



Engineering and Asset Management  
Interoperability Standard  
**M-ST-RS-8102**  
**Wheelset Dimensional  
Limits**

### Document Control

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## 1. Purpose

This standard sets dimensional requirements for rail vehicle wheelsets to be interoperable with the National Rail System. KiwiRail as Access Provider require all Rail Operators ensure their rail vehicles are compliant with this standard.

## 2. Scope

This standard specifies dimensional requirements for rail vehicle wheelsets on the Controlled Network. These requirements are intended to ensure technical interoperability between wheelsets and track infrastructure and are a prerequisite for rail vehicles operating on the Controlled Network.

Measurement datums are outlined for a range of wheelset dimensions, aiming to characterise the complex geometry of railway wheel profiles in a useable form and to align wheelset measurement practice across Rail Operators on the Controlled Network. This includes image-based wheel profile monitoring (WPM) systems installed at some of KiwiRail's wayside condition monitoring sites.

Prescribed in-service limits are defined for select wheelset dimensions to ensure correct wheel-rail interaction is assured over the wear range for both wheelsets and track. Additionally, dimensional limits for wheel flanges uphold compatibility with axle counters present on the Controlled Network.

Wheelset dimensional limits specified in this standard apply to all types of conventional rolling stock with fixed axles – i.e., locomotives, wagons, passenger carriages, multiple units, large mobile track maintenance vehicles, etc.

Alternative dimensional limits may be applied to specialist vehicles or wheelset types with agreement from KiwiRail as the Access Provider – e.g., independently rotating wheels, measurement trolley wheels, small plant, hi-rail vehicles, etc. Refer to KiwiRail Hi-Rail Code OM94001, Trolley Code OM94002, and Mobile Track Maintenance Vehicle Code OM94003 for further information on these vehicle types.

Appendix 1 provides a description of legacy wheelset gauging methodology used in New Zealand's National Rail System and a means to translate dimensional limits to this methodology.

This standard does not specify limits for wheel damage, tread defects, and abnormalities – these remain the responsibility of the Rail Operator to manage according to the specifics of vehicle/wheelset design and accepted good practice. KiwiRail Wheel Code M6000 and RISSB Wheel Defects Code of Practice are appropriate references for accepted good practice, noting that this standard takes precedence where other sources have conflicting information for wheelset dimensional parameters. KiwiRail as the Access Provider reserves the right to impose and enforce wheel tread defect limits as detected by wayside CIMW sites for the purposes of preventing damage to infrastructure assets (e.g., track systems and underline structures).

### 3.

## 3. Associated Documents

Level	Number	Title	Relationship
1	<a href="#">M-PR-GE-8001</a>	Rail Vehicle Interoperability Principle	Superior Document: Clarified / Extended
2	M-ST-RS-8101	Rail Vehicle Interoperability Standard	Companion document
2	M-ST-RS-8103	Heritage Rail Vehicle Interoperability	Companion Document
2	<a href="#">T-ST-DE-5200</a>	Track Design	Companion document
2	<a href="#">OM94001</a>	Hi-Rail Vehicle Code	Supporting Document
2	<a href="#">OM94002</a>	Trolley Code	Supporting Document
2	<a href="#">OM94003</a>	Mobile Track Maintenance Vehicle Code	Supporting Document
2	<a href="#">APIS 11</a>	Heritage Vehicle and Train Management	Companion Document

### 3.1 Withdrawn, closed and superseded

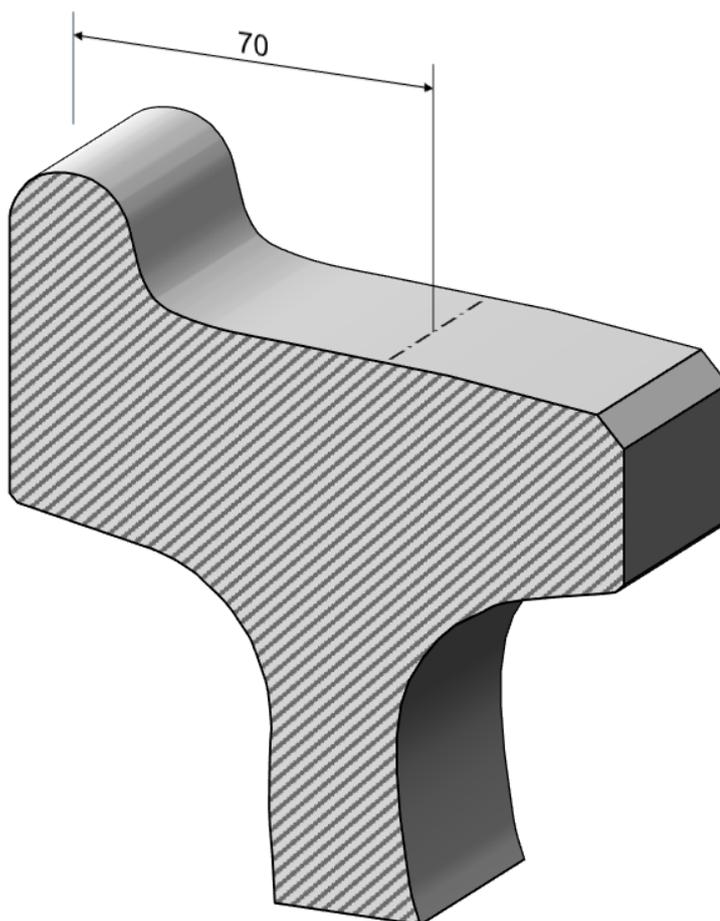
Old Reference	Title	Replaced by
NRSS / 6	Engineering Interoperability Standards	M-ST-RS-8102

