vehicle does not exceed the agreed maximum axle load.

Refer to WOS 01.282 Section 5.

2.2 Derailment Damage

Any vehicle which has become derailed and is suspected of having sustained damage, or has had equipment removed as a consequence of a derailment, which may alter the wheel load distribution shall be weighed to confirm that the wheel load distribution is within acceptable limits before the vehicle is released into traffic.

2.3 The Australian Rail Track Corporation reserves the right to request and have a weigh test carried out by the owner/operator where, in the Australian Rail Track Corporation's opinion there is doubt as to the vehicle's wheel load distribution.

3 When the Weigh Test Is Recommended

A weigh test is recommended on each of the following occasions:

3.1 Bogie Change on Locomotives and Passenger Rolling Stock

Locomotives and Passenger Rolling Stock having undergone a bogie change should be subject to a weigh test to confirm that the wheel load distribution is within acceptable limits, as determined by the formulae in Appendix C (WOS 01.C), before the vehicle is released into traffic.

3.2 Removal/Replacement, Modification, or Adjustment of Suspension Equipment.

Locomotives and Passenger Rolling Stock should be weighed if the suspension equipment (including primary/secondary springs, air springs, levelling valves, torsion bars, and spring packing) have been removed/replaced, modified or adjusted, to confirm that the wheel load distribution is within acceptable limits, as determined by the formulae in Appendix C (WOS 01.C), before the vehicle is released into traffic.

3.3 Investigation for Overloading

Any vehicle which is suspected of being excessively or unevenly loaded should be weighed to confirm the wheel load distribution and determine appropriate operating conditions.

3.4 Investigation of Derailment Cause

It may be appropriate in some derailment investigations to weigh the vehicle involved to determine if wheel load distribution was a contributing factor.

NOTE: In the case of freight vehicles it is possible that the load may have shifted during the derailment.

4 Weighing Test Procedure

For consistency in the method of weighing vehicles, a recommended procedure for performing the weigh test is given in Appendix C (WOS 01.C).

5 Maximum Axle Load

5.1 The maximum axle load for any vehicle shall be as agreed between the Australian Rail Track Corporation and the owner/operator, considering the type of vehicle proposed, vehicle operating conditions and the area of operation.

WOS 01.283 - Static Vehicle Twist Test

1 Introduction

1.1 This test is designed to ensure that the vehicle is compatible with the track twist limits of the Australian Rail Track Corporation network, without exceeding an acceptable level of wheel unloading.

2 When a Twist Test is Required

2.1 A twist test shall be conducted on all vehicle types which have not been approved by the Australian Rail Track Corporation to operate.

2.2 A twist test shall also be performed on any vehicle where the torsional stiffness of the vehicle has increased due to any of the following: ·

- Increased suspension spring rates ·
- Increase in bogie frame torsional stiffness ·
- Reduction in minimum sidebearer clearance ·
- Increase in sidebearer preload,(where applicable)
- Increase in underframe torsional stiffness
- Change in vehicle equipment, and/or mass distribution.

2.3 All vehicle types or modified versions thereof shall meet the requirements of this Rolling Stock Operation Standard before any movement on the Australian Rail Track Corporation network, other than in the confines of yards, including the movement of vehicles for test purposes.

2.4 The Australian Rail Track Corporation reserves the right to request and have a twist test carried out by the owner/operator where, in the Australian Rail Track Corporation's opinion, there is doubt as to a vehicle's twist capability.

3 Twist Test Requirements

3.1 The vehicle, and in particular, the bogie shall be capable of accommodating the track twist conditions specified herein with the loss of absolutely no more than 60% of the static wheel load on the rail for any wheel. For vehicles fitted with a centre plate, the vehicle centre plate shall have no less than 14 mm engagement with the bogie centre casting at any point, under the twist configuration called for in this Rolling Stock Operation Standard.

3.2 A track twist test using a certified weighbridge, or other approved load measuring device, and adopting the test procedures detailed below shall be used to verify compliance with the above requirements.

4 Vehicle Configuration for Twist Test

4.1 Vehicles shall be twist tested in the operating configuration tending to give the highest wheel unloading.

This will require the test to be undertaken with the vehicle at minimum tare condition. For locomotives this means minimum fuel and sand. For passenger vehicles, symmetrically located tanks shall be empty. For eccentrically located tanks, the worst loading case shall be tested.

4.2 For vehicles which are not fully symmetrical, the twist test shall be performed such that the wheel unloading is measured at each of the four outer wheels in turn, (ie all four corners of the vehicle.)

