Tram Wheel Inspection and Defects Standard

Engineering Standard

ENG-ENS-NIL-0026

Document Control

Table 1: Torrens Connect Document Control

V	Date	Description of Change	Review	Accountable	Endorse
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Definitions

Table 2: Definitions

Term	Definitions
AMPRN	Adelaide Metropolitan Passenger Rail Network
DIT	Department for Infrastructure and Transport
PM	Preventative Maintenance
RISSB	Rail Industry Safety and Standards Board
Tram	A light passenger rolling stock vehicle which runs on tracks, along both public urban streets, and dedicated separate rights of way.

1 Introduction

The Department for Infrastructure and Transport (DIT) owns the Rolling Stock and Infrastructure assets that comprise the Adelaide Metropolitan Passenger Rail Network (AMPRN). Torrens Connect maintain and operate the Trams on behalf of DIT. This standard forms part of the Engineering Management system used to ensure safety and customer service levels are efficiently and effectively supported.

2 Purpose

The purpose of this document is to provide technical information about Tram wheel data, defects classifications and wheel inspection.

This document sets the minimum wheel profile standard, allowable defects, and response criteria.

3 Scope

This standard applies to the following Tram Rolling Stock, operating with the Modified Glenelg Tram Profile (MGTP);

- Bombardier Flexity Classic (101-115)
- Alstom Citadis 302 Class (201-209)

This standard applies to staff working in:

- Torrens Connect Rail Engineering and Maintenance functional areas
- Torrens Connect Rail Operations functional areas
- Torrens Connect contractors to the extent specified in their contract.

4 References

- Rail Safety National Law (South Australia) Act 2012
- P-3-104886 Flexity Classic Adelaide Profile
- PBE-03-00041586 Citadis Adelaide Wheel Profile
- RS2-DRG-3000001 Modified Glenelg Tram Profile (MGTP) Condemn Gauge
- ENG-WIN-NIL-0054 MiniProf Wheel Profile Work Instruction
- ENG-WIN-NIL-0058 Visual Inspection of Wheel Condition
- RISSB Code of Practice – Wheel Defects v1.2 (2 August 2013)

5 Standard Terminology for Tram Wheel Features

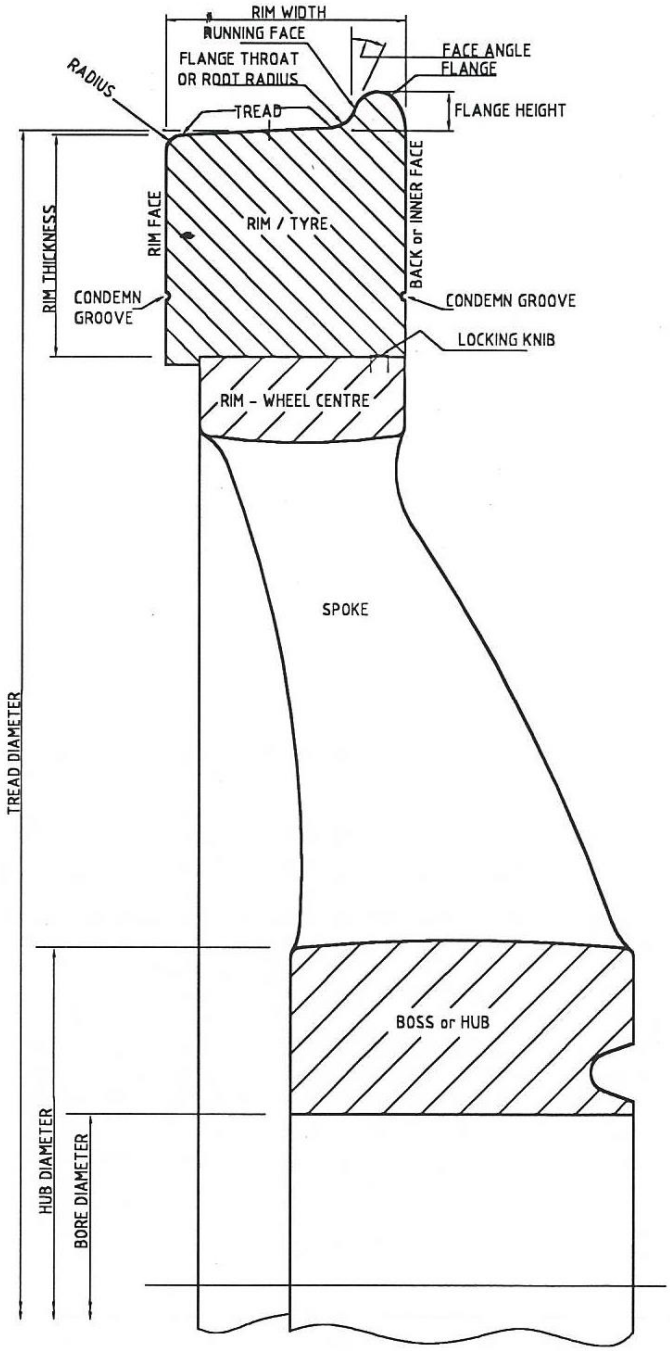
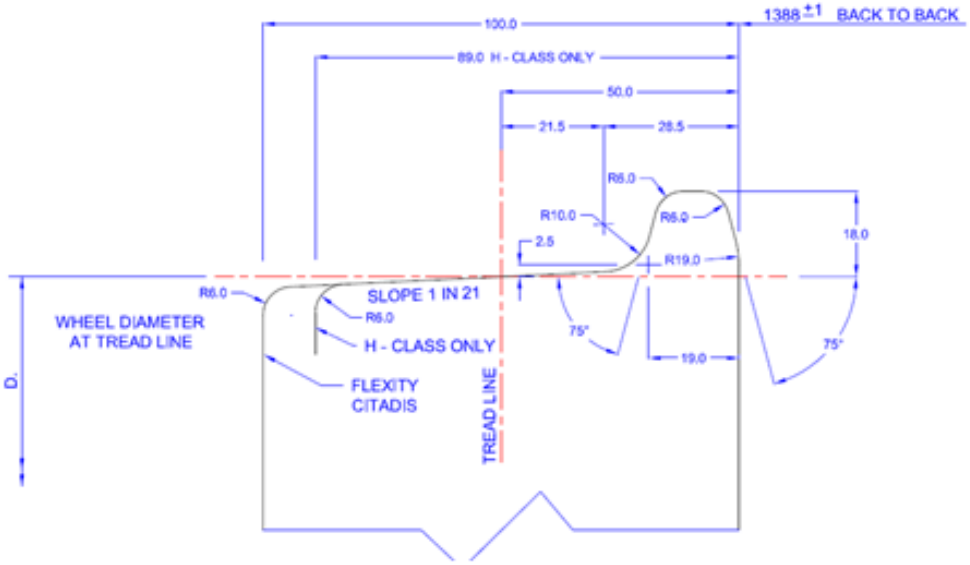


