Engineering Standard
Rolling Stock

ESR 0330

WHEEL DEFECT MANUAL

Version 1.2

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Engineering Standard

Document control

Version	Date	Summary of change
(RSU 212) 1.0	August 1997	Based on Mechanical Branch Spec F163 and TRS 0163
(RSU 212) 2.0	April 2001	Photos included & diagrams amended
(RSS 0030) 1.0	Jan 2004	New standard. Content taken from RSU 212.
(RSS 0030) 1.1	July 2004	Description of defects expanded
(RSS 0030) 1.2	October 2005	Reissued as a Railcorp standard. Scaled wheel classes amended, witness marks altered, quick reference tables added.
(RSS 0330) 1.0	May 2008	Standard moved to General Maintenance Standards and renumbered RSS 0330. Classes of Scaled wheels amended
(ESR 0330) 1.0	June 2010	Reformatted and renumbered ESR 0330
(ESR 0330) 1.1	July 2010	Document revision history corrected
1.2	May 2012	

Summary of changes from previous version

Summary of change	Section
Version 1.2	
Minor reformatting	
New section on rolling contact fatigue added	5.2
New section on sub surface fatigue added	5.3
Note added re minimum cut 10 mm for removing spalling	5.5.3
Requirement for trim blocks on suburban and intercity cars with class 1 skidded wheels	5.6.1
Requirement for trim blocks on suburban and intercity cars with class 2 skidded wheels	5.6.2
Increase in speed for diesel and electric passenger trains to 115 km/h	5.6.2
Actions required for Class 3 short flanges added	5.9.5.1
New section on machining defects added	5.10
New section on out of round wheels added	5.10.2

Contents

1 Introduction

Wheels with defective wheels may cause damage to both the track and the vehicle or lead to derailment.

2 Purpose

This standard provides staff with a summary of wheel conditions under which wheels may continue in service and operating restrictions imposed for defective wheels found on vehicles operating on the RailCorp network.

3 Application

This standard is intended for use by train crew, vehicle maintainers and engineering staff for any vehicle operating on the RailCorp network.

4 Referenced documents

4.1 RailCorp standards

ESR 0331 Wheel and axle reference manual

ESR 0334 Welding of skidded wheels in situ

ESR 0311 Single car air test

5 Wheel rim thickness

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

- Freight vehicles up to 25 tonne axleload 20 mm
- Freight vehicles over 25 tonne axleload 22 mm
- Passenger vehicles 25 mm
- Locomotives 22 mm (See below)

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

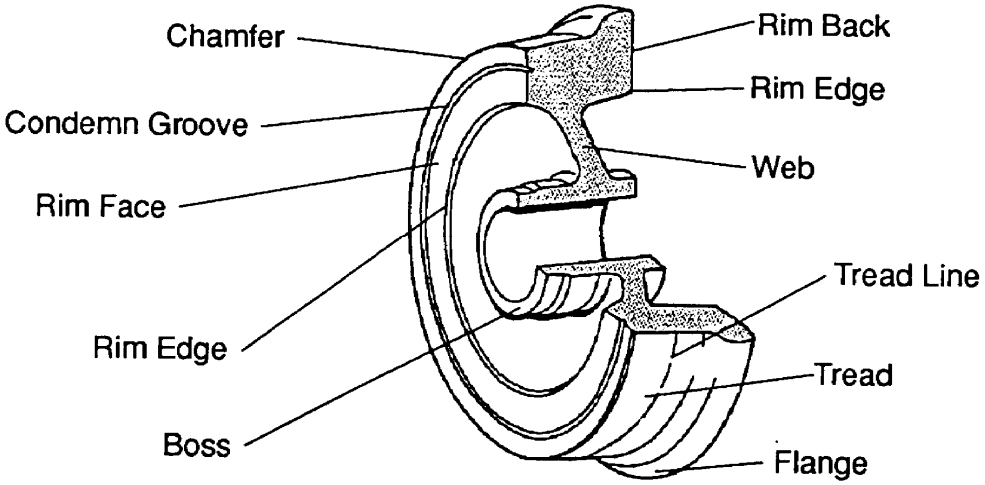


Figure 1 Standard wheel terminology

6 Permissible variation in wheel diameter

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:

- Maximum permissible variation in wheel tread diameter per axle (new or re-turned) 0.5mm
- Maximum permissible variation in wheel tread diameter per axle (in service) 1mm
- Maximum permissible variation in wheel tread diameter per bogie 25mm
- Maximum permissible variation in wheel tread diameter per vehicle 60mm

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 the limits in dot points 2 and 3 above.

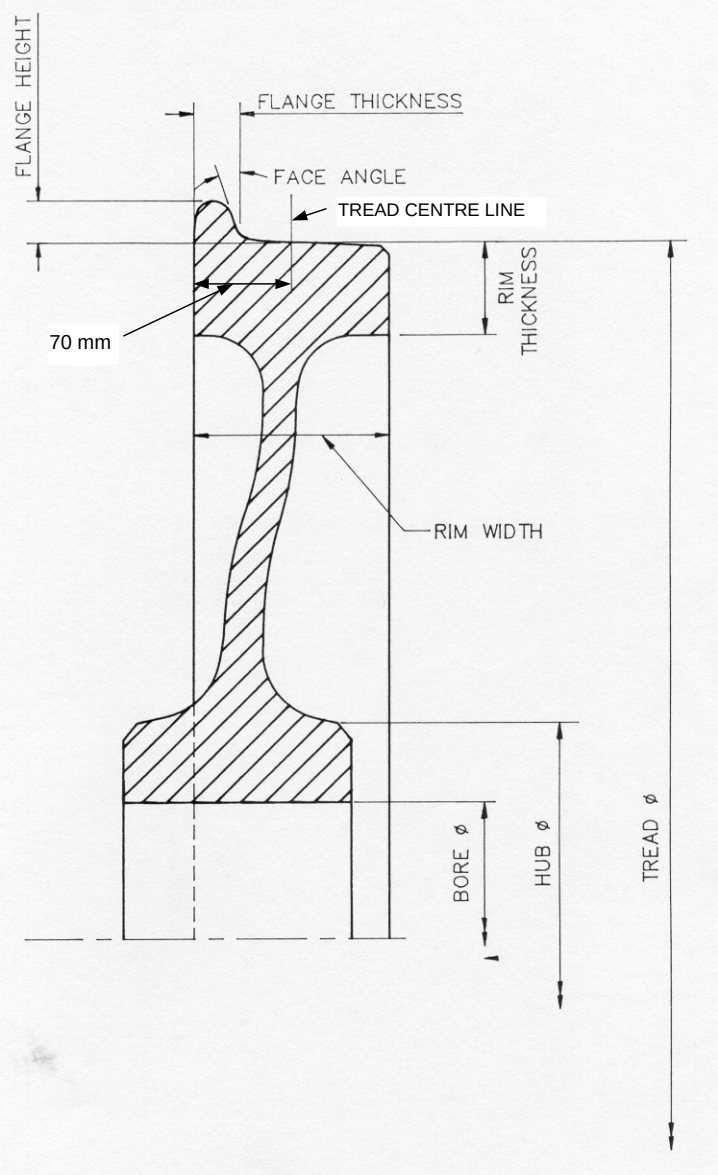


Figure 2 Location of limiting dimensions

7 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.

7.1 Thermal cracks

Thermal cracks are the result of alternate heating and cooling of the wheel tread and rim area, and originate from metallurgical changes in the wheel material. Thermal cracks are the most severe form of wheel defect.

Heating from brake blocks when braking frequently produces a fine network of fine, shallow, superficial lines or "checks" running in many different directions on the wheel tread surface. Because of its similarity to the type of fine cracks found in pottery glazes, it is sometimes referred to as surface crazing. This should not be confused with true thermal cracking, and if found on its own causes no problems.

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).

7.1.1 Class 1 thermal cracks

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.

Action Required:

No action required for class 1 thermal cracking

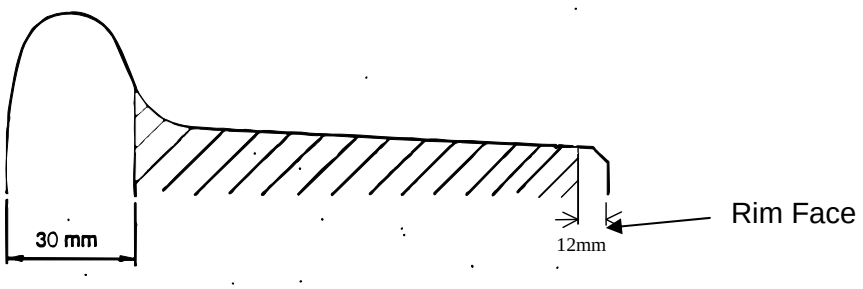


Figure 3 Class 1 thermal crack zone

Speed Restriction: No speed restriction.

7.1.2 Class 2 thermal cracks

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

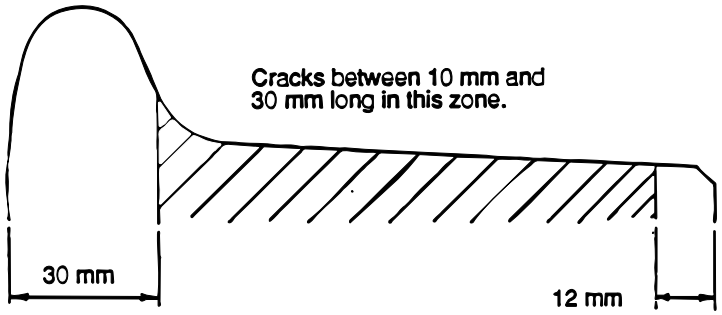


Figure 4 Class 2 thermal crack zone

Action Required:

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.