4.3 For vehicles equipped with air springs, the twist test shall be performed with air springs in the deflated and the inflated condition.

4.4 For vehicles with moveable gantries, buckets, cranes or other plant, the twist test shall be performed with that plant positioned to give the maximum wheel unloading, whilst still complying with the rolling stock outline requirements.

5 Track Twist Criteria

5.1 A local (bogie) twist of 1 in 100 over 4 metres, in combination with a general twist of 1 in 250, shall be applied to the vehicle overall wheelbase, as shown in Figure 1 below. All ramps are relative to the horizontal.

5.2 Conventional bogie vehicles shall be packed and wheel loads measured as shown in Figure 1 below:

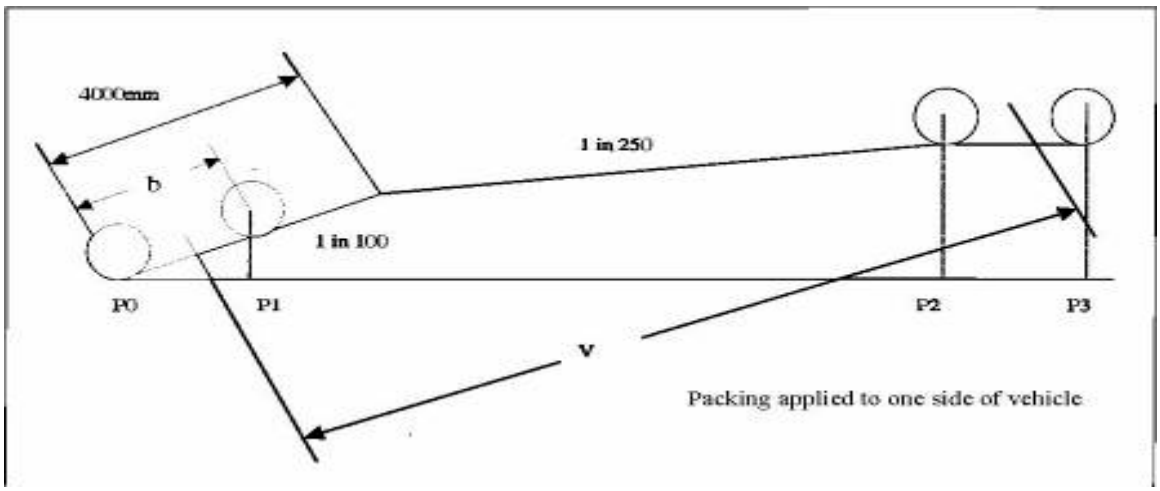


Figure 1 *- Twist Configuration*

The wheel load measured at the wheel is designated by P0

Packing under wheel P1 = b/100 mm

Packing under wheel P2 = P3 = 40+(V+b/2-4000)/250 mm

Where, b = Bogie Wheelbase (mm), V = Vehicle Bogie Centres (mm)

For articulated vehicles, the combined twist shall be applied in accordance with Figures 2, 3 and 4 below.