Figure 1: Half Section through Wheel – Typical

6 Tram Wheel Profile



D - WHEEL DIAMETER AT TREADLINE	
FLEXITY	600^{+3}_{0}
CITADIS	590 ± 1.5

NOTE: MACHINING SURFACE FINISH - 6.3 ✓

Figure 2: MGTP – Wheel Profile RS2-DRG-300000

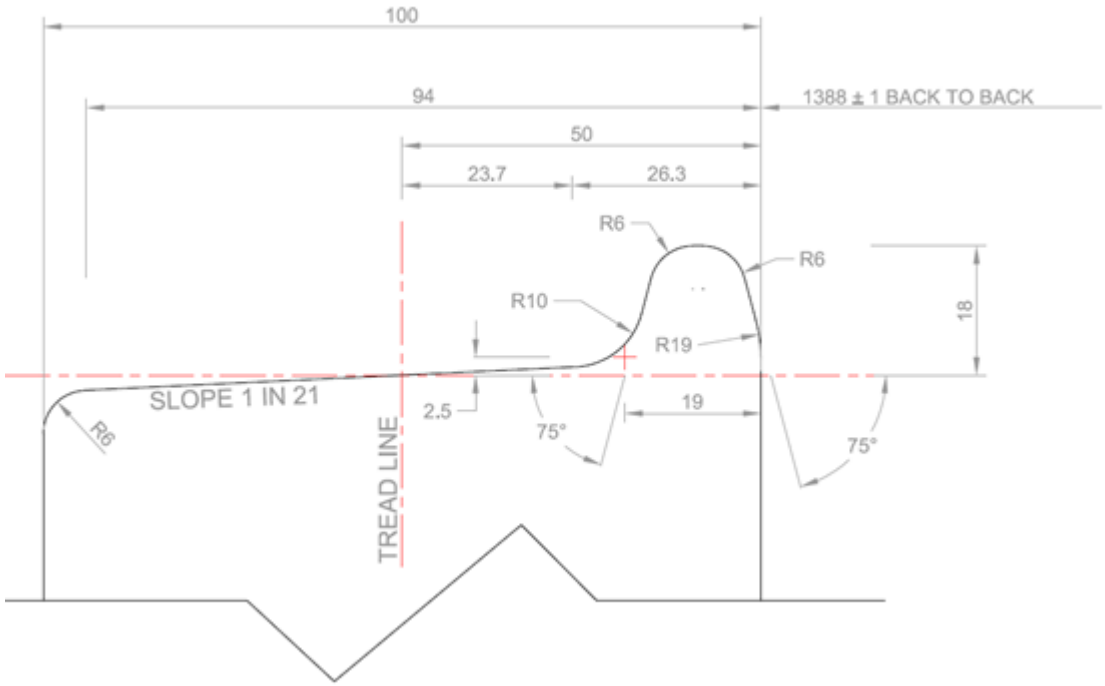


Figure 3: 7/8 MGTP – Wheel Profile RS2-DRG-300034

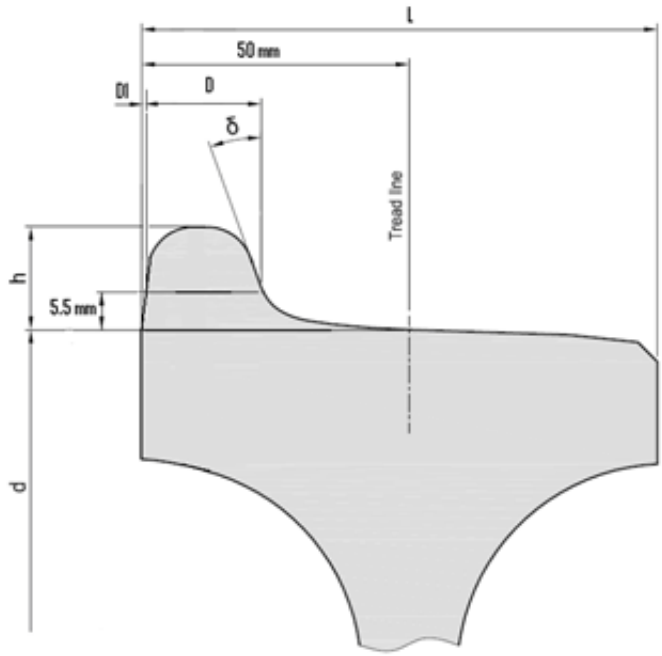
7 Wheel Inspection

Wheels shall be inspected in accordance with this Standard for profile, flange, tread and rim non-conformances and general physical condition. Inspection shall also be carried out to detect various wheel defects such as:

- Thin flange
- Steep flange
- Back flange wear
- Tread hollowing
- Flange defects
- Tread defects
- Out-of-round wheels
- Fractured wheels
- Overheating
- Displaced / loose tyre

The figure below shows the locations for limiting dimensions. It shows the unworn profile but is also applicable for worn profiles.

The Condemn Gauge is shown in Appendix 1. Every gauge shall be traceable, calibrated annually and must be stamped with gauge type and serial number.



d: Wheel diameter
D: Flange width / thickness
D1: Flange back wear
L: Rim width
h: Flange height
δ: Flange angle

Figure 4: Wheel profile critical dimensions

8 Wheel Turning (Machining)

Wheel turning is performed to remove defects and to ensure wheels remain within condemn limits.

Wheel shall be scrapped if any of defects in accordance with Sections 9 and 10 cannot be machined out during wheel turning.

Wheel may be turned to full MGTP or 7/8 MGTP profile. Historically wheel may be turned to 7/8 profile at the last turn only. However, sometimes it is difficult to form the required flange profile at the last turn. This difficulty can be overcome by turning wheel to 7/8 profile in normal service before the last turn as determined by the Rolling Stock Reliability Engineer or delegate.

Wheel shall not be turned with a diameter less than 529mm. This is to allow for full-service life to be utilised before condemning on diameter.

Planned wheel turning shall take place every 50,000 km.

9 Wheel Profile Limits

The Tram wheel profile shall be inspected for the following:

- Thin flange
- Worn back flange
- Steep flange
- High flange
- Small tread diameter
- Tread hollowing
- Wheel defects

9.1 Inspection Frequency

Tram wheels shall be inspected in accordance with the schedule shown in Table 3 and by a qualified person deemed to be competent in wheel inspection.

Rail Wheel Class	Visual Inspection	Detailed Inspection
Flexity	At every service	First inspection at 50,000 km from renewed profile and every service after
Citadis	At every service	

Table 3: Frequency for Visual and Detail inspection

9.1.1 Visual Inspection

The wheel profile shall be inspected visually against the wheel profile limits and defect criteria described in this standard by walking under the Tram at the Maintenance Depot. The Condemn Gauge (Appendix 1) should be used where the visual inspection indicates a potential defect. Visual inspection shall be conducted at the following frequencies;

- Flexity – At every scheduled service in accordance with the Torrens Connect PM schedule which is every 12 weeks.
- Citadis – At every scheduled service in accordance with the Torrens Connect PM schedule which is every 16 weeks.

9.1.2 Detailed Inspection

The wheel profile shall be measured using the MiniProf - Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0058, or the Calipri C41 at the following frequencies;

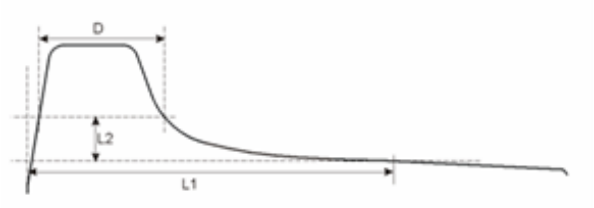
- Flexity – at 50,000 km from renewed profile and then at every minor service after i.e., every 12 weeks in accordance with Torrens Connect PM Schedule.
- Citadis – at 50,000 km from renewed profile and then at every minor service after i.e., every 16 weeks in accordance with Torrens Connect PM Schedule.

The wheel profile shall also be measured for both Flexity and Citadis Trams following any derailment or collision accident.

9.2 Flange Width

Inspection frequency for measurement of flange width shall be in accordance with Table 3 for detailed inspection.

9.2.1 Basic Measurement Configuration



D= Flange width
L1= 50 mm
L2 = 5.5 mm

Figure 5: Configuration for flange width measurement

9.2.2 Method of Measurement

Flange width shall be measured using the MiniProf -Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0054, or the Calipri C41.

9.2.3 Intervention Limits and Defects Identification

The following table shows the minimum and maximum limits for flange width dimensions for different Tram wheels and the relevant response criteria.

Tram Wheel	Minimum (mm)	Maximum (mm)	Defect Classification	Action Required	Speed Limitation
Flexity	10	20 as new	< 10 mm	Re-profile the wheels before further use.	40 km/h
Citadis	≤ 12mm			Wheel shall be inspected on a weekly basis to ensure the wheel remains within condemning limits	

Table 4: Flange Width Limits

9.2.4 Wheel Condemn Gauge – Thin Flange

Thin flange shall be confirmed using the Wheel Condemn Gauge drawing no. RS2-DRG-300001 (see Appendix 1) as follows:

- Hold the gauge horizontal and lower over the flange.
- If portion “C” touches the tread line first, then flange thickness is not acceptable.

Example below shows condemned wheel due to ‘Thin Flange’.