Speed restriction:no speed restriction

Photograph 1 - Class 2 thermal crack

7.1.3 Class 3 thermal cracks

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.

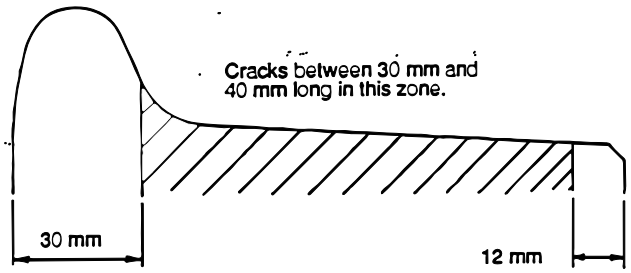


Figure 5 Class 3 thermal crack zone

Action Required:

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.

Speed restriction: No speed restriction

Photograph 2 - class 3 thermal crack

7.1.4 Class 4 thermal cracks

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 tread.

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.

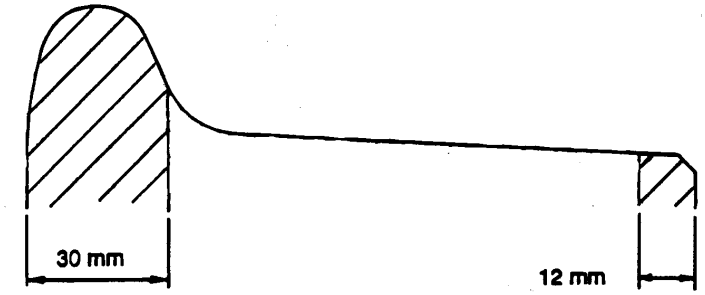


Figure 6 Class 4 thermal crack zone

Photograph 3 - class 4 thermal crack

Action Required:

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.

Speed Restriction: 40 km/h.

7.1.5 Class 5 thermal crack

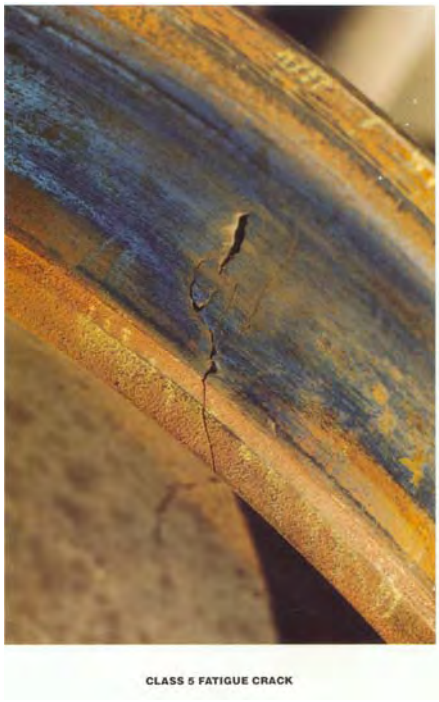
Any crack running through the rim, web or boss of the wheel must be considered as a class 5 defect.

Action Required:

The vehicle shall not be moved until the damage has been examined and assessed by the attending Qualified Worker.

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

Speed Restrictions: Vehicle not to be moved until inspected.



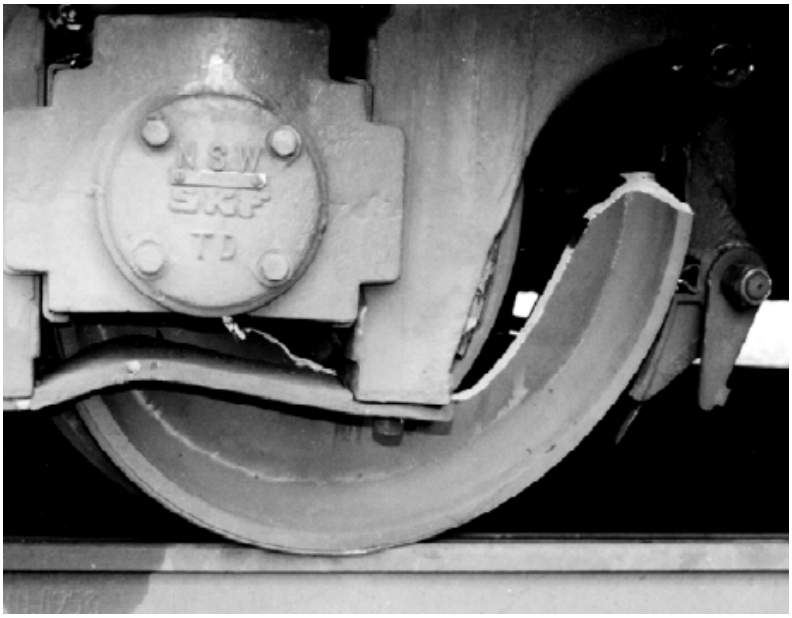
Photograph 4

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.

7.1.6 Fractured wheel

A fractured wheel is 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.



Photograph 5 Fractured wheel caused by thermal crack

Action Required:

This vehicle shall not be moved until:

- a wheelset/bogie change; or the fitting of a pony bogie, or
- a pony bogie is fitted.

Speed Restrictions: Vehicle not to be moved

7.2 Rolling contact fatigue

Rolling contact fatigue cracks is caused by repeated contact stress during the rolling motion. Rolling contact fatigue cracks usually develop on rhe tread surface and are generally not oriented perpendicular to the running direction. This type of defect can lead to spalling.

7.2.1 Class 1 rolling contact fatigue cracks

Any rolling contact fatigue 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 7.1.3).

Action Required:

No action required for class 1 rolling contact fatigue cracking

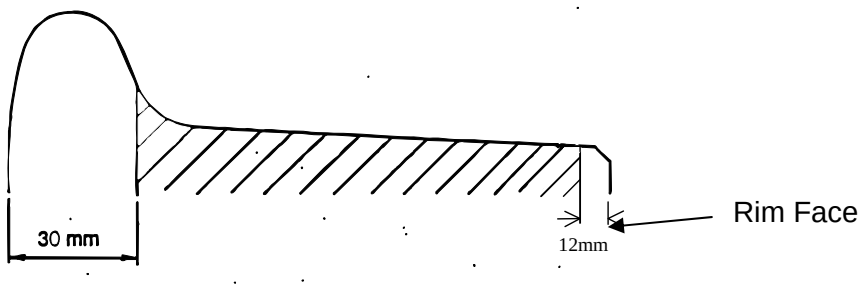


Figure 7 Class 1 rolling contact fatigue crack **zone**

Speed Restriction: No speed restriction.

7.2.2 Class 2 rolling contact fatigue cracks

Any rolling contact fatigue cracks between 10 mm and 30 mm long in the zone shown in

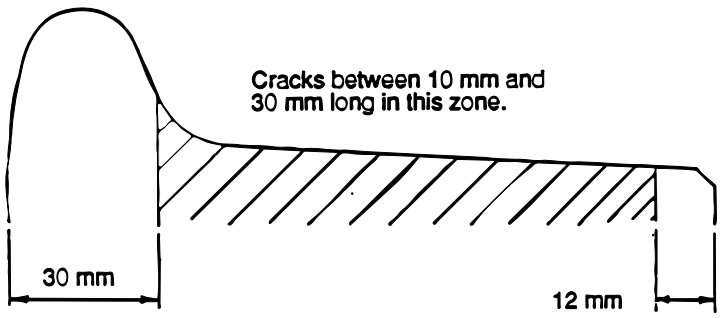


Figure 8 Class 2 rolling contact fatigue crack zone

Action Required:

Locomotives and passenger vehicles: Any wheels with class 2 rolling contact fatigue 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 rolling contact fatigue crack.

Freight vehicles: If any class 2 rolling contact fatigue 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 rolling contact fatigue cracks.

Speed restriction:no speed restriction

7.2.3 Class 3 rolling contact fatigue cracks

Any rolling contact fatigue 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 rolling contact fatigue 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.

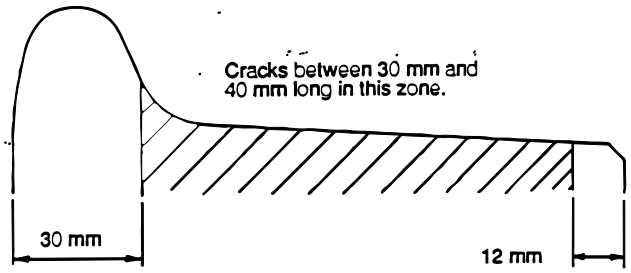


Figure 9 Class 3 rolling contact fatigue cr**ack zone**

Action Required:

Locomotives and passenger vehicles with class 3 rolling contact fatigue cracks must be scheduled for wheel turning within 14 days of detection.

Electric multiple unit vehicles with class 3 rolling contact fatigue 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 rolling contact fatigue crack.

Freight vehicles with class 3 rolling contact fatigue cracks must be worked out of service for repairs.