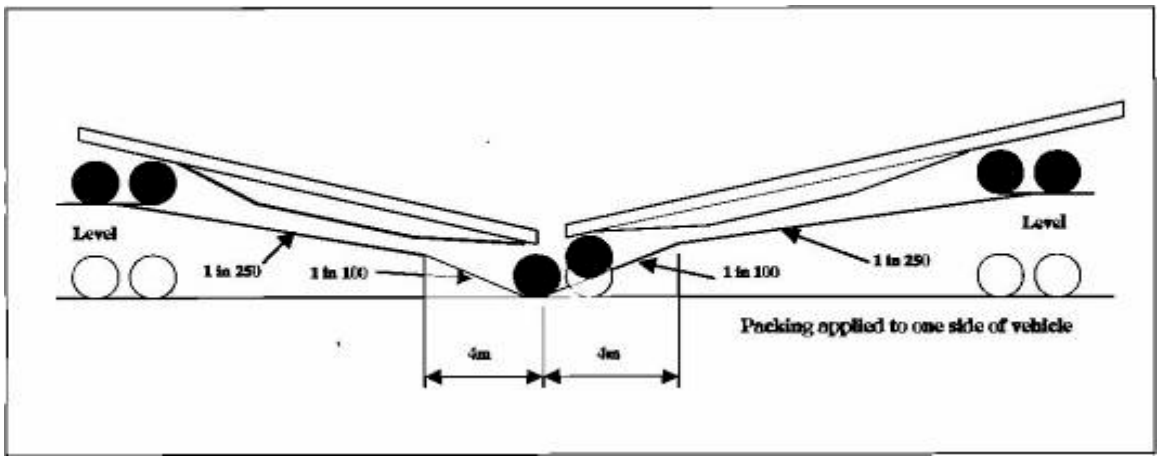


Figure 2 *- Articulated vehicle, end platform twist*

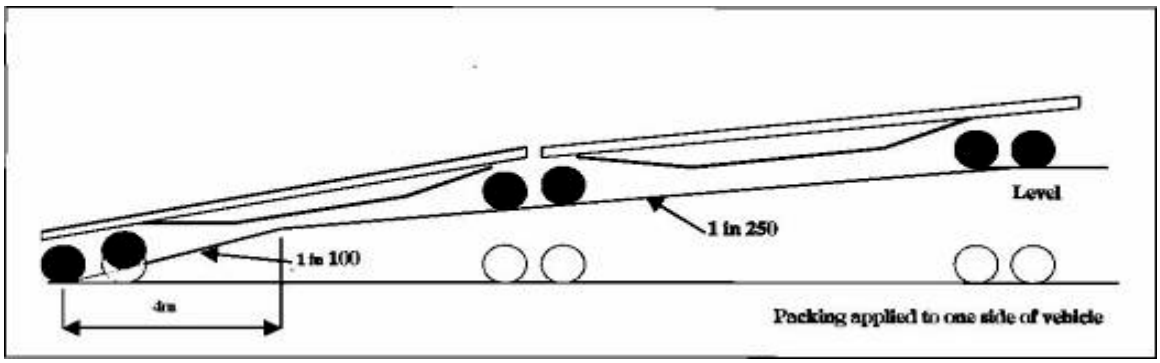


Figure 3 *- Articulated vehicle, intermediate bogie twist*

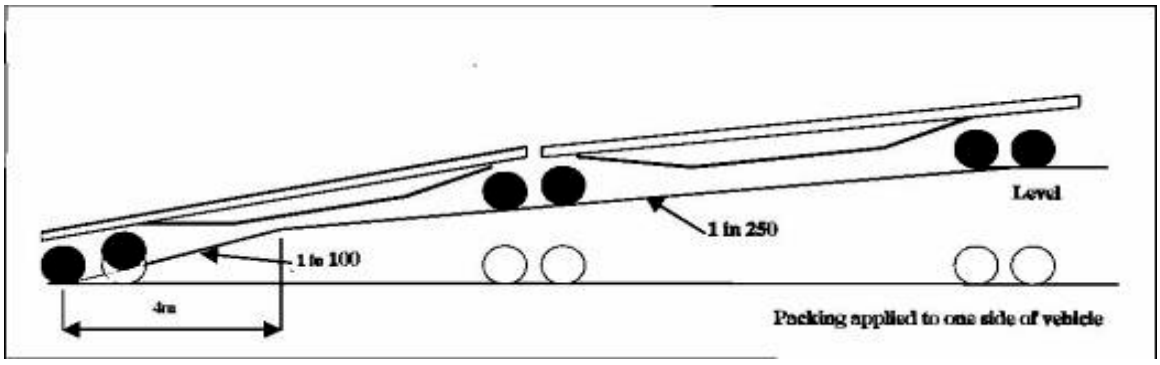


Figure 4 *- Articulated vehicle, maximum length twist*

5.3 For vehicles with other wheel configurations, such as steam locomotives, the twist parameters shown in Figure 1 shall be used to determine the packing required.

WOS 01.284 - Static Vehicle/Bogie Swing Test

1 Introduction

1.1 A static vehicle / bogie swing test is designed to ensure adequate bogie to underframe / body clearance when negotiating the most extreme track curve radius. The swing test is required for bogie vehicles only.

1.2 The swing test consists of a simulation whereby a bogie of the vehicle is rotated relative to the body such that the angle of rotation is equivalent to the specified curve radius. This may be achieved by using a turntable or traverser, or by slewing the vehicle body using a crane.

1.3 The test is a type test only.

1.4 The vehicle is not expected to negotiate the curve radius specified for this test while in service. Refer to WOS 01.120 for actual track geometry limits.

2 Vehicle Configuration

2.1 When a vehicle is subjected to a swing test its suspension system shall be in the solid condition. This may be achieved by replacing the springs with suitable packers, equivalent to the spring's solid height.

2.2 Vehicles equipped with air springs shall be tested with these in the deflated condition as well as the inflated condition.