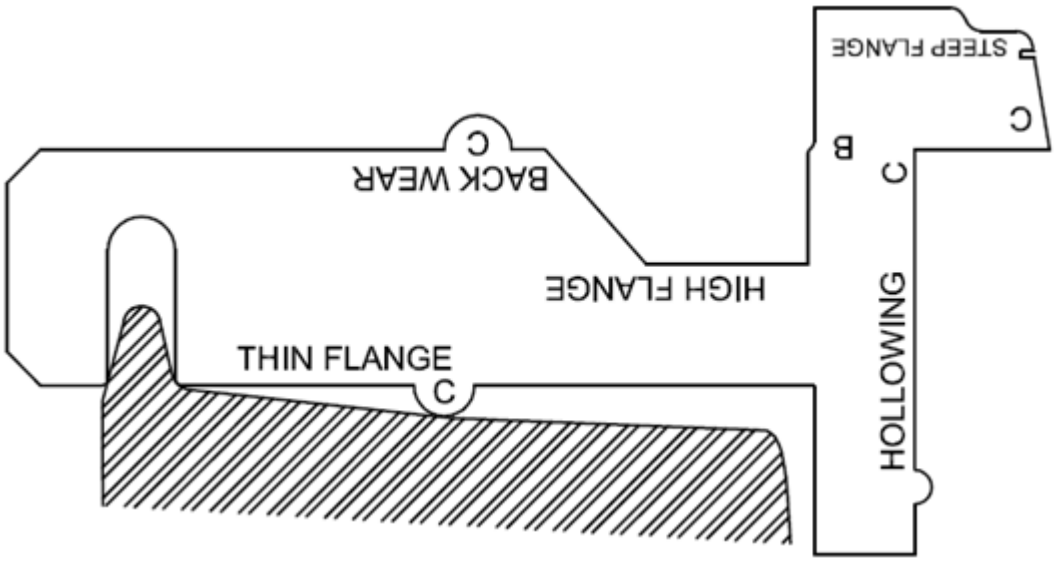
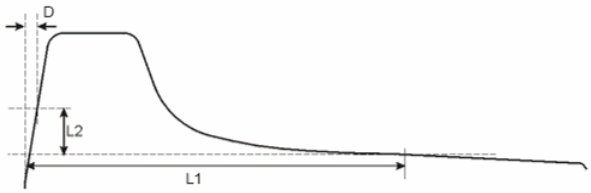


Figure 6: Wheel Condemn Gauge - Thin Flange Indication

9.3 Flange Back Wear

Inspection frequency for measurement of Flange Back Wear shall be in accordance with Table 3 for Detailed Inspection.

9.3.1 Basic Measurement Configuration



D = Flange Back Wear
L1 = 50 mm
L2 = 5.5 mm

Figure 7: Configuration for Flange Back Wear measurement

9.3.2 Method of Measurement

Flange Back Wear shall be measured using the MiniProf -Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0054 or using the Calipri C41.

9.3.3 Intervention Limits and Defects Identification

The following table shows the maximum limits for Flange Back Wear dimensions for different Tram wheels and the relevant response criteria.

Tram Wheel	Minimum (mm)	Maximum (mm)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	N/A	1.5	> 1.5 mm	Re-profile the wheels before further use.	40 km/h

Table 5: Flange Back Wear Limits

9.3.4 Wheel Condemn Gauge – Flange Back Wear

Thin flange shall be confirmed using the Wheel Condemn Gauge drawing no. RS2-DRG-300001 (See Appendix 1) as follows:

- The gauge is to be held flush against the inner face of the rim as shown in the figure below.
- If the gauge short arm “C” touches the tread before the gauge “B” contacts the back of flange, then the Flange Back Wear is NOT acceptable.

Example below shows condemned wheel due to ‘Flange Back Wear’.

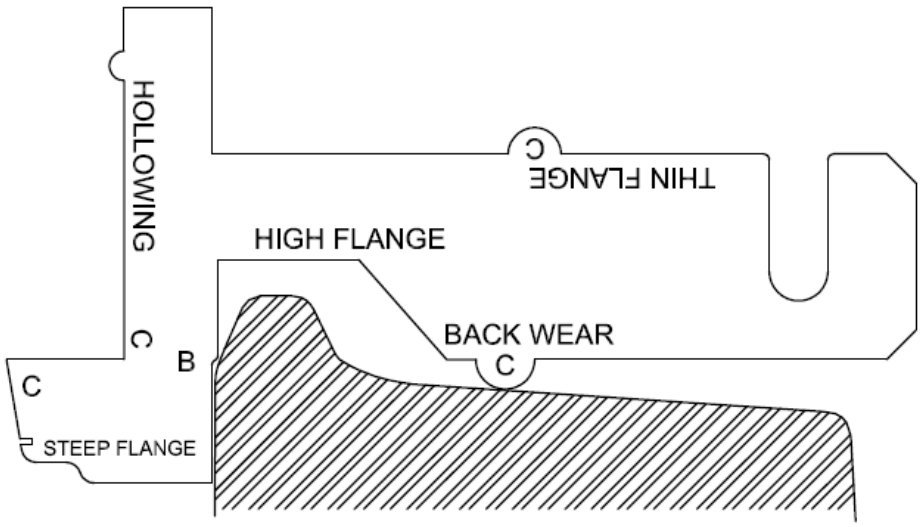
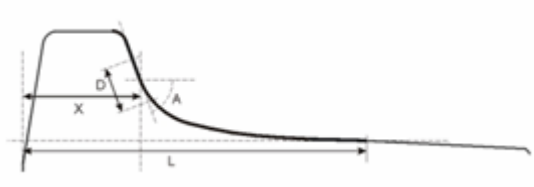


Figure 8: Wheel Condemn Gauge Drawing - Flange Back Wear indication

9.4 Flange Angle

Inspection frequency for measurement of maximum flange angle shall be in accordance with Table 3 for Detailed Inspection.

9.4.1 Basic Measurement Configuration



A= Maximum Flange Angle (°)
D = 5 mm
L = 50 mm
X = Point of maximum flange angle

Figure 9: Configuration for maximum Flange Angle measurement

9.4.2 Method of Measurement

Maximum Flange Angle shall be measured using the MiniProf -Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0054 or using the Calipri C41.

9.4.3 Intervention Limits and Defects Identification

Steep flanges may be an indication of the following problems:

- One (1) steep flange only may indicate a wheel set that has a variation in wheel diameters.
- Two (2) steep flanges on diagonally opposite corners may be caused by a crabbing effect due to side frame misalignment.
- Two (2) steep flanges on the same side may indicate mismatched side frame lengths.
- Four (4) steep flanges may indicate a hunting condition caused by worn friction wedges or side-bearers.

The following table shows the maximum limits for flange angle for different Tram wheels and the relevant response criteria.

Tram Wheel	Minimum (°)	Maximum (°)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	N/A	80	> 80°	Re-profile the wheels within 14 days Examine bogie and wheel parameters for possible cause of steep flanges	Normal Speed

Table 6: Flange Angle Limits

9.4.4 Wheel Condemn Gauge – Steep Flange

Steep Flange shall be checked with the Wheel Condemn Gauge drawing no. RS2-DRG-300001 (see Appendix 1) as follows:

- The gauge is to be held horizontal, touching the tread and running face as shown.
- An acceptable flange angle is indicated where no part of the gauge above the slot is touching the flange surface.
- If any part of the gauge above the slot at “C” touches the flange surface, the wheel has a steep flange and is NOT acceptable.

Example below shows condemned wheel due to ‘Steep Flange’.