Speed restriction: No speed restriction

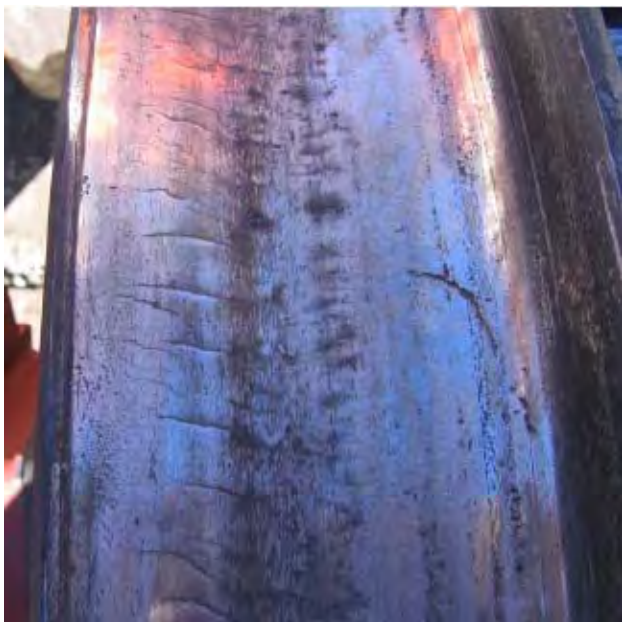
7.2.4 Class 4 rolling contact fatigue cracks

Any rolling contact fatigue crack greater than 10 mm long in the shaded zone adjacent to the rim face, or any visible rolling contact fatigue crack on the flange shaded zone, as shown in Figure 5 or a rolling contact fatigue crack greater than 40 mm long anywhere on the wheel tread.

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.

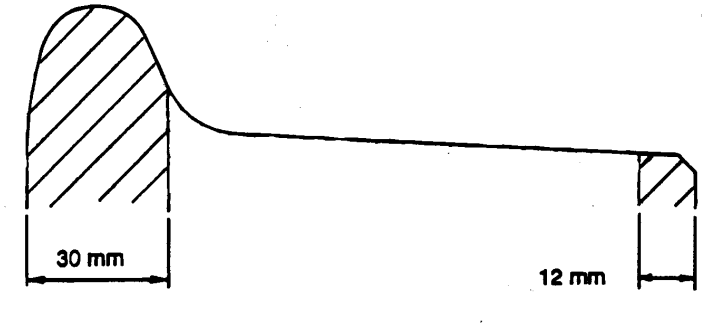
Note: If there is any evidence of a crack on or extending onto the rim face, then this condition will be considered a class 4 defect.

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.



Photograph 6 Class 4 Rolling contact fatigue

Note: Cracks are angled across the wheel tread and may vary up to 45 degrees.



Any visible crack on Flange	Cracks greater than 40 mm long anywhere on the wheel tread	Cracks greater than 10 mm long

Figure 10 Class 4 rolling contact fatigue crack zone

Action Required:

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.

Speed Restriction: 40 km/h.

7.3 Sub surface fatigue

Sub surface fatigue cracks initiate from metallurgical defects in the wheel. The cracks generally develop 3 to 25 mm below the tread surface in the region of maximum shear stress in the wheel/rail contact area.

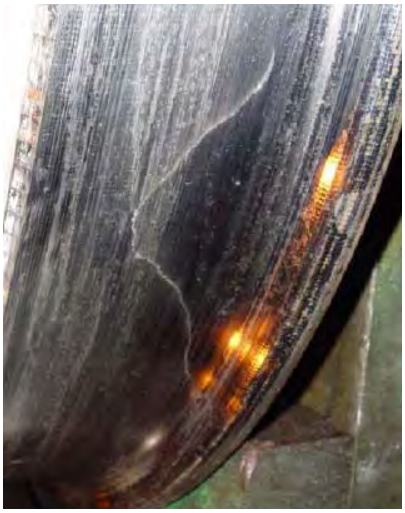
Sub surface defects are normally identified by ultrasonic testing; however there are three visual ways to identify a sub surface fatigue defect.

Cracks appear on the tread or flange during wheel turning.

Cracks appear on the rim or back of the wheel and these cracks will be circumferential.

A portion of the tread may be displaced and protrude past the wheel rim.

Any sub surface crack running through the rim, web, boss or back of wheel that can be visually identified is to be treated as a Class 4 or 5 defect, depending on severity.



Photograph 7 Sub surface fatigue crack (identified during wheel turning)

Photograph 8 Sub surface fatigue crack (extending to back of wheel)

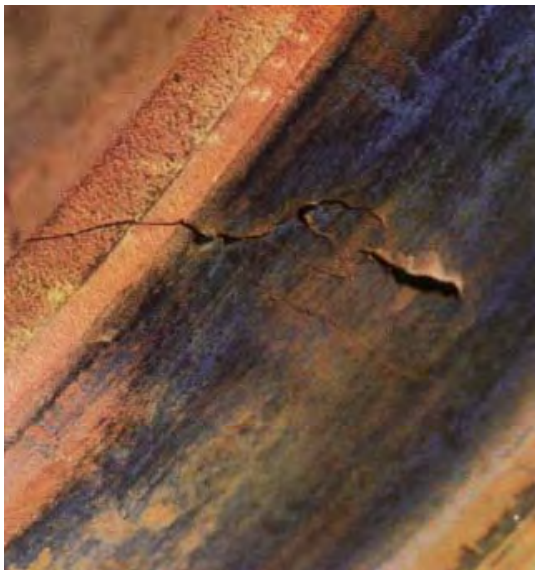
Photograph 9 Sub surface fatigue crack
Note: protrusion on chamfer/rim of wheel

Photograph 10 Sub surface fatigue crack propagated to surface

7.4 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.



Photograph 11 Class 5 Fatigue Crack (propagated from a thermal crack)

Action Required:

Any fatigue crack found in a wheel must be classified as a class 4 defect (see clause 7.10.4) or a class 5 defect (see clause 7.1.5).

Speed Restrictions: 40 km/h for Class 4, vehicle not to be moved for Class 5.

7.5 Spalling or shelled tread

Spalling or shelled tread occurs when pieces of metal break out of the tread surface in several places more or less continuously around the tread circumference. This defect can result from thermal damage, skidding or over-stressing at the wheel-rail contact point. It is usually attributed to a combination of two or more of the following factors: poor track and excessive speed resulting in high impact stresses, excessive vertical loads, excessive braking (thermal damage and/or skidding) or the use of wheels of insufficient hardness.

Spalls can range in size depending on the age and depth of the defect. Their frequency can be such that the entire tread circumference is covered with craters to the extent that they become joined. Wheel tread condition, particularly spalling, has a pronounced effect on wheel and brake block life. For example, brake block wear is approximately 1.5mm per 1000km travelled with new wheels and extreme spalling can increase this rate to approximately 20mm per 1000 km.

Pitting is the presence of very small marks on the tread. It can be the initial stages of spalling but is not in itself a concern.

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

7.5.1 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.

Photograph 12

Action Required:

No action required. However, Trim Blocks or cast iron brake blocks may be used to dress the wheel tread surface.

Speed Restriction: No speed restriction.

7.5.2 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.

Photograph 13

Action Required:

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. However, Trim Blocks or cast iron brake blocks may be used to dress the wheel tread surface.

Speed Restriction: No speed restriction.

7.5.3 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.

Photograph 14

Action Required:

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

Note: The minimum 10 mm depth of cut at required when turning wheels.

Freight vehicles must be worked out of service for repairs.

No speed restriction for any vehicle with class 3 spalling.

Speed Restriction: No speed restriction.

7.5.4 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.

Photograph 15

Action Required:

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.

Speed Restriction: 40 km/h.

7.6 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.

A single car air test (Refer to ESR 0311) must be carried out on vehicles with skidded wheels.

7.6.1 Class 1 skidded wheels

A single skid with length less than 25 mm.

Action Required:

No action required for locomotives or freight vehicles. However, Trim Blocks or cast iron brake blocks may be used to dress the wheel tread surface.

Trim blocks must be fitted to suburban and intercity cars with class 1 skids.

Speed Restriction: No speed restriction.

7.6.2 Class 2 skidded wheels

Single skid length between 25 mm and 40 mm or multiple class 1 skids

Action Required:

Passenger vehicles: Any wheels with class 2 skids must be fitted with trim blocks.

Locomotives: 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 re-examine the wheel during vehicle examination/inspection or maintenance. No other action is required for class 2 skids.

However, Trim Blocks or cast iron brake blocks may be used to dress the wheel tread surface.

Speed Restriction: Diesel and electric passenger trains 115 km/h, all other vehicles 80 km/h.

7.6.3 Class 3 skidded wheels

Single skid length between 40 mm and 60 mm or multiple class 2 skids.

A speed restriction of 40 km/h must be placed on any vehicle with class 3 skids

Action Required:

Locomotives and passenger vehicles must have inspection details recorded by the operator and be scheduled for wheel turning.

Freight vehicles must be worked out of service for repairs.

Speed Restriction: 40 km/h.

Photograph 16

Class 3 skidded wheel

Photograph 17

Class 3 skidded wheel

(note build up of scale)

7.6.4 Class 4 skidded wheels

Single skid length between 60 mm and 100 mm or multiple class 3 skids.

Photograph 18

Action Required:

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.

Speed Restriction: 25 km/h.

7.6.5 Class 5 skidded wheels

Single skid greater than 100 mm in length or multiple class 4 skids.

Action Required:

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 ESR 0334 Welding of skidded wheels in situ.

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.
- a pony bogie is fitted, the vehicle shall then be transferred to the nearest wheel lathe in accordance with section 9.

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.