2.3 The vehicles shall be tested complete with all equipment such as brake rigging, hoses, etc.

3 Minimum Curve Radius

3.1 The minimum curve radius for conducting a swing test shall be a 70 metre simple curve.

4 Minimum Clearance

4.1 There shall be no interference or contact between any bogie component and any vehicle underframe/body/structure component after allowances for all possible modes of vehicle bogie/body relative movement. These allowances will depend on the vehicle design.

WOS 01.285 - Vehicle Swing Test

1 Introduction

1.1 A static vehicle/vehicle swing test is designed to ensure adequate inter-vehicle clearances and inter-vehicle coupling compatibility when negotiating the most extreme track curve radii.

1.2 The vehicle/vehicle swing test consists of a simulation whereby one vehicle is rotated or translated relative to the other such that their relationship is equivalent to that of the vehicles negotiating the specified curve radii. This may be achieved by using a turntable or traverser, or by slewing one vehicle body using a crane.

1.3 1.4 This test is a type test only.

2 Vehicle Configuration

2.1 2.1 When a vehicle is subjected to a vehicle/vehicle swing test, allowance shall be made for the extremes in different vehicle heights, vehicle overhangs and coupler lengths on adjacent vehicles

2.2 2.2 All inter-vehicle connections including hoses, control cables, power cables, etc shall be correctly fitted and coupled during this test.

2.3 2.3 The vehicles shall be tested complete with all equipment such as brake rigging, hoses, etc.

3 Minimum Curve Radius

3.1 The minimum curve radius for which the vehicle to vehicle swing test shall be conducted is as follows:

- Simple curve 90m
- Reverse curve 120 m

3.2 These curve radii are tighter than those which vehicles would normally be required to negotiate in service. Refer to WOS 01.120 for reference to Australian Rail Track Corporation standards for actual track curve radius limits.

4 Minimum Clearance

4.1 There shall be no interference or contact between any vehicle/vehicle component. Allowance shall be made for all possible modes of vehicle/vehicle relative movement. These allowances will depend on the vehicle design.

4.2 Hoses and other flexible couplings shall also be checked for adequate length and to avoid abrasion and kinking.

WOS 01.286 - Static Break Test

1 Introduction

1.1 A static brake test is designed to ensure that the brakes on a vehicle apply and release prior to the vehicle being permitted to travel on the Australian Rail Track Corporation network.

1.2 A static brake test includes the following tests where applicable for the type of vehicle.

- Measurement of brake block force and calculation of net brake ratio ·
- Single car air test ·
- Parking/hand brake holding test on a grade ·
- Static brake valve operation test

2 When a Static Brake Test Is Required

2.1 A static brake test shall be conducted on all vehicle types, where specified in the appropriate Rolling Stock Operation Standard for that type of vehicle, which have not been approved by the Australian Rail Track Corporation to operate on its network.

2.2 All vehicle types, where a static brake test is specified in the appropriate Rolling Stock Operation Standard for that type of vehicle, or modified versions thereof, shall meet the requirements of this Rolling Stock Operation Standard before any movement on the Australian Rail Track Corporation network, other than in the confines of yards.

2.3 The brake block forces shall be remeasured following any alteration to brake rigging ratios or brake cylinder size or pressures.

2.4 The static brake valve operation test shall be conducted on all locomotives, multiple unit trains and ‘on track’ maintenance vehicles prior to the vehicle being permitted to move on the Australian Rail Track Corporation network.

2.5 The Australian Rail Track Corporation reserves the right to request and have a static brake test carried out by the owner/operator where, in the Australian Rail Track Corporation’s opinion, there is doubt at to the vehicle’s braking capability.

3 Net Brake Ratio

3.1 The net brake ratio shall be determined by dividing the sum of the actual measured brake block forces by the total vehicle mass at rail, at both tare and gross mass.

3.2 Net brake ratios are specified for locomotive hauled vehicles in the appropriate Rolling Stock Operation Standard section for that type of vehicle.

4 Single Car Air Test

4.1 All locomotive hauled freight and passenger vehicle brake systems shall be periodically maintained and a single car test conducted on the automatic brake system in accordance with operators procedures.

4.2 A single car test shall be conducted on any vehicle after the replacement of any major air brake equipment.

4.3 Any vehicle having skidded wheels (class 3 or greater) or scaled wheels (class 4 or greater) shall be given a single car test prior to release into service.