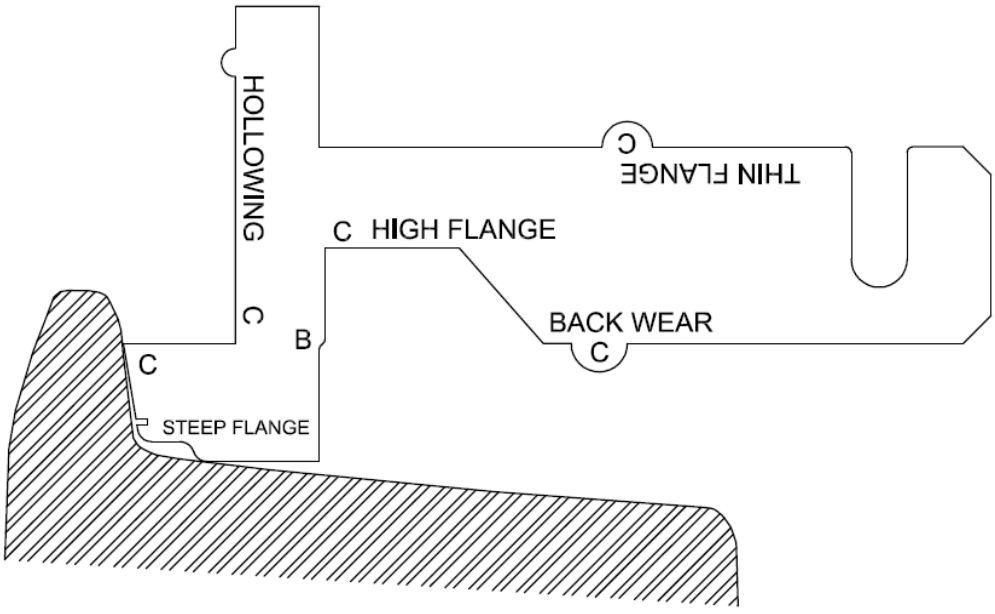
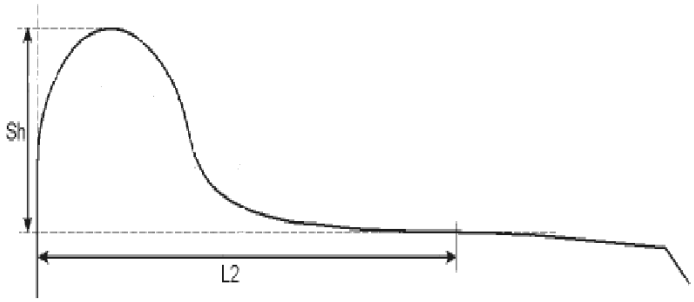


Figure 10: Wheel Condemn Gauge Drawing - Steep Flange Indication

9.5 Flange Height

Inspection frequency for measurement of Flange Height shall be in accordance with Table 3 for detailed inspection.

9.5.1 Basic Measurement Configuration



Sh = Flange Height

L2 = 50 mm

Figure 11: Configuration for flange height measurement

9.5.2 Method of Measurement

Flange Height shall be measured using the MiniProf -Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0054 or using the Calipri C41.

9.5.3 Intervention Limits and Defects Identification

The following table shows minimum and maximum limits for flange height for different Tram wheels and the relevant response criteria.

High Flange can lead to damage to track components and increase the risk of derailment.

Tram Wheel	Minimum (mm)	Maximum (mm)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	17	22	Out of Limits	Re-profile the wheels within 14 days	Normal Speed

Table 7: Flange Height Limits

9.5.4 Wheel Condemn Gauge – High Flange

Flange Height shall be checked with Wheel Condemn Gauge drawing no. RS2-DRG-300001 (see Appendix 1) as follows:

Gauge is held horizontal to the wheel and slid down against the inner wheel face. Let the gauge ride over the back flange bump on the gauge until the gauge touches at either the top of flange or the tread line.

If the gauge touches at the HIGH FLANGE point ‘C’ then the flange height is NOT acceptable.

Example below shows condemned wheel due to ‘High Flange’.

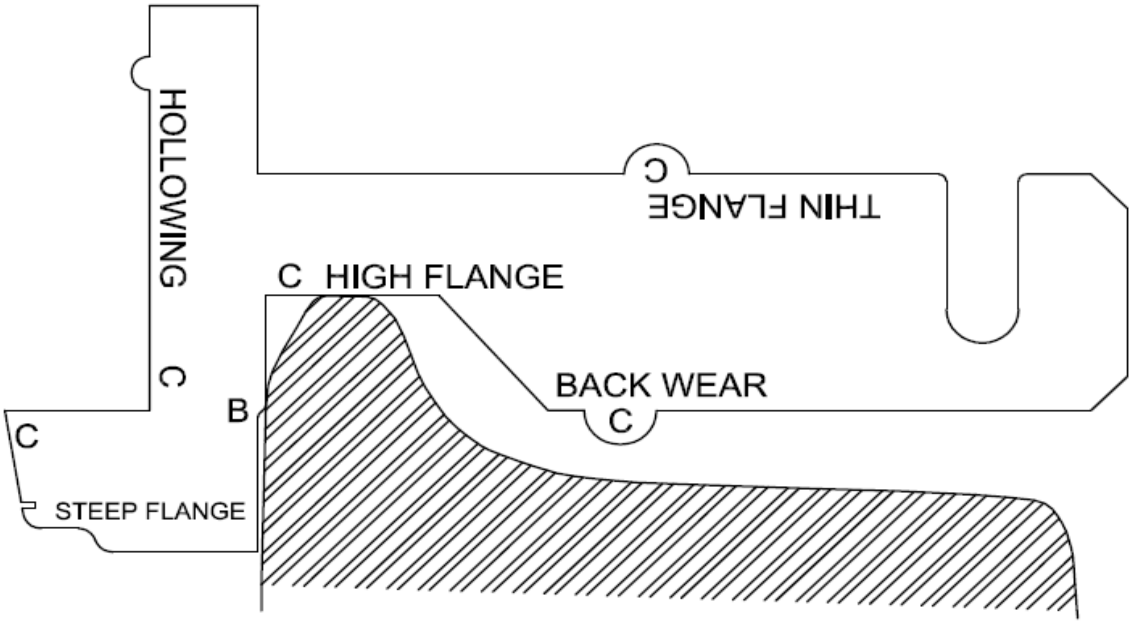
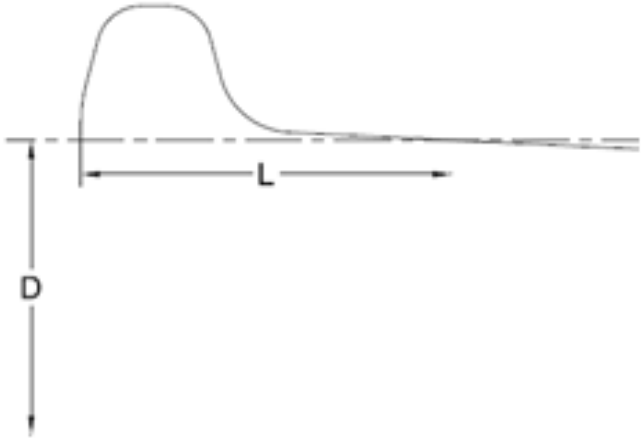


Figure 12: Wheel Condemn Gauge Drawing - Flange Height Indication

9.6 Tread Diameter

Inspection frequency for Tread Diameter shall be in accordance with Table 3 for Detailed Inspection.

9.6.1 Basic Measurement Configuration



D = Tread diameter

L = 50 mm

Figure 13: Configuration for Tread diameter measurement

9.6.2 Method of Measurement

- For in-service wheels, the Tread Diameter may be measured by referencing the condemn groove machined in the outer face of the tyre.
- For new or re-profiled wheels, the Tread Diameter is to be measured using a calibrated measuring device.

9.6.3 Intervention Limits and Defects Identification

Tram Wheel	Minimum (mm)	Maximum (mm)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	520 520	603.0 591.5	Out of limits	NOT TO RUN on AMPRN until wheel is rectified	N/A

Table 8: Tread Diameter Limits

9.6.4 Variation in Tread Diameter

Following variation shall be allowed:

	Maximum variation in tread diameter (mm)	
	New or re-profiled wheels	In service
Any axle, Wheel to Wheel	0.25	N/A
Wheelset in bogie	0.25	N/A
Bogie to bogie	No limit	

Table 9: Allowable tread diameter variance

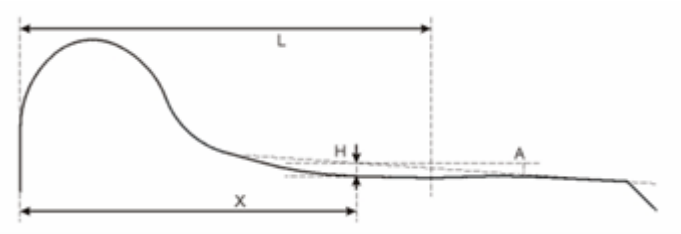
9.7 Tread Hollowing

Inspection frequency for measurement of tread hollowing shall be in accordance with Table 3 for Detailed Inspection.

Inspection of the wheel tread is necessary to determine the presence of tread hollowing. The Tread Hollowing limit is set to manage the following issues:

- Rolling contact fatigue and deformation of rail
- Damage at points & crossings
- Bogie stability and steering – resulting susceptibility to hunting and increased power consumption.