Speed Restriction: Vehicle not to be moved.

Photograph 19 Class 5 skidded wheel

7.7 Scaled wheels

Scaling is the build up of metallic material on the surface of the wheel tread. It is usually attributed to sticking brakes which cause the wheel to slip or slide on the rail, thus heating it to the stage where the material becomes soft enough to flow on the tread surface. It mixes with brake dust and other foreign material and is deposited back onto the wheel where it cools in layers, giving the tread a scaly appearance.

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.

A single car air test (Refer to ESR 0311 must be carried out on 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.

7.7.1 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 1 mm). This smearing effect is caused by the wheel sliding, but not completely stopping, for a very short time.

Photograph 20 - Class 3 scaled wheel

Action Required:

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 1 scale. However, Trim Blocks may be used on multiple unit trains and cast iron brake blocks on locomotives and locomotive hauled vehicles to dress the wheel tread surface.

Speed Restriction: No speed restriction.

7.7.2 Class 4 scaled wheel

Measurable scale height not exceeding 15 mm.

Photograph 21 - Class 4 scaled wheel

Action Required:

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:

- scale height 1 mm up to 5 mm:- 25 km/h maximum
- scale height greater than 5 mm up to 10 mm:- 15 km/h maximum
- scale height greater than 10 mm 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:

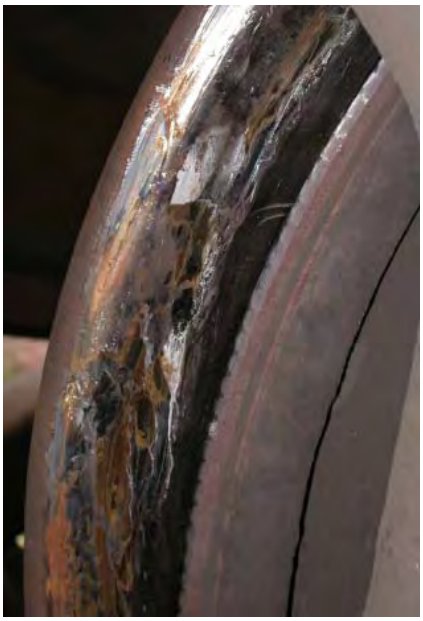
- the scale build-up has been completely removed by grinding, chiselling, etc.; or
- a wheelset/bogie change; or
- the fitting of a pony bogie. If a pony bogie is fitted, the vehicle shall then be transferred to the nearest depot in accordance with section 9.

Upon reaching the depot/workshop, an abrasive brake block may be used to clean the tread and restore it to unrestricted operation as per ESR 0315 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.

Speed Restriction: 25 km/h, 15 km/h or 5 km/h – see above.

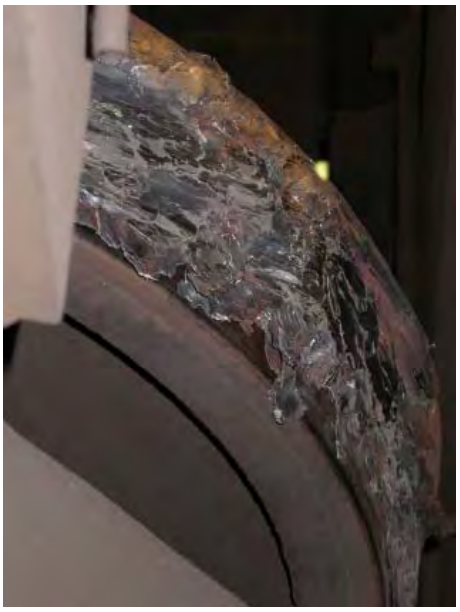
7.7.3 Class 5 scaled wheels

Scale height greater than 15 mm.



Photograph 22

Class 5 scaled wheel



Photograph 23

Class 5 scaled wheel (extreme)

Note: scale over the flange

Action Required:

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 9.

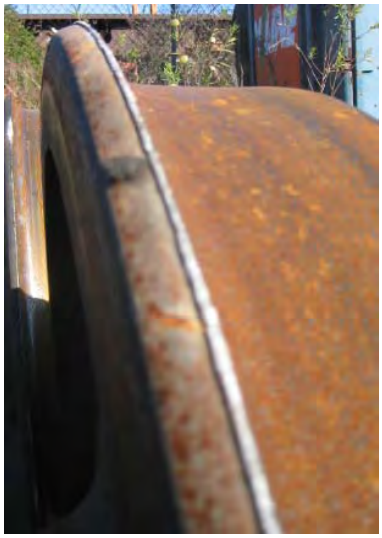
Bogies which have had wheels with class 5 scale must have their running gear thoroughly examined for evidence of loose or adrift components particularly in the axlebox and traction motor areas. Bearings shall be rumble tested and visually inspected with the removal of the front cover or gas plug. The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

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

Speed Restriction: Vehicle not to be moved.

7.8 Arrises

An aris is formed when flange metal has rolled towards the tip of the flange causing a step with a sharp point at the flange tip.



Photograph 24

View of arris from outside of wheel

Photograph 24

Wheel with arris (note flange wear)

7.8.1 Class 1 arris

This classification is not relevant.

7.8.2 Class 2 arris

A class 2 arris is less than or equal to 1.5 mm high.

Action Required:

No action required for a wheel with a class 2 arris.

Note: A class 2 arris in conjunction with a steep flange is a class 4 defect.

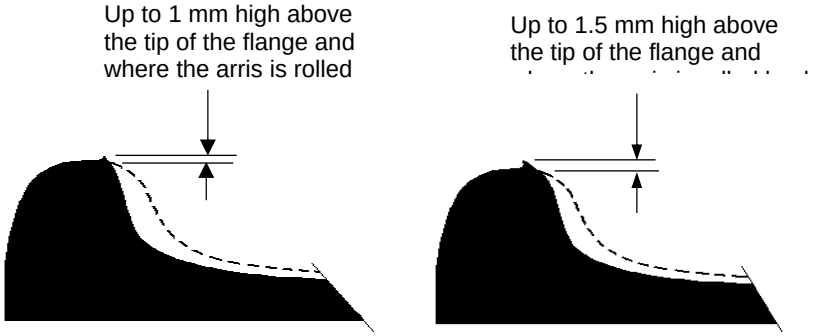


Figure 11 - Class 2 arris

Speed Restriction: No speed restriction.

7.8.3 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.

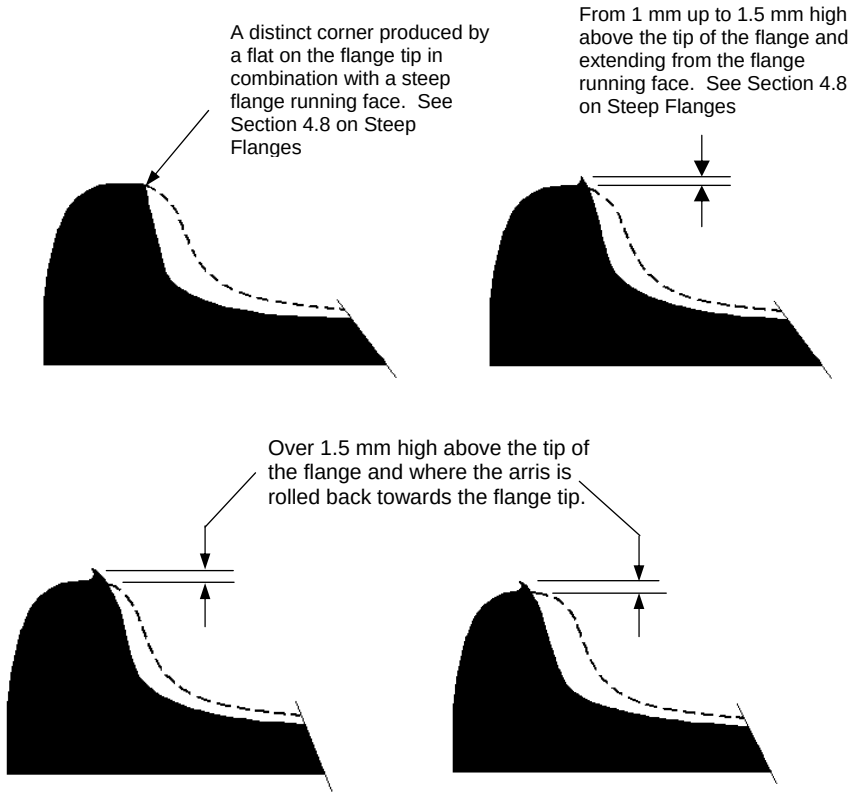


Figure 12 - Class 3 arris

Note: A class 2 or greater arris in conjunction with a steep flange is a class 4 defect.

Action Required:

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 at the location to allow vehicle movement as per a lower classification of defect.

Speed Restriction: No speed restriction.

7.8.4 Class 4 arris

The combination of a near vertical flange running face and an arris greater than 1.5 mm high can split incorrectly housed points and result in a derailment.

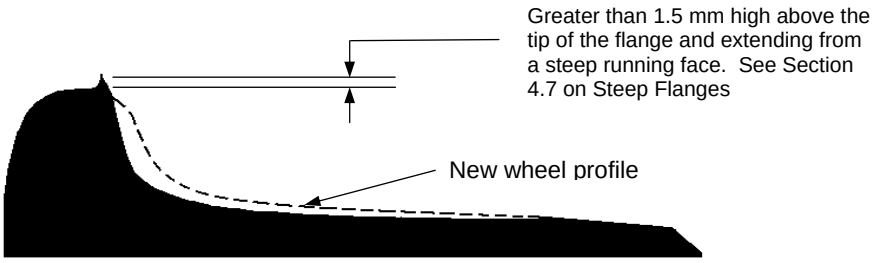


Figure 13 - Class 4 arris

Note: A class 2 arris in conjunction with a steep flange is a class 4 defect.