4.4 During the single car test, the following would normally be verified:-

Test	**Allowable limits**
brake pipe leakage	20 kPa/min maximum
main reservoir leakage	10 kPa/min maximum
sensitivity on application	
sensitivity on release	
accelerated release operation (where fitted	
grade control valve operation (where fitted)	
load compensation operation (where fitted)	
slack adjuster operation	
brake cylinder leakage	10 kPa/5 min maximum
auxiliary reservoir leakback	
main reservoir leakback	
independent brake (where fitted)	
• double check valve leakage	nil leakage allowed
• independent brake over automatic brake	
• independent control pipe leakage	
emergency valve operation	
(passenger vehicles only)	

WOS 01.287 - Break Performance Test

1 Introduction

1.1 Brake performance testing is designed to ensure that all self propelled vehicles and multiple unit trains, operate safely within the current signalling limits.

1.2 Brake performance testing is also carried out on locomotive hauled trains of varying lengths.

1.3 Brake performance tests include the following tests where applicable for the type of vehicle.

- Stopping distance tests for individual vehicles or trains
- Deceleration tests for track maintenance vehicles

2 When a Brake Performance Test Is Required

2.1 A brake performance test shall be conducted on all self propelled vehicles and multiple unit trains which have not been approved by the Australian Rail Track Corporation to operate on its network.

2.2 A brake performance test shall be conducted on all self propelled vehicles and multiple unit trains following any modifications to the braking system, including any change in brake block material, before entering service on the Australian Rail Track Corporation network.

2.3 The Australian Rail Track Corporation reserves the right to request and have brake performance tests carried out by the owner/operator where, in the Australian Rail Track Corporation's opinion, there is doubt as to the braking capability a train or individual vehicle.

3 Track Configuration

3.1 A brake performance test should be conducted on level tangent track. If tests have to be conducted on a grade, the grade should be constant for the length of the stopping test and the measured test results shall be corrected for level track.

WOS 01.288 - Ride Performance Test

1 Introduction

1.1 A ride performance test is designed to ensure vehicle compatibility with the track and to establish the optimum vehicle operating conditions consistent with the need to mitigate track degradation whilst meeting acceptable train pathing criteria.

1.2 This Rolling Stock Operation Standard covers base ride performance. For vehicle specific recommended ride performance refer to the appropriate Rolling Stock Operation Standard covering that vehicle type.

2 When a Ride Performance Test Is Required

2.1 A ride performance test shall be conducted on all vehicle types which have not been approved by the Australian Rail Track Corporation to operate on its network.

2.2 The Australian Rail Track Corporation reserves the right to request and have a ride performance test carried out by the owner/operator on any vehicle for the following reasons:

- Proposed modification to the suspension characteristics
- Proposed change in bogie rotational resistance ·
- Proposed change in wheel profile ·
- Proposed change in bogie type
- Proposed change in vehicle operating conditions
- Any proposed vehicle modification which may affect the vehicle ride performance
- Significant change in the vehicle tare mass
- Where, in the Australian Rail Track Corporation's opinion, there is suspected poor ride performance

3 Base Ride Performance Requirements

3.1 The base ride performance requirements for all vehicle types operating on the Australian Rail Track Corporation network shall be as follows:

Parameter	Limit	Test Speed
Maximum lateral acceleration	+/- 0.5g	110% design
Average lateral acceleration	+/- 0.35g	110% design
Maximum vertical acceleration	+/- 0.8g	110% design
Average vertical acceleration	+/- 0.5g	110% design

3.2 Ride performance shall be measured using vertical and lateral accelerometers positioned on the vehicle body as near as possible to the trailing bogie centre.

3.3 All measured accelerations shall be filtered at 10 Hz low pass.

3.4 Average acceleration shall be taken as the mean peak acceleration measured about the zero axis. The mean peak acceleration shall be calculated from the 10 Hz low pass filtered acceleration.

3.5 Sustained hunting is not permitted. In this case, hunting is defined as sinusoidal lateral oscillations of the wheelset resulting in greater than 0.5 Hz lateral vehicle body accelerations measured at the bogie centre of greater than 0.35g sustained for 10 seconds or longer.

4 Vehicle Test Configuration

4.1 All wheels on the vehicle under test shall have a worn wheel test profile, which has been agreed to by the Australian Rail Track Corporation, to ensure that the vehicle is tested for lateral stability under the most adverse wheel wear conditions likely to be experienced in service.