9.7.1 Basic Measurement Configuration



H = Hollowing

A = 0 °

L = 50 mm

X = Point of maximum hollowing

Figure 14: Configuration for Tread Hollowing measurement

9.7.2 Method of Measurement

Tread Hollowing shall be measured using the MiniProf -Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0054 or using the Calipri C41.

9.7.3 Intervention Limits and Defects Identification

Tram Wheel	Minimum (mm)	Maximum (mm)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	N/A	2.5	> 2.5 mm	Re-profile the wheels within 14 days	Normal speed

Table 10: Tread Hollowing Limits

9.7.4 Wheel Condemn Gauge – Tread Hollowing

The gauge Wheel Condemn Gauge drawing no. RS2-DRG-300001 (See Appendix 1 for details of this gauge)

- The gauge is to be held against the outer surface of the wheel as shown below:
- If the gauge touches the tread at HOLLOWING point ‘C’ before the touching at the tread line, then the wheel hollowing is NOT acceptable.

Example below shows condemned wheel due to ‘Tread Hollowing’.

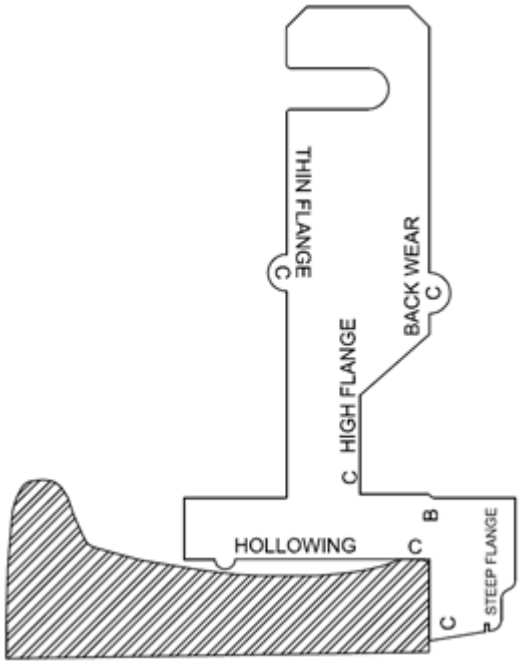


Figure 15: Wheel Condemn Gauge - Tread Hollowing Indication

9.8 Back Face to Back Face Dimension of a Wheelset

AMPRN’s Tram network gauge is 1435 mm (Standard Gauge).

Back Face to Back Face Dimension of the Wheelset shall be measured at all tyre changes and post derailments.

9.8.1 Method of Measurement

Back Face to Back Face Dimension of the Wheelset shall be measured at 120-degree intervals around the wheel disc i.e., at minimum 3 different points on wheel disc. Back Face to Back Face Dimension of the Wheelset is to be measured using a calibrated measuring device.

9.8.2 Intervention Limits and Defects Identification

The following table shows minimum and maximum limits for Back Face to Back Face Dimension of Wheelset.

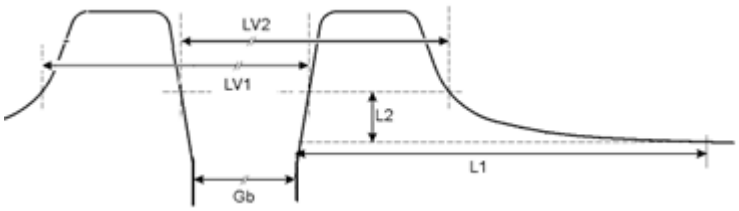
Tram Wheel	Minimum (mm)	Maximum (mm)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	1387	1389	Out of limits	NOT TO RUN on AMPRN until wheel is rectified	N/A

Table 11: Back Face to Back Face Dimension of Wheel set Limits

9.9 Back of Flange to Front of Flange Dimension of a Wheelset

Inspection frequency for Back of Flange to Front of Flange measurement of a wheelset shall be in accordance with Table 3 for Detailed Inspection.

9.9.1 Basic Measurement Configuration



L1 = 50 mm
L2 = 10.5 mm
LV2 = Back to Front Dimension
LV1 = Front to Back Dimension
Gb = Measured back face to back face dimension

Figure 16: Configuration for Back of Flange to Front of Flange measurement

9.9.2 Method of Measurement

Back of Flange to Front of Flange of opposing wheels shall be measured using the MiniProf -Wheel Profile Instrument according to the MiniProf Wheel Profile Work Instruction ENG-WIN-NIL-0054 or using the Calipri C41. This dimension shall be measured @ 10.5 mm above the tread line to coincide with track gauge measurement position.

9.9.3 Intervention Limits and Defects Identification

The following table shows the maximum limits for the Back of Flange to Front of Flange dimension measured at 10.5 mm above the tread line.

Tram Wheel	Minimum (Mm)	Maximum (Mm)	Defect Classification	Action Required	Speed Limitation
Flexity Citadis	N/A	1409	Out of limits	NOT TO RUN on AMPRN until wheel is rectified	N/A

Table 12: Back of Flange to Front of Flange dimension Limits at 10.5 mm above the tread line

10 Classification of Tram Wheel Defects

10.1 Skidded Wheels (Flats)

Skidding appears as areas of the tread where base metal has flowed leaving flat spots. Skidding occurs because the wheel is not moving while the vehicle is moving. Skidding is detected by general visual inspection of the tread surface. Skidding leads to more damage to the wheel, such as spalling and reduces the life of other rotating components like bearings. Refer to Appendix B for visual examples.

Various classification of skidded wheels is shown in Table 13:

Class	Description of Defect	Action Required	Speed Limitation
1	Single skid length of flat < 15 mm	No action required	Normal speed
2	Single skid length of flat between 15 mm & 25 mm or Multiple Class 1 skids	Closer inspection required to ensure no Class 3 skids exist. Report fault on inspection sheet.	Normal speed
3	Single skid length of flat between 25 mm & 40 mm or Multiple Class 2 skids	Reprofile wheels to remove flat within 14 days.	**40 km/h** MAXIMUM SPEED
4	Single skid length of flat between 40 mm & 60 mm or Multiple Class 3 skids.	Remove vehicle from service until wheel fault remedied.	**25 km/h** MAXIMUM SPEED
5	Single skid length of flat > 60 mm	Wheel is to be examined by Rolling Stock Reliability Engineer or delegate to determine method of travel to Maintenance Depot.	**NOT TO MOVE** until assessed

Table 13: Skidded Wheels

10.2 Spalling

Spalling appears as areas of the tread where base metal has broken out leaving irregular shaped shallow holes normally < 3 mm deep. This defect is due to the thermal damage, over stressing at rail-wheel contact point or skidding. Spalling is detected by general visual inspection of the tread surface. The signs of spalling are easy to identify as wheel surface becomes rough. Refer to Appendix C for visual examples.

Various classification of wheel spalling is shown in Table 14.

Class	Description of Defect	Action Required	Speed Limitation
1	Areas < 8 mm in diameter together covering < 10 % of tread surface.	No action required	Normal speed
2	Areas < 15 mm in diameter together covering < 20 % of tread surface.	Closer inspection required to ensure no Class 3 spalls exist. Report fault on inspection sheet.	Normal speed
3	Areas > 15 mm in diameter, sharp and jagged, together covering < 50 % of tread surface.	Re-profile wheels to remove spalling within 14 days.	Normal speed
4	Extensive spalling ≥ 2 mm deep, sharp and jagged, together covering > 50 % of tread surface.	Remove vehicle from service until wheel fault remedied	**40 km/h** MAXIMUM SPEED

Table 14: Spalled wheels

10.3 Thermal Cracking

Thermal cracks are the most severe form of wheel defect. They are detected by close visual inspection of the tread and flange surfaces. The main reason for the thermal crack is the alternate heating and cooling of tread and rim area. Lack of proper inspection and corrective action can develop more severe cracks and ultimately end up with fractured wheel. So preventive action must be taken at the early stage of development and detection of thermal cracks. Refer to Appendix D for visual examples.

Various classifications of thermal cracks are shown in Table 15.