Action Required:

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 at the location to allow vehicle movement as per a lower classification of defect. The arris may be ground off for a permanent measure.

Speed Restriction: 40 km/h.

7.9 Tread/flange wear

7.9.1 Steep flanges

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

Note: Class 2 steep flange, class 3 steep flange, class 4 steep flange and class 5 steep flange classifications are not relevant.

A steep flange in conjunction with a class 2 arris is a class 4 defect as per section 7.8.4.

7.9.1.1 Class 1 steep flange

Action Required:

No action required.

Speed Restriction: No speed restriction for any vehicle with steep flanges where not associated with an arris.

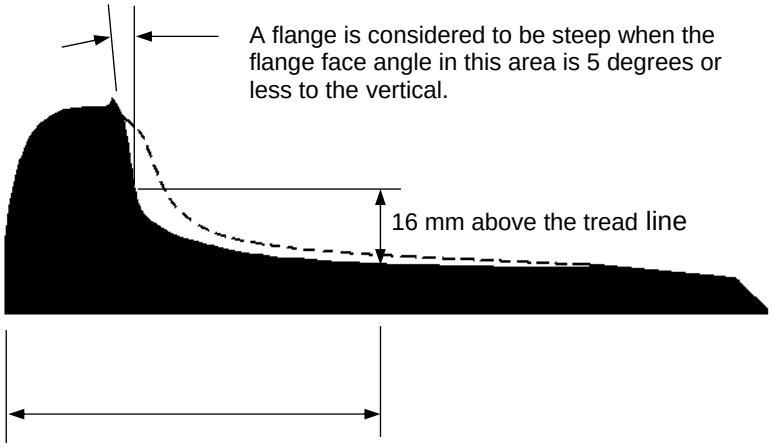


Figure 14 - Steep flange

7.9.2 High flanges

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

Note: Class 1 high flange, class 2 high flange, class 4 high flange and class 5 high flange classifications are not relevant.

7.9.2.1 Class 3 high flange

High flanges exceed a height of 35 mm.

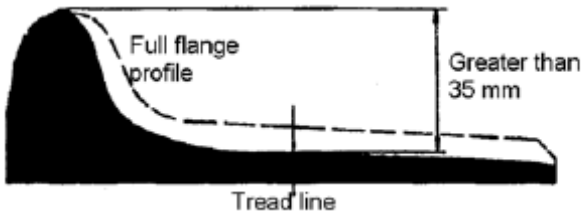


Figure 15 Class 3 high flange

Action Required:

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.

Speed Restrictions: No speed restriction for any vehicle with high flanges.

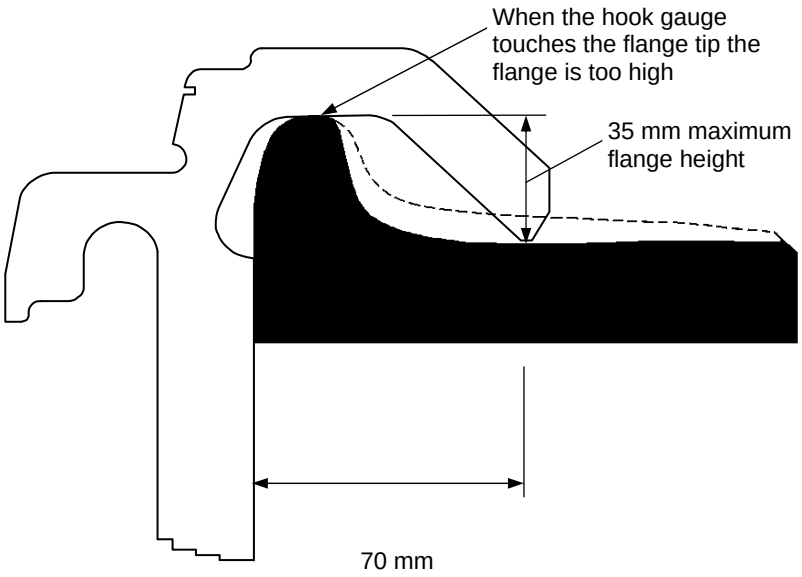


Figure 16 - Application of flange height gauge

Refer to Figure 18 for flange height and thin flange gauge

7.9.3 Hollow tread

A visual examination of the wheel will be necessary to determine if a hollow tread is evident.

Note: Class 1 hollow tread, class 2 hollow tread, class 4 hollow tread and class 5 hollow tread classifications are not relevant.

Photograph 25 Tread wear showing hollow tread

7.9.3.1 Class 3 hollow tread

The maximum permissible tread hollowing is 3 mm nominal, as determined using the wheel gauge as shown in Figure 11. Refer to Figure 20 for wheel hollow tread gauge.

Action Required:

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.

Speed Restrictions: No speed restriction for any vehicle with a hollow tread.

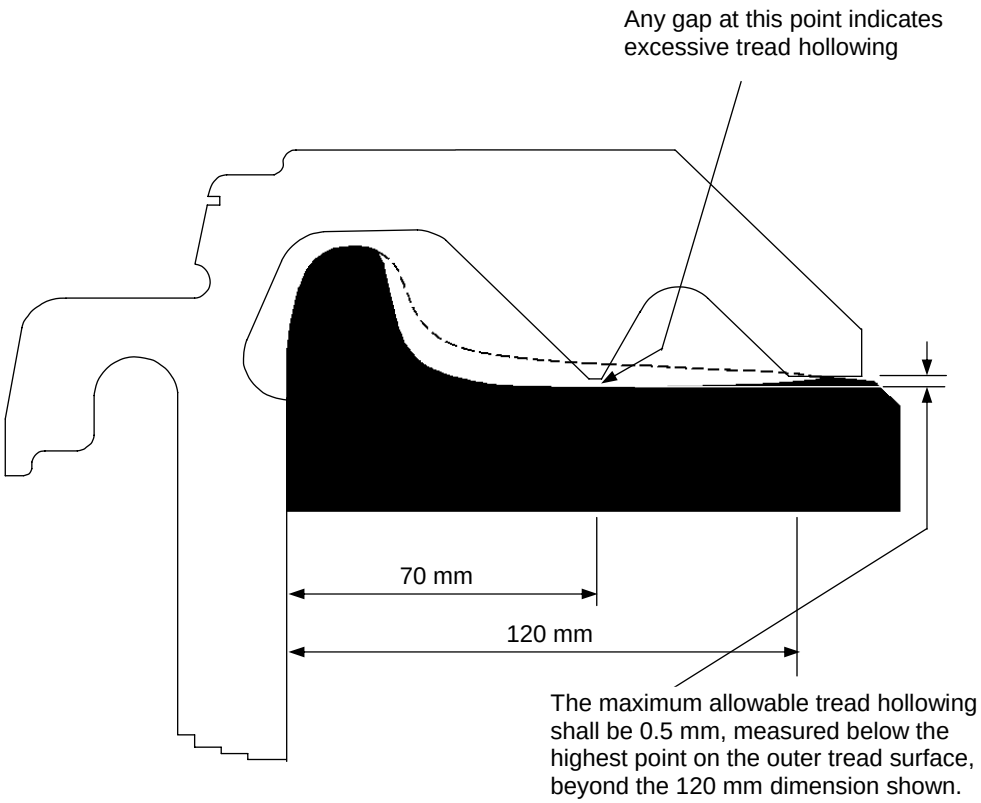


Figure 17 - Application of hollow tread gauge

7.9.4 Thin flanges

A visual examination of the wheel will be necessary to determine if a thin flange is evident.

Note: Class 1 thin flange, class 2 thin flange, and class 3 thin flange classifications are not relevant.

7.9.4.1 Class 4 thin flange

The minimum allowable flange thickness is 19 mm.

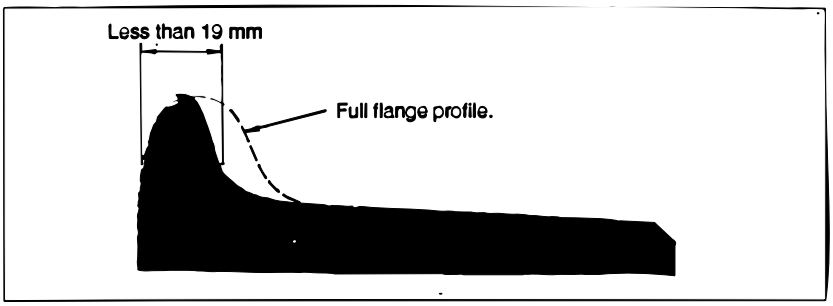


Figure 18 - Thin flange

The recommended method for detecting a thin flange is using a flange height and thin flange gauge. (see Figure 18) A thin flange will be detected when the end of the gauge touches the tread surface of the wheel.

Action Required:

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, 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.