4.2 Alternatively the agreed wheel test profile may initially be the “as new” profile on the proviso that later vehicle tests shall be conducted with an agreed field worn wheel profile. The tests on the vehicle with the agreed field worn wheel profile shall be conducted prior to the remaining vehicles of that type reaching a state of wheel wear equivalent to the agreed field worn wheel profile.

4.3 In the case where tests are initially conducted with an “as new” wheel profile, the Australian Rail Track Corporation reserves the right to request and have the owner/operator conduct further tests prior to the wheels reaching the agreed field worn wheel profile.

4.4 In the case where tests are initially conducted with an “as new” wheel profile, interim approval to operate will be granted following successful completion of these tests but final approval to operate will not be granted until all required tests with the agreed field worn wheel profiles have been successfully completed.

4.5 The Australian Rail Track Corporation reserves the right to request and have the vehicle tested by the owner/operator in the fully loaded and/or tare condition.

4.6 Where applicable, the test vehicle shall be the trailing vehicle in the test consist.

5 Test Track Configuration

5.1 Ride performance testing shall be tested on a minimum length of track of 3 km with a TCI less than or equal to 45 and with no significant defects, or as mutually agreed between the owner/operator and the Australian Rail Track Corporation. The test track should represent at least 60 per cent of the routes on which the vehicle would be operating.

WOS 01.289 - Kinematic Rolling Stock Outline Test

1 Introduction

1.1 This test is designed to ensure that the vehicle performs within the confines of the particular kinematic rolling stock outline specified for that vehicle type and the corridor/s along which the vehicle is to operate.

1.2 No part of the vehicle shall infringe the kinematic rolling stock outline under all conditions of loading, wear and dynamic behaviour unless otherwise approved by the Australian Rail Track Corporation.

1.3 Refer to WOS 01.110 for details of the kinematic rolling stock outline.

2 When a Kinematic Outline Test Is Required

2.1 A kinematic outline test shall be conducted on all vehicle types which have not been approved by the Australian Rail Track Corporation to operate on the Australian Rail Track Corporation network.

2.2 The Australian Rail Track Corporation reserves the right to request and have a kinematic outline test carried out by the owner/operator on any vehicle for the following reasons:

- Proposed modification to the suspension characteristics
- Proposed increase in vehicle centre of gravity height
- Proposed change in wheel profile
- Proposed change in bogie type
- Proposed change in vehicle operating conditions
- Any proposed vehicle modification which may affect the vehicle lateral ride performance
- Where, in the Australian Rail Track Corporation's opinion, there is suspected infringement of the kinematic rolling stock outline

3 Kinematic Outline Test Requirements

3.1 The fully loaded vehicle shall be instrumented to determine roll relative to the rail plane and lateral displacement relative to the track centreline.

3.2 The test shall be conducted with the vehicle negotiating an agreed test track site as specified in section [4] below with 'x' per cent of the design cant deficiency.

Where 'x' = 160 % for freight vehicles

'x' = 145 % for passenger vehicles and locomotives.

In addition the roll and lateral displacements shall be determined on a fully loaded vehicle standing on a simulated 160 mm superelevation.

3.3 The worst condition of roll and the worst condition of lateral displacement determined in both of the above tests 3.2 and 3.3 shall be used in assessing vehicle compliance with the kinematic rolling stock outline requirements.

4 Test Track Configuration

4.1 Kinematic outline testing shall be conducted on a minimum length of track of 500 m with a TCI less than or equal to 50 and with no significant defects, or as mutually agreed between the owner/operator and the Australian Rail Track Corporation. The test track should represent at least 60 per cent of the routes on which the vehicle would be operating.

WOS 01.290 - Pitch and Bounce Performance Test

1 Introduction

1.1 A pitch and bounce test is designed to ensure that the vehicle suspension is adequately damped to control vehicle oscillations created when negotiating cyclic vertical track perturbations at critical speed.

2 When A Pitch and Bounce Test Is Required

2.1 The Australian Rail Track Corporation reserves the right to request and have a pitch and bounce test carried out by the owner/operator on any vehicle for the following reasons:

- New vehicle types ·
- Proposed modification to the suspension characteristics ·
- Proposed change in bogie type ·
- Proposed change in vehicle operating conditions ·
- Any proposed vehicle modification which may affect the vehicle vertical ride performance
- Where, in the Australian Rail Track Corporation's opinion, there is suspected poor ride performance.