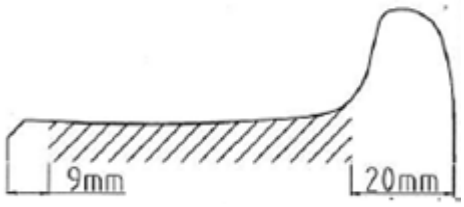
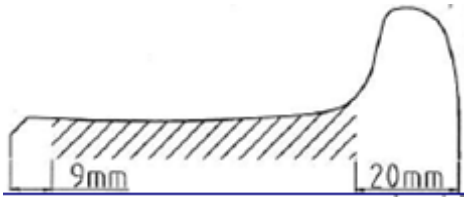
Class	Description of Defect	Action Required	Speed Limitation
1	Visual cracks < 7 mm long on the flange or tread.	No action required	Normal speed
2	Between 7 mm and 20 mm long cracks on tread. 	Closer inspection required to ensure no Class 3 thermal cracks exist. Report fault on inspection sheet.	Normal speed
3	Between 20 mm and 30 mm long cracks on tread. 	Re-profile wheels to remove cracks within 14 days. If wheel is approaching condemning diameter, treat as Class 4 defect.	Normal speed
4	Crack > 7 mm long on flange or outer edge of tread and any crack > 30 mm 	Remove vehicle from service until wheel fault remedied	**40 km/h** MAXIMUM SPEED
5	**FRACTURED WHEEL** Any crack through rim, web or boss of the wheel	Wheel is to be examined by Rolling Stock Reliability Engineer or delegate to determine method of travel to Maintenance Depot.	**NOT TO MOVE** until wheel has been inspected

Table 15: Thermal cracking

Where significant cracks are identified the wheel rim should be marked to allow for inspection to ensure the full extent of the crack has been removed. After machining, a non-destructive crack detection test should be conducted, for example magnetic particle or die-penetrate.

10.4 Scaled Wheels

Scaling appears as areas of the tread where material has adhered and built up on the tread leaving a lumpy surface. Normally it is due to heating of wheel tread surface area resulting in material becomes soft, flows on tread surface, mixes with foreign particles, and deposited back onto the wheel. Scale build up is detected by general visual inspection of the tread surface. Refer to Appendix E for visual examples.

Classifications of scaled wheels are shown in Table 16:

Class	Description of Defect	Action Required	Speed Limitation
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 ≤ 3 mm	Re-profile wheels to remove scale.	Clear section at: **25 km/h** MAXIMUM SPEED
4(ii)	Scale height ≤ 6 mm		**15 km/h** MAXIMUM SPEED
4(iii)	Scale height ≤ 10 mm		**5 km/h** MAXIMUM SPEED
5	Scale height > 10 mm	Wheel is to be examined by Rolling Stock Reliability Engineer or delegate to determine method of travel to Maintenance Depot.	**NOT TO MOVE** until wheel is rectified.

Table 16: Scaled wheels

10.5 Rolled Edge

Rolled edge occurs when the rolling of the wheel on the rail causes the tread metal to flow horizontally out past the chamfer on the rim. High lateral contact stresses due to incorrectly tracking of the vehicle are often a contributing factor. If rolled edge extends past the rim face 3 mm or more for more than half of the tread circumference it is listed as a Class 3 defect. Any crack found on the rolled edge shall be classified as a Class 4 thermal crack. Refer to Appendix F for visual examples.

Classifications of various rolled edge are shown in Table 17:

Class	Description of Defect	Action Required	Speed Limitation
1	Classification not relevant	No action required	Normal speed
2	Rolled edge extends past rim face but < 3 mm	Defect is to be recorded on inspection sheet.	Normal speed
3	Rolled edge extends past rim face > 3 mm for more than half of the tread circumference	Grind the edge or re-profile wheels to remove offending metal within 14 days.	Normal speed
4	Classification not relevant		

Table 17: Rolled Edge

- The occurrence of a localised area of “Rolled Edge” on a wheel rim is called Spread Rim. It may be an early sign of a cracked or broken rim and shall be examined by Rolling Stock Reliability Engineer or delegate to determine further action.

Figure 17: Rolled Edge

10.6 Damaged / Fractured Wheels

Refer to Appendix G for visual examples.

Class	Description of Defect	Action Required	Speed Limitation
1,2 & 3	Classification not relevant	Not relevant	Normal speed
4	**FATIGUE CRACKS IN WHEEL RIM OR FLANGE** Solitary cracks with no critical propagation, usually initiated from a manufacturing defect. With no critical propagation means that the cracks are not running through the rim of the wheel.	Remove vehicle from the service until wheel fault remedied.	**40 km/h** MAXIMUM SPEED
	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 or a wheel distortion.		
5	**FRACTURED WHEEL** Any crack running through the rim, web or boss of the wheel.	Examination by the Rolling Stock Reliability Engineer or delegate of the wheel before movement to the Maintenance Depot.	**NOT TO MOVE** until wheel has been inspected.
	SHATTERED WHEEL Circumferential crack visible on rim face, often in combination with beak-away of rim material		

Table 18: Damaged / Fractured wheels

10.7 Overheated Wheels

Based on current experience, overheating of wheels due to braking is not high risk for AMPRN Trams.

Disc brakes are used on Flexity and Citadis.

Any wheels which have become severely overheated due to excessive braking or sticking brakes is classified as a Class 4 defect and should be treated as a ‘Damaged Wheel’ per Table 18.

Refer to Appendix H for visual examples.

10.8 Out of Round Wheels

Out of round wheels are not a high risk for AMPRN Trams. However, for a fully assembled new or machined wheelset a maximum tolerance for tread radial run out is 0.5 mm.

10.9 Witness Mark – After machining

A witness mark (a circumferential area of original surface) may remain on the running face of the flange after machining the rim to restore the tread profile. To be acceptable, the witness mark must not be more than 1.0 mm deep, or be closer than 5.5 mm to the tread line per the figure:

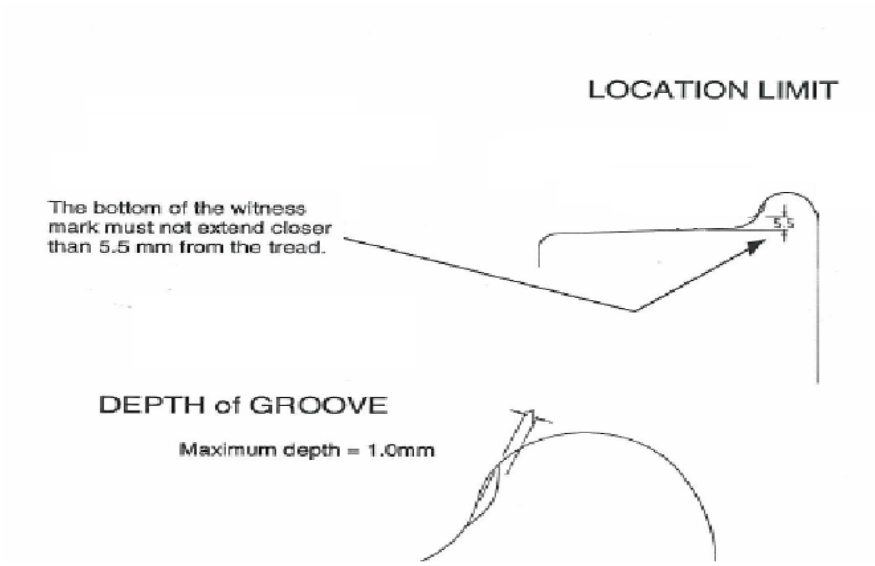


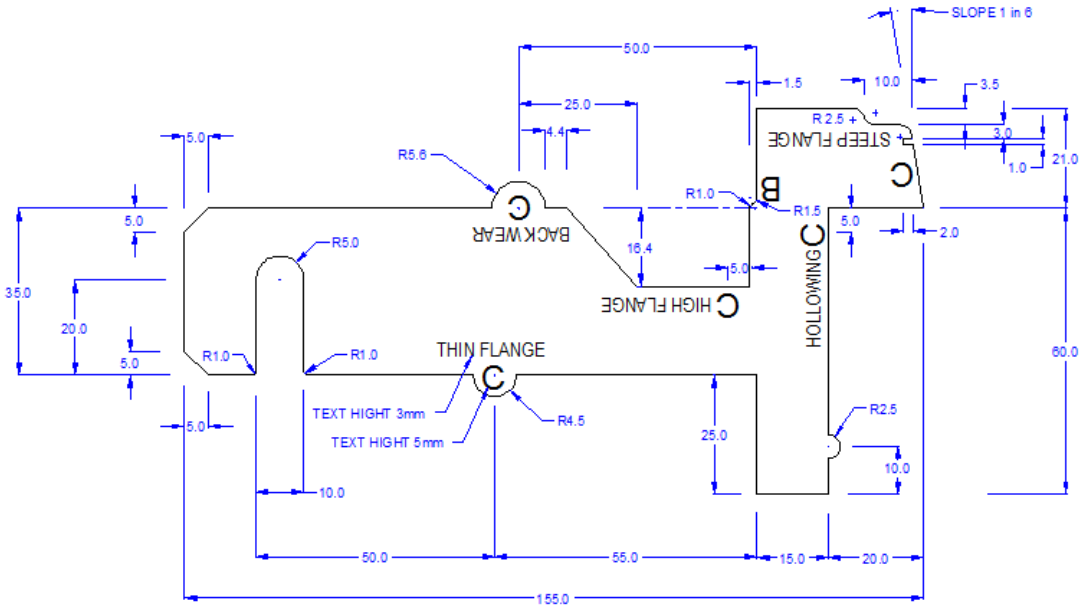
Figure 18: Witness Mark – After machining limit