Speed Restrictions: 40 km/h

7.9.4.2 Class 5 thin flange

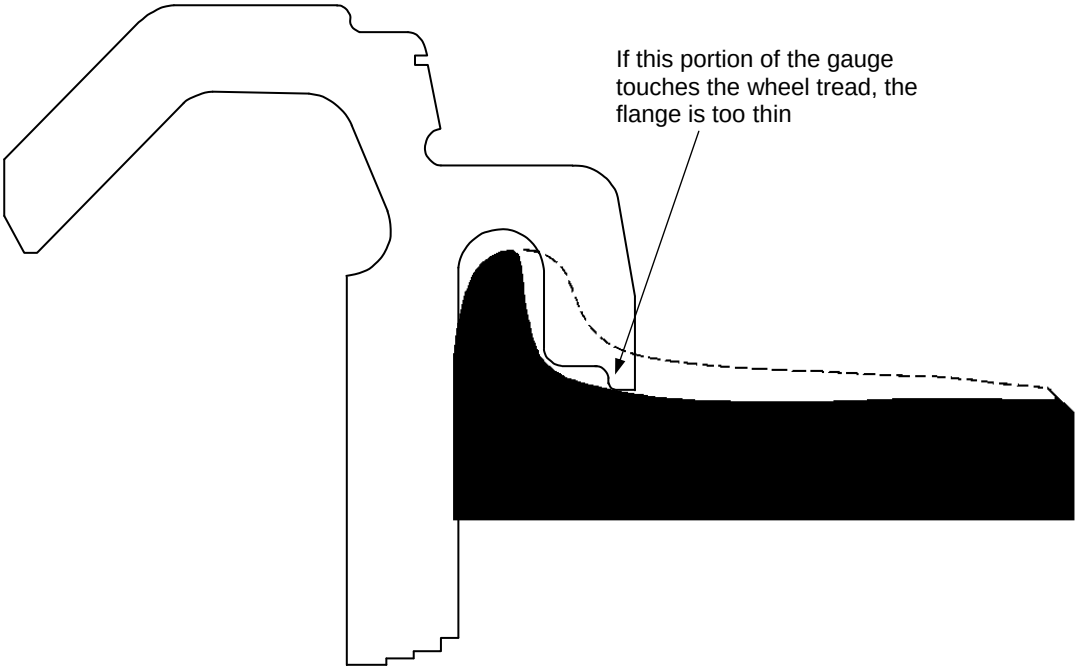


Figure 19 - Application of thin flange gauge

Refer to Figure 18 for flange height and thin flange gauge

Action Required:

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

Speed Restrictions: Vehicle not to be moved.

7.9.5 Short flange

A visual examination of the wheel will be necessary to determine if a short flange is evident.

Note: Class 1 short flange, class 2 short flange, class 4 short flange, and class 5 short flange classifications are not relevant.

7.9.5.1 Class 3 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.

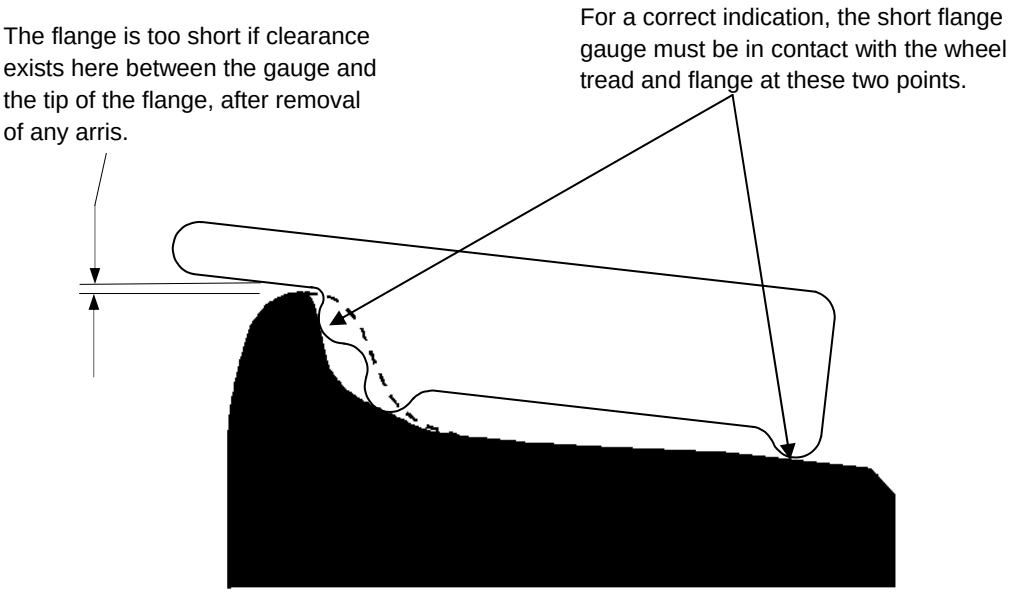


Figure 20 - Application of short flange gauge

Action Required:

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.

Speed Restrictions: No speed restriction for any vehicle with a short flange.

Refer to Figure 20 for short flange gauge.

7.10 Damaged wheels

7.10.1 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.

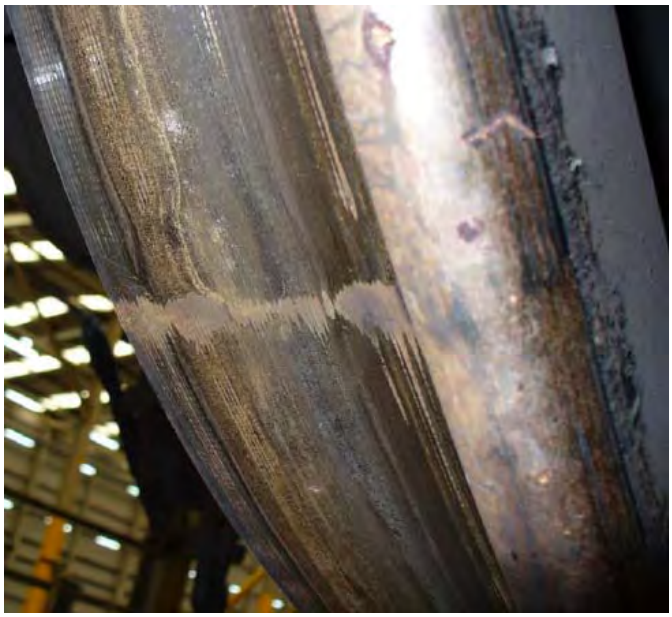
W37 type freight wheels originating in New South Wales, (these are fitted with 18R or 9R axleboxes), are particularly prone to manufacturing defects and should be specifically examined for cracks. Although this type of wheel has essentially been phased out of service, some wheels may still be in service.

Action Required:

Any crack originating from a manufacturing defect shall be classified as a class 4 or greater defect (see clause 7.10.4).

Speed Restrictions: 40 km/h.

Photograph 26 badly turned wheel resulting incorrect turning process



Photograph 27 badly turned wheel resulting incorrect mill feed

Photograph 28 badly turned wheel resulting from impact from foreign object

Photograph 29 badly turned wheel resulting from impact from foreign object

7.10.2 Out of round wheels

One type of machining defect is wheels that have been turned out of round, for example, if the mill cutter has not been fed in correctly or the wheel tread has not been turned concentric to the axle centre.

Out of round wheels (≥ 0.3 mm) have been detected on the WILD (wheel impact load detector) sites.

Action Required:

These wheels must be returned to the wheel lathe and returned.

Speed Restrictions: 40 km/h.

7.10.3 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.

Action Required:

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 clause 7.10.4).

Speed Restrictions: 40 km/h.

7.10.4 Class 4 manufacturing defect or 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.

Action Required:

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.

Speed Restriction: 40 km/h.

7.10.5 Overheated wheels

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.

Action Required:

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 shall then be repaired (bogie/wheelset change) at the location where the defect was found.

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.

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

Speed Restrictions: 40 km.h.

7.11 Miscellaneous

7.11.1 Misaligned brake gear

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

7.11.1.1 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.

Action Required:

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 standard.

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

If a shoulder has worn on the edge of the brake block face, then action shall be as per clause 7.11.1.2.

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.

Speed Restrictions: No speed restriction.

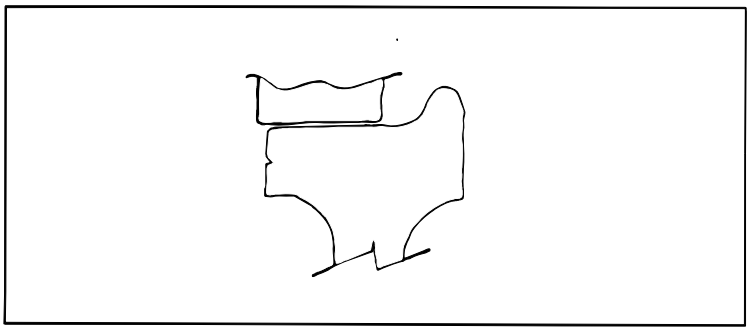


Figure 21 - Example of temporary overhanging brake block

7.11.1.2 Permanent brake block overhang.

An overhanging brake block is 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.

Action Required:

The vehicle shall not be permitted to enter service until the matter is rectified

Speed Restrictions: Vehicle not to enter service.