## 4. Acronyms

Acronyms	Definition
CIMW	Continuous In-Motion Weighing
FAI	Flange Angle (note: this acronym uses a lower-case L)
F <sub>h</sub>	Flange Height
F <sub>w</sub>	Flange Width
F <sub>wt</sub>	Flange Width Top
HT	Tread Hollow
qR	Flange Gradient
RO	Roll Over
W	Wheel Rim Width
WPM	Wheel Profile Monitoring

## 5. Wheel Tread Diameter

- 5.1.1 Wheel tread diameter shall be measured at the taping line, defined as being 70 mm horizontally from the inner face of the wheel (i.e., the flange back plane).



**Figure 1: Wheel Taping Line Datum**

- 5.1.2 Wheel tread diameter limits are specific to vehicle and wheelset designs. KiwiRail as the Access Provider do not have prescribed universal limits for this dimension.

*Guidance: Wheel diameters of less than 330 mm may not reliably be detected by axle counters used on the Controlled Network. Operating procedures for small-wheeled vehicles must account for this.*

*Guidance: In some cases, minimum wheel diameter may be limited by rail contact stress, or P/D ratio, which shall generally not exceed 147 kN/m. See M-ST-RS-8101.*

- 5.1.3 For newly manufactured wheelsets, and following wheelset re-profiling, wheel tread diameter difference within a wheelset shall not exceed 0.5 mm.

*Guidance: This standard does not set an in-service limit for wheel diameter difference, however where it exceeds 1.0 mm the source of asymmetry in tread wear should be investigated.*

## 6. Wheel Flange Dimensions

### 6.1 Flange Height and Width

- 6.1.1 Flange height,  $F_h$ , is defined as the vertical dimension between the flange tip and the wheel tread surface at the taping line.
- 6.1.2  $F_h$  shall be maintained so as to remain within the range 26 – 34 mm.
- 6.1.3 Flange width,  $F_w$ , is defined as the horizontal dimension between the flange back and the point on the flange face 10 mm above the tread surface at the taping line (flange back wear, if present, is ignored).
- 6.1.4  $F_w$  shall be maintained so as to remain within the range 19 – 33 mm.

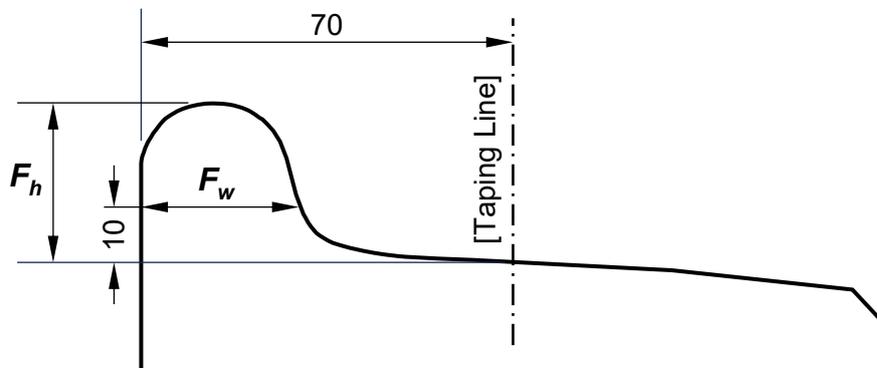


Figure 2: Wheel Flange Dimensions (mm)

- 6.1.5 Flange width top,  $F_{wt}$ , is the horizontal dimension between the flange front and flange back surfaces at a vertical dimension 5 mm below the flange tip.