11 Associated Documents

Table 19: Associated Documents

Document ID	Title
RS2-DRG-300000	Modified Glenelg Tram Profile (MGTP)
RS2-DRG-300001	Tram Wheel (MGTP) Condemn Gauge
RS2-DRG-300034	7/8 Modified Glenelg Tram Profile (MGTP)
RS2-DRG-300007	7/8 Modified Glenelg Tram Profile (MGTP) Gauge Template
RS2-DRG-300006	Modified Glenelg Tram Profile (MGTP) Full Profile Gauge Template
805-A3-2000-4	Wheel Wear Gauge – Pre ‘MGTP’
805-A3-2000-5	Wheel and Tyre Gauge – Pre ‘MGTP’

I. Appendix A: Tram Wheel Condemn Gauge RS2-DRG-300001



II. Appendix B: Visual Example of Wheel Defect – Skidded Wheels (Flats)

Figure 19 – Class 3 Skidded Wheel – (Multiple Class 2 skids)

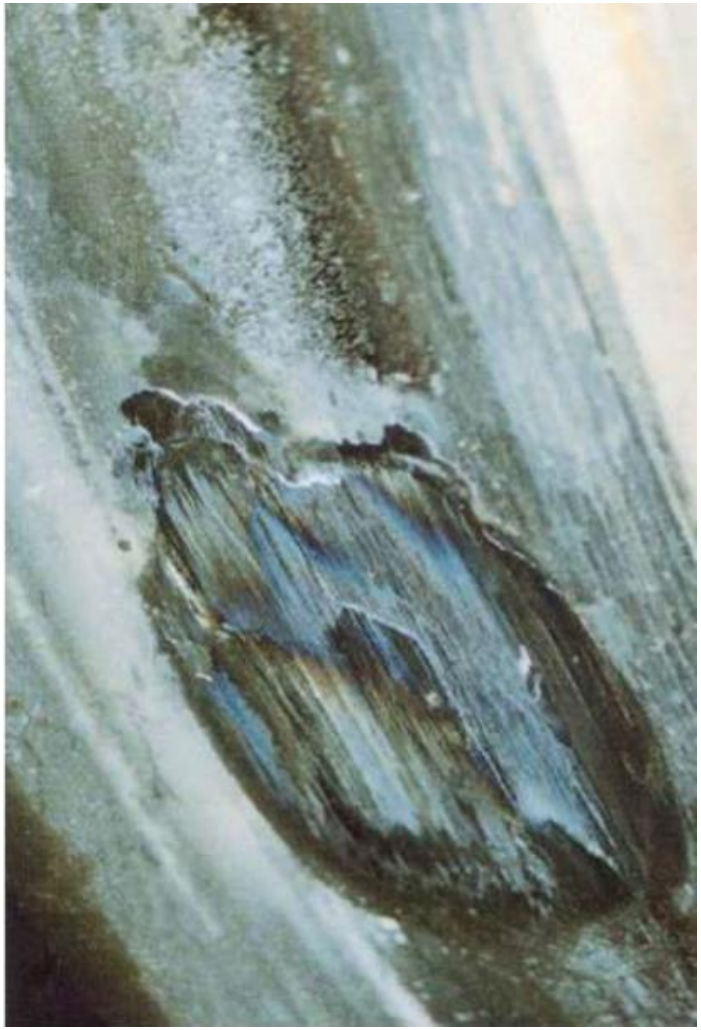


Figure 20 – Class 4 Skidded Wheel

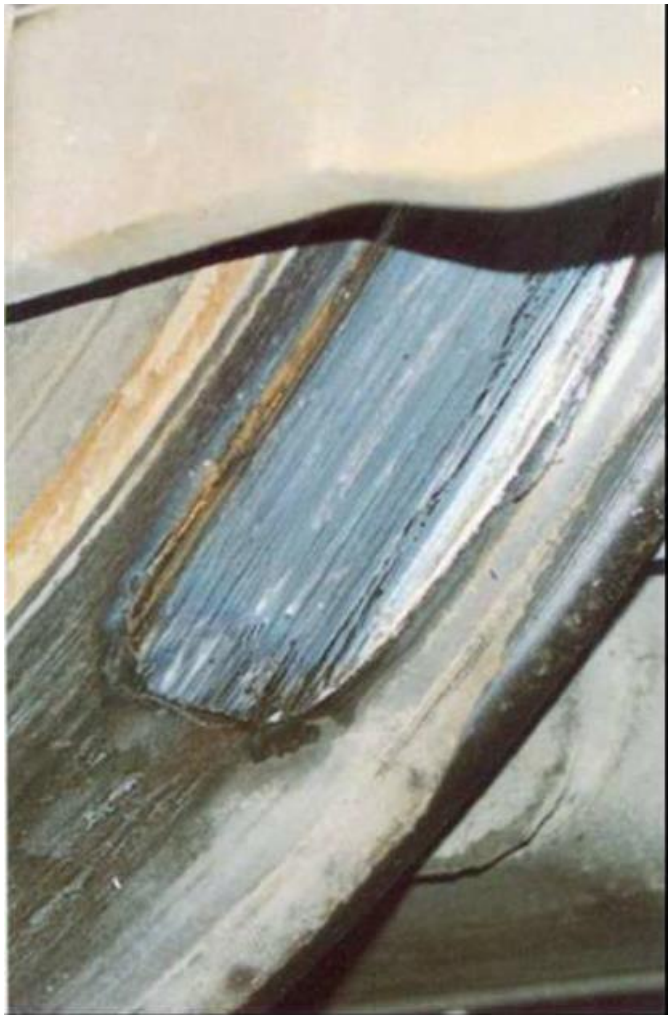


Figure 21 – Class 5 Skidded Wheel

III. Appendix C: Visual Example of Wheel Defect – Spalling

Figure 22 – Class 1 Spalling

Figure 23 – Class 2 Spalling