Figure 16 - Example of permanent brake block overhang

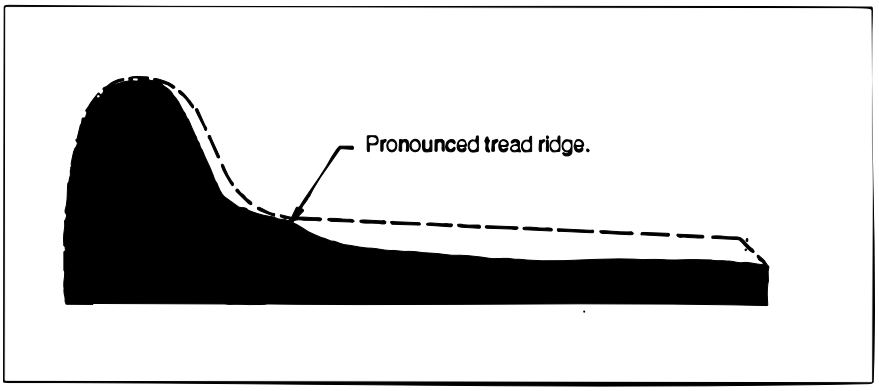


Figure 22 - False flange due to brake block overhang

7.11.2 Weld repairs of wheel skids

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 section 7.6.5. Refer to ESR 0334 for Welding of skidded wheels in situ.

After weld repair the vehicle must proceed directly to the nearest repair facility for wheelset change or reprofiling.

A suitable weld procedure must be developed for the repair.

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.

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.

7.11.3 Wheel tread profile remachining

7.11.3.1 Surface finish

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 12.5 µm (micrometres) RA (Roughness Average).

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.

7.11.3.2 Witness marks

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

7.11.3.3 Tolerance

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.

7.11.4 Examination of tyred wheels in service

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

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

8 Wheel gauges

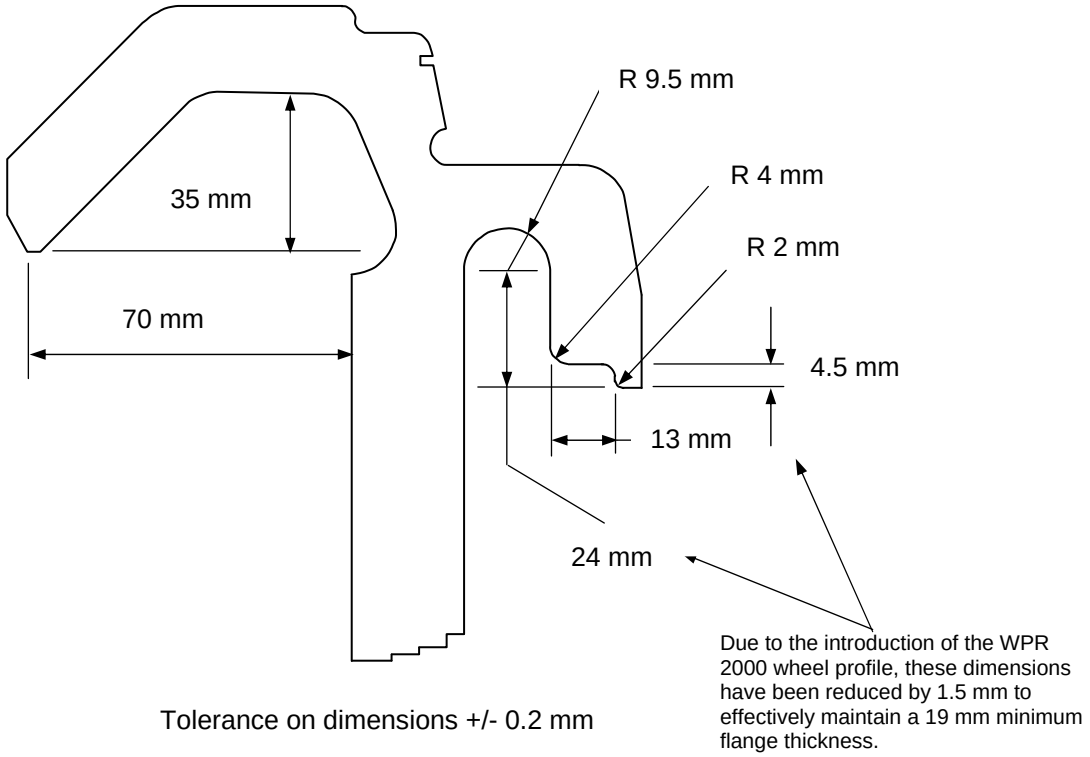


Figure 23 Flange height and thin flange gauge – controlling dimensions

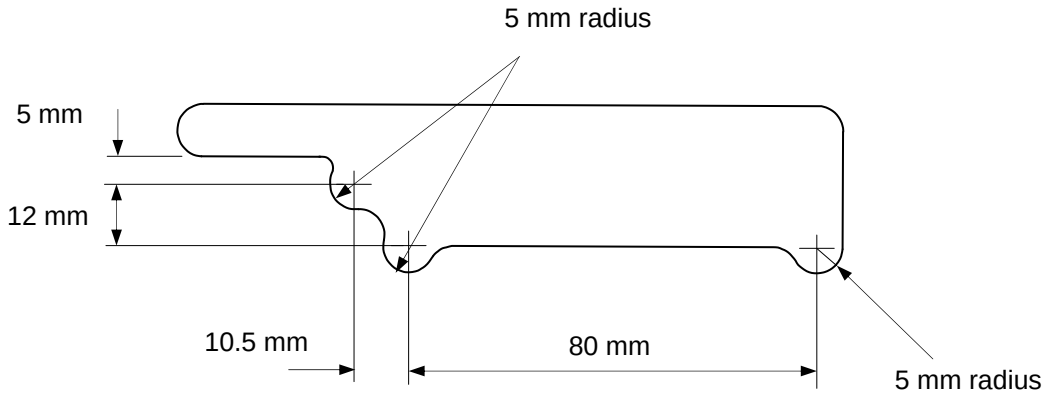
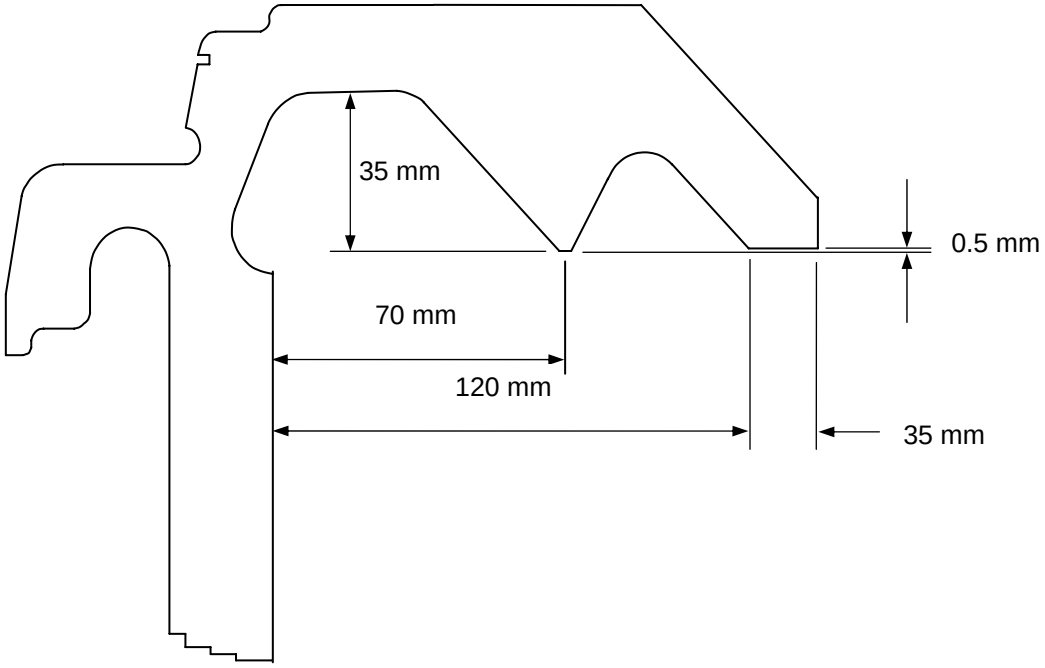


Figure 24 Short flange gauge - controlling dimensions



Tolerance on dimensions marked * +/- 0.1 mm

Tolerance on other dimensions +/- 0.2 mm

Figure 25 Hollow tread gauge – controlling dimensions

9 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.

Photograph 30 Pony bogie assembled and in position

Note: A pony bogie is used to move a Class 5 defect.