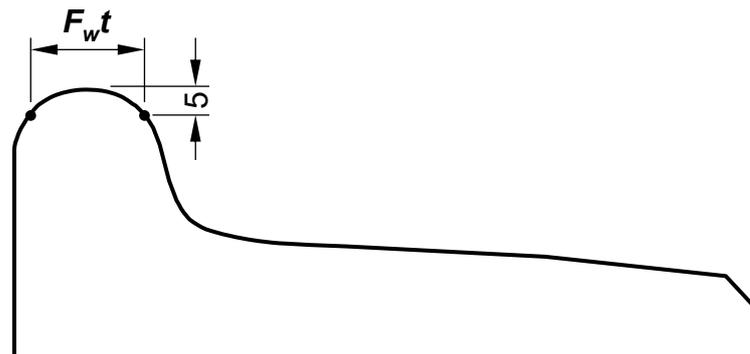
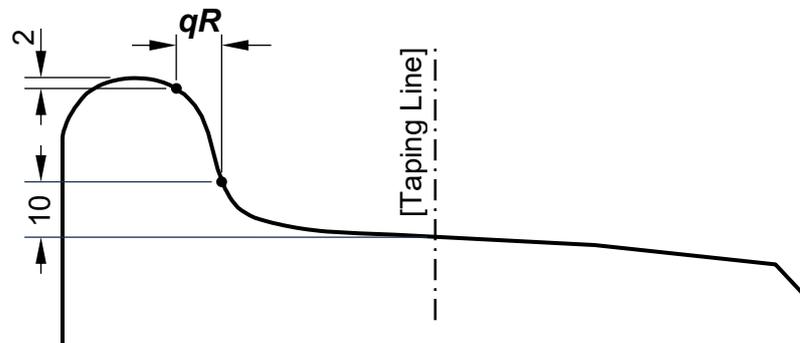


Figure 3: Flange Width Top Dimension (mm)

- 6.1.6 KiwiRail as the Access Provider do not have prescribed limits for  $F_{wt}$ , however where it is quoted it must conform to the above definition and it is recommended it is maintained above 15 mm.

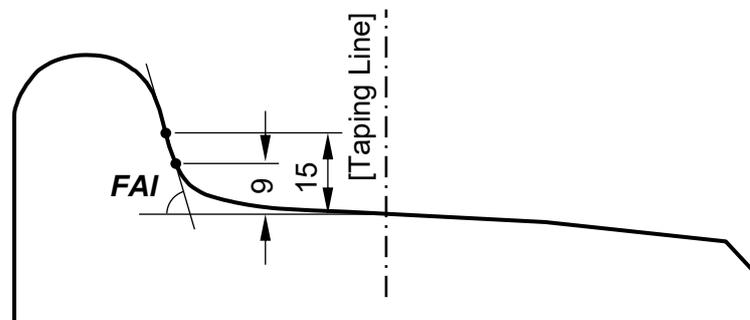
## 6.2 Flange Gradient / Angle

- 6.2.1 Flange gradient,  $qR$ , is defined as the horizontal dimension between the point on the flange face 2 mm below the flange tip and the point on the flange face 10 mm above the flange face. Low  $qR$  values describe a steep flange face angle and high  $qR$  values describe a shallow flange angle.



**Figure 4: Wheel Flange Gradient Dimension (mm)**

- 6.2.2 KiwiRail as the Access Provider do not have prescribed limits for  $qR$ , however where it is quoted it must conform to the above definition and it is recommended it be maintained within the limits 6.5 mm – 10.5 mm.
- 6.2.3 Flange angle,  $FAl$ , is the angle of the line connecting points on the flange face at 9 mm and 15 mm above the wheel tread surface at the taping line.  $FAl$  is expressed in degrees and is relative to the horizontal.



**Figure 5: Flange Angle Dimension (mm)**

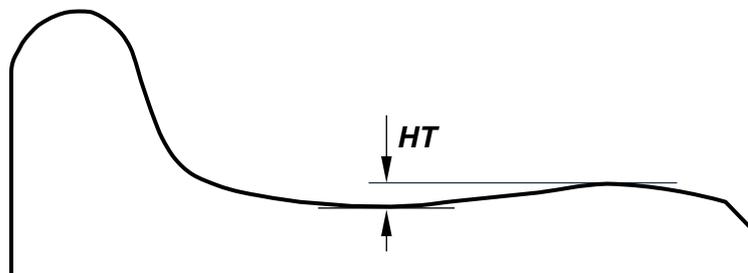
- 6.2.4 KiwiRail as the Access Provider do not have prescribed limits for  $FAl$ , however where it is quoted it must conform to the above definition.

*Guidance:  $FAl$  is typically around 70 degrees.*

## 7. Wheel Tread Dimensions

### 7.1 Tread Hollow

- 7.1.1 Tread hollow, HT, is defined as the vertical dimension between the highest point on the outer side of the wheel tread and the most worn point on the wheel tread.