Figure 24 – Class 3 Spalling

Figure 25 – Class 4 Spalling

IV. Appendix D: Visual Example of Wheel Defect – Thermal Cracking

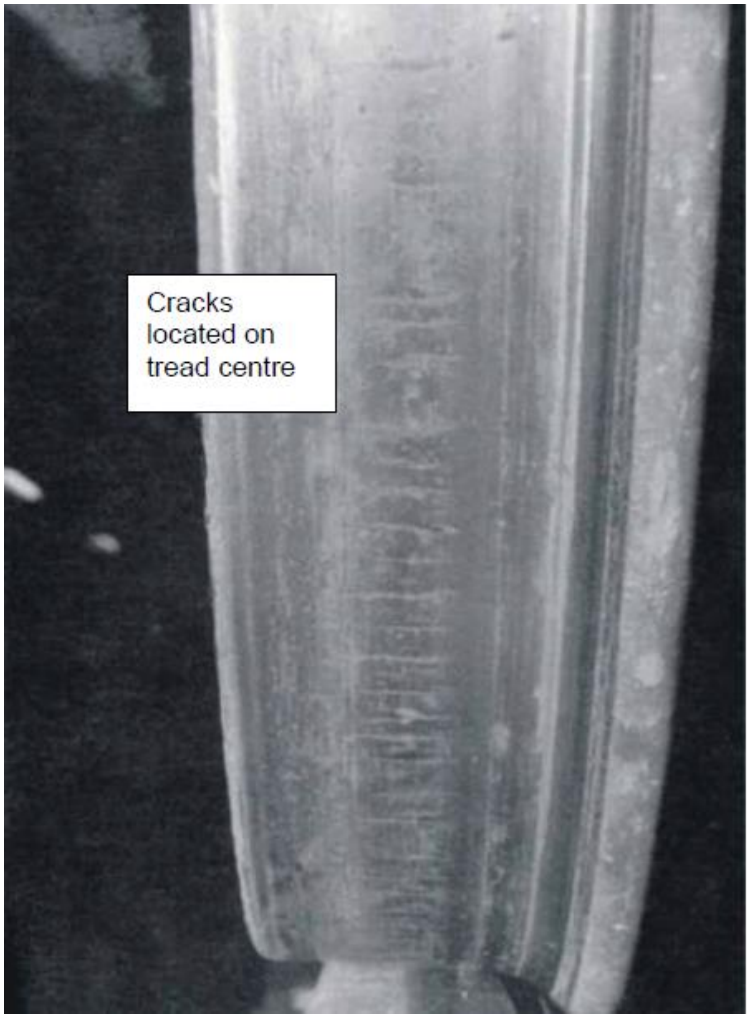


Figure 26 – Class 2 Thermal Crack

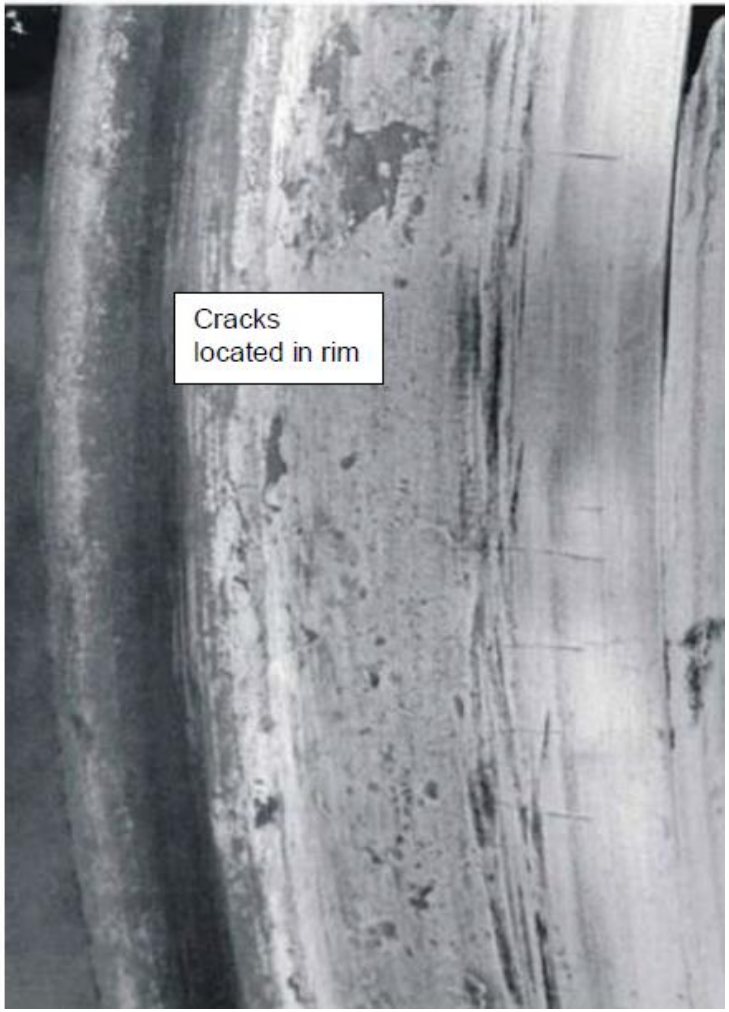


Figure 27 – Class 3 Thermal Crack

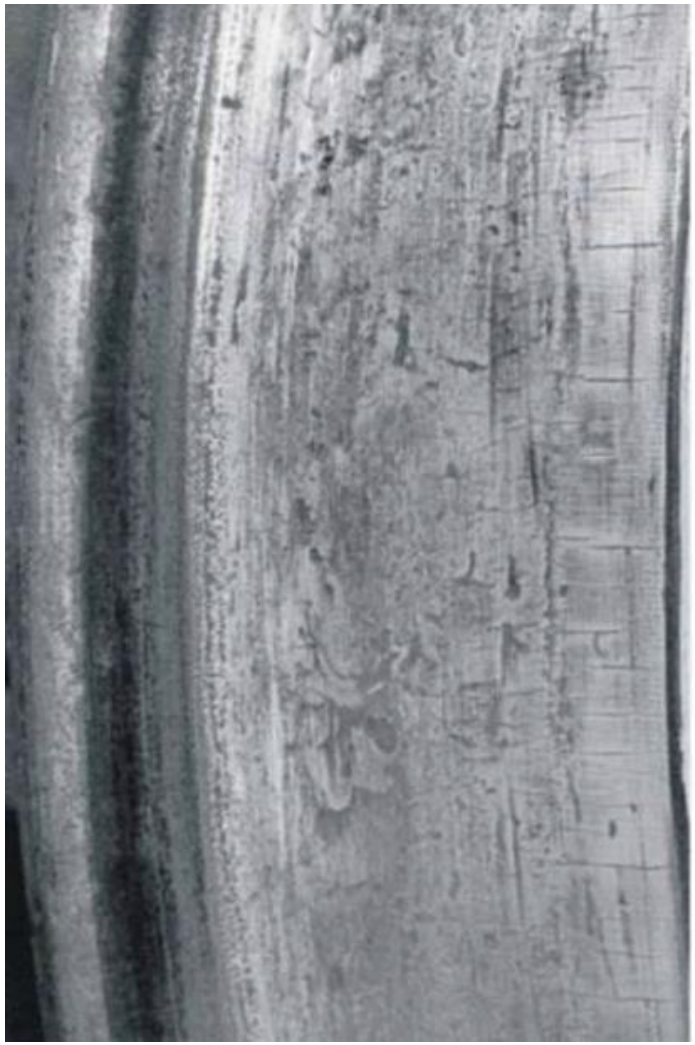


Figure 28 – Class 4 Thermal Crack

Figure 29 – Class 5 Thermal Crack

V. Appendix E: Visual Example of Wheel Defect – Scaled Wheels

Figure 30 – Class 3 Scaled Wheel

Figure 31 – Class 4 Scaled Wheel

VI. Appendix F: Visual Example of Wheel Defect – Rolled Edge / Spread Rim

Figure 32 – Rolled Edge

Figure 33 – Spread Rim

VII. Appendix G: Visual Example of Wheel Defect – Damaged / Fractured Wheels

Figure 34 – Cracked or Broken Web

Figure 35 – Scrape, Dent or Gouge

VIII. Appendix H: Visual Example of Wheel Defect – Overheated Wheels

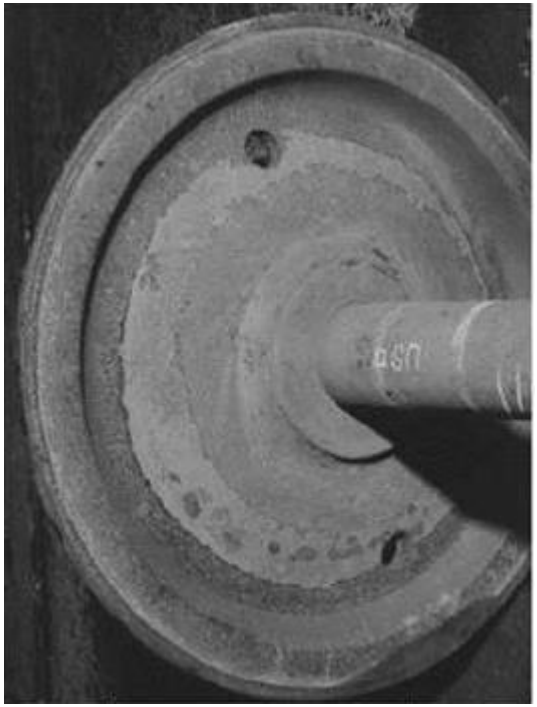


Figure 36 – Overheated Wheel