3 Pitch and Bounce Test Requirements

3.1 The pitch and bounce test performance requirements for all vehicle types operating on the Australian Rail Track Corporation network shall be as follows:

Parameter	Limit	Test Speed
Maximum vertical acceleration	+/- 0.8g	Up to 110% design
Average vertical acceleration	+/- 0.5g	Up to 110% design
Maximum vertical wheel load	10% of static	Up to 110% design

3.2 Pitch and bounce performance shall be measured using vertical accelerometers positioned on the vehicle body as near as possible to the leading and trailing bogie centres.

3.3 All measured accelerations shall be filtered at 10 Hz low pass.

3.4 Average acceleration shall be taken as the mean peak acceleration measured about the zero axis. The mean peak acceleration shall be calculated from the 10 Hz low pass filtered acceleration.

3.5 The fully loaded vehicle shall first approach and negotiate the test site at a constant speed well below any calculated resonant speed, and there after increasing in 10 km/h increments for each subsequent test run until the critical values of the table above are reached, the resonance level is passed, or 110% of the design speed is reached.

3.6 If the critical acceleration levels in the table of section 3.1 above are exceeded, the vehicle is regarded as unsuitable for the proposed operation, but may be relegated to a lower maximum speed of at least 10 percent less than the critical speed.

4 Pitch and Bounce Test Track Configuration

4.1 The test track configuration for the pitch and bounce test shall consist of three (3) cycles, with phase, wavelength and amplitude as defined in diagram 1 (Reference Diagram 3-12A of the ROA Manual of Engineering Standards and Practices). (see Appendix G [WOS 01.G] of this manual)

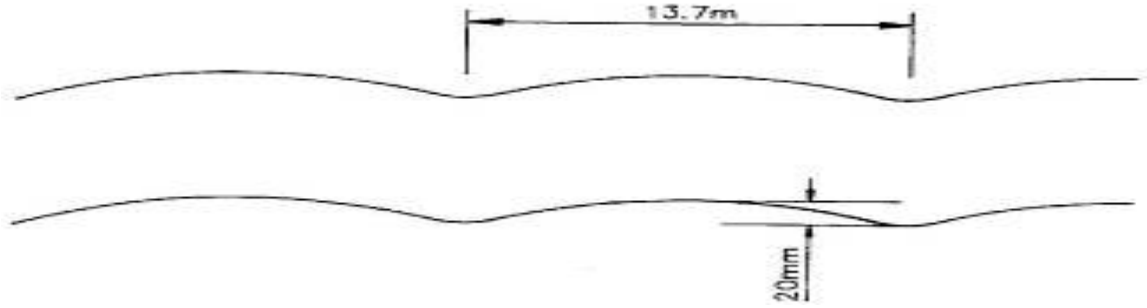


Diagram 1

4.2 In addition, the test track shall include a single bump as defined in diagram 2 (Refer to Diagram 3-12B of the ROA Manual of Engineering Standards and Practices). (see Appendix G [WOS 01.G] of this manual)

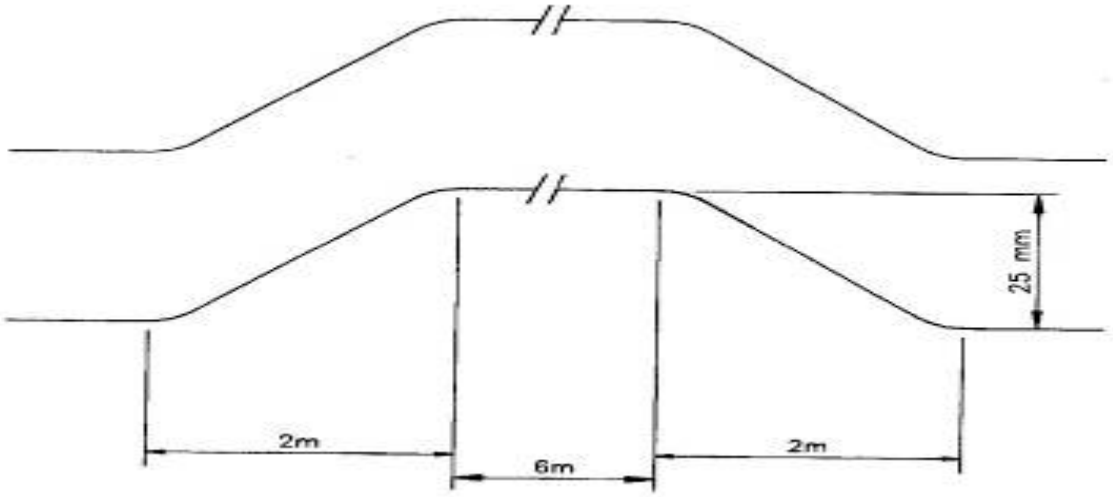


Diagram 2

4.3 Where an instrumented wheelset is not available to measure vertical wheel forces, the vertical acceleration in the table of section 3.1 shall be taken as the test limit.