Appendix A Quick reference tables of wheel defects and actions

Table 1 – Thermal cracks

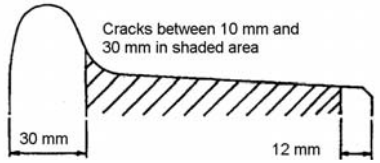
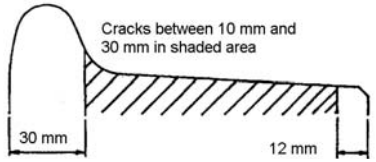
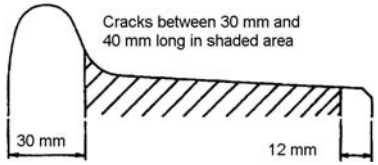
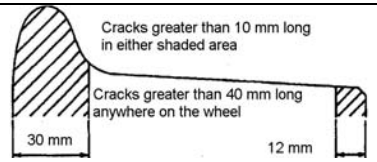
Class	Description of defect	Action required	Speed restriction
1		No action required	Normal speed
2		Re-examine carefully to ensure that no class 3 thermal cracks exist. Defects must be reported	**Normal speed**
3		If wheel is approaching condemning diameter, treat as class 4 defect. **Locomotives & passenger vehicles:** Defects must be recorded and scheduled for turning within 14 days. For EMU's, turning may be deferred provided inspections monitor cracks before reaching class 4. **Wagons:** Green card "For Repairs"	**Normal speed**
4		If found pre-trip or at a depot, the wheel must not enter service. If found en-route continue at reduced speed with the brakes cut out.	**Speed 40 km/h Maximum**
5	**Fractured Wheel** Any crack running through the rim, web or boss of wheel	Examine defect in the section before movement to the nearest siding at the speed nominated by the attending maintenance officer.	**NOT TO MOVE** until wheel inspected

Table 2 – Spalling			
Class	**Description of defect**	**Action required**	**Speed restriction**
1	Spalled regions less than 12 mm in diameter. Maximum 10% wheel coverage	No action required	**Normal speed**
2	Spalled regions less than 25 mm in diameter. Maximum 20% wheel coverage	Re-examine carefully to ensure that no Class 3 Spalls exist. Defects must be reported	**Normal speed**
3	Spalled regions greater than 25 mm in diameter. Sharp and jagged. Maximum 50% wheel coverage	Locomotives & passenger vehicles: Defects must be recorded and scheduled for turning within 14 days. Wagons: Green card “For Repairs”	**Normal speed**
4	Extensive spalling 3 mm or more deep, sharp and jagged. More than 50% wheel coverage.	If found pre-trip or at a depot, the wheel must not enter service. If found en-route continue at reduced speed with the brakes cut out.	**Speed 40 km/h maximum**

Table 3 – Skidded wheels (flats)			
Class	**Description of defect**	**Action required**	**Speed restriction**
1	Single skid length less than 25 mm.	No action required	**Normal speed**
2	Single skid length between 25 mm and 40 mm OR multiple class 1 skids.	Re-examine carefully to ensure that no Class 3 Skids exist. Defects must be reported	**Diesel and electric passenger trains:** 115 km/h operation **Other trains:** 80 km/h operation
3	Single skid length between 40 mm and 60 mm OR multiple class 2 skids.	**Locomotives & passenger vehicles**: Defects must be recorded and scheduled for turning within 14 days. **Wagons:** Green card "For Repairs"	**Speed 40 km/h maximum**
4	Single skid length between 60 mm and 100 mm OR multiple class 3 skids.	If found pre-trip or at a depot, the wheel must not enter service. If found en-route continue at reduced speed with the brakes cut out.	**Speed** **25 km/h maximum**
5	Single skid length greater than 100 mm or multiple Class 4 Skids.	Rectify defect in the section before movement to the nearest siding at a speed nominated by the attending maintenance officer.	**NOT TO MOVE** **until wheel is rectified**

Table 4 – Scaled wheels

Class	Description of defect	Action required	Speed restriction
1 & 2	Classification not relevant.	No action required	**Normal speed**
3	Light surface smearing too small to measure with a standard rule.	Examine brake gear for defects.	**Normal speed**
4(i)	Scale height from 1 mm to 5 mm.	If found pre-trip or at a depot, the wheel must not enter service. If found en-route, clear the section at reduced speed with brakes cut out.	**Speed 25 km/h maximum**
(ii)	Scale height greater than 5 mm up to 10 mm.		**Speed 15 km/h Maximum**
(iii)	Scale height greater than 10 mm up to 15 mm.		**Speed 5 km/h maximum**
5	Scale height greater than 15 mm.	Rectify defect in the section before movement to the nearest siding at a speed nominated by the attending maintenance officer.	**NOT TO MOVE until wheel is rectified**

Table 5 – Arrisses

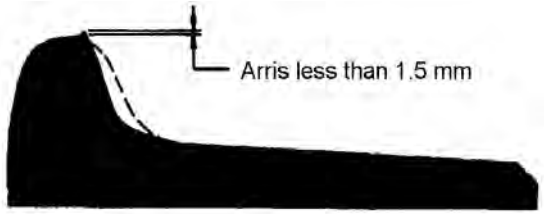
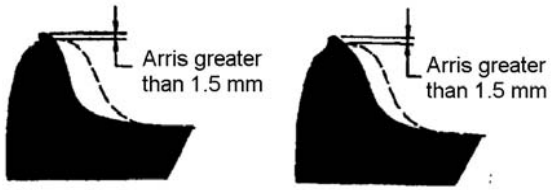
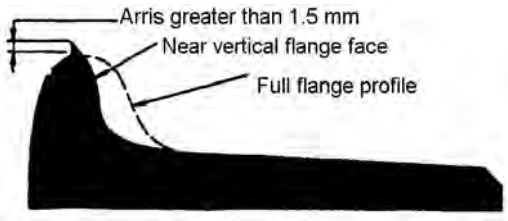
Class	Description of defect	Action required	Speed restriction
1	Classification not relevant.	No action required	**Normal speed**
2		No action required	**Normal speed**
3		**Locomotives & passenger vehicles:** Defects must be recorded and scheduled for turning within 14 days. **Wagons:** Green card “For Repairs”	**Normal speed**
4		If found pre-trip or at a depot, the wheel must not enter service. If found en-route continue at reduced speed with the brakes cut out.	**Speed 40 km/h Maximum and 25 km/h over points, cross-overs & turnouts.**

Table 6 – Tread/flange wear

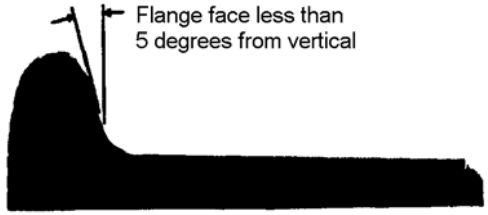
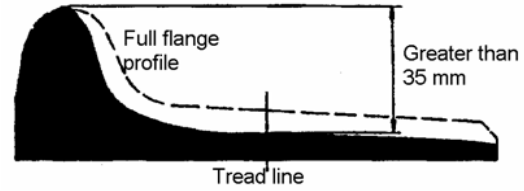
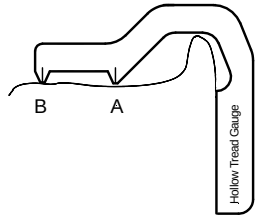
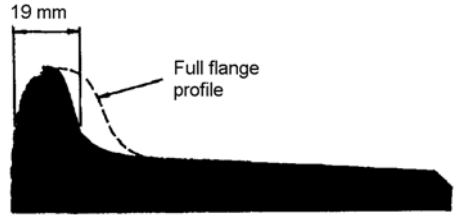
Class	Description of defect	Action required	Speed restriction
1 **Steep flanges**		Examine bogie and check wheel diameters for possible cause of steep flanges. **NOTE:** A Steep Flange in conjunction with a Class 2 Arris is a Class 4 defect, treated as per Class 4 Arris.	**Normal speed**
3 **High flanges**		**Locomotives & passenger vehicles:** Defects must be recorded and scheduled for turning within 14 days. **Wagons:** Green card “For Repairs”	**Normal speed**
3 **Hollow tread**		**Locomotives & passenger vehicles:** Defects must be recorded and scheduled for turning within 14 days. **Wagons:** Green card “For Repairs”	**Normal speed**
4 **Thin flanges**		If found pre-trip or at a depot, the wheel must not enter service. If found en-route, flanges up to a minimum of 18mm may continue at reduced speed with the brakes cut out and any arris removed.	**Speed 40 km/h Maximum**

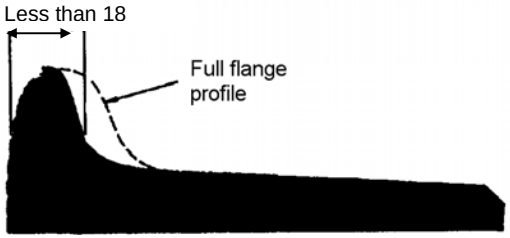
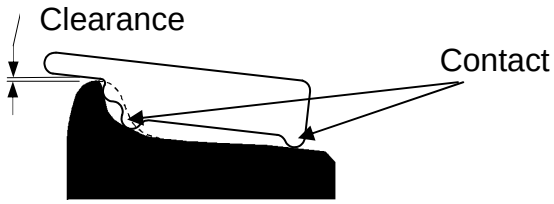
Table 6 – Tread/Flange Wear (continued)			
Class	**Description of Defect**	**Action Required**	**Speed restriction**
5 **Thin flanges**		Flanges with thickness less than 18mm must be removed from service immediately.	**NOT TO MOVE until wheel is replaced or Pony Bogie used.**
3 **Short flanges**		**Locomotives & passenger vehicles:** Defects must be recorded and scheduled for turning within 14 days. **Wagons:** Green card “For Repairs”	**Normal speed**

Table 7 – Damaged Wheels

Class	Description of defect	Action required	Speed restriction
4	**Fatigue cracks** Solitary cracks that usually have propagated from a manufacturing defect.	If found pre-trip or at a depot, the wheel must not enter service. If found en-route continue at reduced speed with the brakes cut out.	**Speed 40 km/h maximum**
	Manufacturing defects Include those that: i) degenerate into fatigue cracks in the wheel web; and ii) cause large portions of the flange to break away from the wheel.		
	External wheel damage generally results from heavy impact loads on the wheel which may show up as a chip or gouge in the flange or as a bruise on the tread.		
5	**Fractured wheel** Any crack running through the rim, web or boss of the wheel.	Examine defect in the section before movement to the nearest siding at a speed nominated by the attending maintenance officer.	**NOT TO MOVE until wheel has been inspected**