5 Simulation of Pitch and Bounce Test

5.1 As an alternative to conducting the pitch and bounce test, a computer-simulated test may be accepted.

5.2 The simulation must be verified by comparing the ride results with that of an actual ride.

WOS 01.291 - Rock and Roll Test

This unit is yet to be completed

WOS 01.292 - Environmental Tests

1 Introduction

1.1 1.1 Environmental testing is designed to ensure that vehicles and trains do not exceed acceptable noise, vibration and air quality limits.

2 Noise Tests

2.1 All rolling stock shall comply with the noise requirements as specified in WOS 01.150 [2].

2.2 Type testing will apply for all rolling stock of the same vehicle type providing they have not been substantially modified.

3 Vibration Tests

3.1 All rolling stock shall comply with the vibration requirements as specified in WOS 01.150 [3].

3.2 Type testing will apply for all rolling stock of the same vehicle type providing they have not been substantially modified.

4 Emission Tests

4.1 All powered rolling stock shall comply with the emission requirements as specified in WOS 01.150 [4].

4.2 Type testing will apply for all rolling stock of the same vehicle type providing they have not been substantially modified.

4.3 Emission testing shall include:

- Visible smoke
- Nitrogen oxides (NOx)
- Particulates
- Carbon monoxide
- Hydrocarbons (VOC)
- Exhaust flow

WOS 01.293 - Signal Visibility Test

1 Introduction

1.1 Signal visibility testing is designed to ensure that drivers or operators of all self propelled vehicles including locomotives and multiple unit trains can clearly see trackside signals from their driving positions.

2 Visibility Tests

2.1 Signal visibility tests shall be conducted as specified in WOS 01.160 [6].

2.2 Type testing will apply for all rolling stock of the same vehicle type providing they have not been substantially modified.

WOS 01.294 - Electrical Safety Inspection

1 Introduction

1.1 An electrical safety inspection is designed to ensure that vehicles operating under the overhead wires are safe as follows:

- There is adequate clearance between the vehicle and the overhead wires.
- Moving parts, such as cranes and elevating platforms, are secured in a locked position while the vehicle is in travelling mode.
- There is adequate signage warning personnel not to climb on the vehicle when under the overhead wires.

2 When an Electrical Safety Inspection is Required

2.1 All new vehicles that may operate under the overhead wires must be inspected.

2.2 Any vehicle that has been modified such that equipment can come within contact with the overhead wires or within 3 metres of the overhead wires.

2.3 Any vehicle that has been modified such that personnel operating the vehicle can come within contact with the overhead wires or within 1 metre of the overhead wires.

2.4 An electrical safety inspection is not required where vehicles only operate outside of electrified areas. Vehicles that fail the electrical safety inspection will be restricted to operation outside the electrified area.

3 Electrical Safety Inspection

3.1 Where personnel could, in carrying out his duties, climb onto a vehicle within 1 metre of the overhead wires, appropriate safety warning signs shall be displayed.

3.2 Any movable part of a vehicle, such as cranes, work platforms, out riggers, etc. shall be fitted with positive locking devices to prevent accidental upward movement.

3.3 All vehicles fitted with cranes, work platforms, etc. must display ‘Danger’ signs. Signs should be adjacent to the controls of the cranes, work platforms, etc.

WOS 01.295 - Signal Compatibility Test

1 Introduction

1.1 Signal compatibility testing is designed to ensure that vehicles operating on the Australian Rail Track Corporation network operate the trackside signalling equipment.

1.2 With the exception of locomotive hauled vehicles, vehicles that do not satisfactorily operate the signalling system, such as road/rail vehicles and some track maintenance vehicles, shall only operate under special operating condition. Refer to Appendix F (WOS 01.F) [F1].

2 Signal Compatibility Tests

2.1 Signal compatibility tests shall be conducted in accordance with the requirements specified in Appendix F (WOS 01.F).

WOS 01.296 - Signal Interference Test

1 Introduction

1.1 Signal interference testing is designed to ensure that electrical equipment operating on a vehicle does not interfere with the operation of trackside signalling equipment.

2 Signal Compatibility Tests

2.1 Signal interference tests shall be conducted in accordance with the requirements specified in Appendix F (WOS 01.F) [F5].