**Figure 6 : Wheel Tread Hollow Dimension**

- 7.1.2 HT shall not exceed 2.0 mm.

*Rationale: Tread hollow reflects the loss, and even reversal, of wheelset conicity. This has adverse impacts on wheelset steering and stability.*

*Guidance: Equivalent conicity – a product of wheel profile, wheelset back-to-back, rail head profile, and track gauge – is not directly controlled by this standard.*

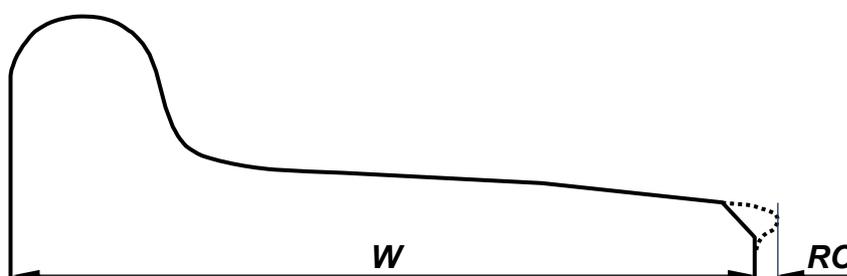
- 7.1.3 For passenger vehicle wheelsets, HT should not exceed 1.0 mm.

### 7.2 Wheel Rim Width and Tread Roll Over

- 7.2.1 Wheel rim width, W, is defined as the horizontal dimension between the unworn inner and outer faces of a wheel at its rim.

*Guidance: W in this context should not be confused with the legacy dimension 'W' used to describe wheel flange sharpness. See Appendix 1.*

- 7.2.2 Tread roll over, RO, measures the burr formed on the outer edge of the wheel tread by how far it overhangs the outer face of the wheel. For new wheel profiles this is zero.



**Figure 7: Wheel Rim Width and Tread Roll Over Dimensions**

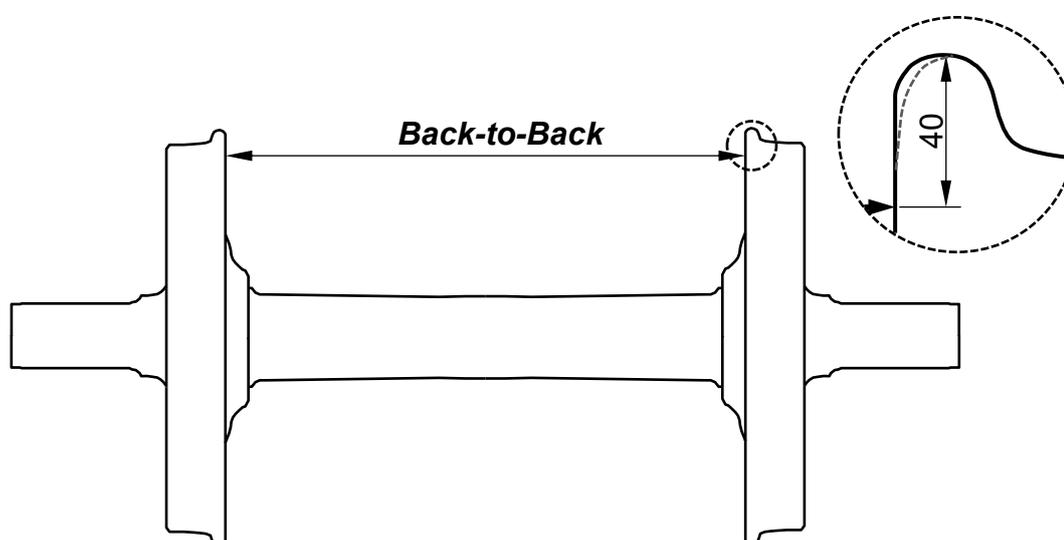
- 7.2.3 For passenger vehicles, no tread roll over shall be present (i.e., RO = 0 mm).

- 7.2.4 For all other vehicles, RO shall not exceed 3 mm.
- 7.2.5 The combined wheel rim width and tread roll over,  $W + RO$ , shall not exceed 145 mm.
- Guidance:  $W$  is typically in the range 127 mm – 140 mm for newer wheelsets. Historically a lower limit of 114 mm was used and there are widths as great as 145 mm for existing wheelsets.*

## 8. Wheel Spacing

### 8.1 Back-to-Back

- 8.1.1 Wheelset back-to-back is defined as the dimension between wheel flange back faces. Nominally this is measured at points 40 mm below the flange tip and should ignore flange back wear, if present.

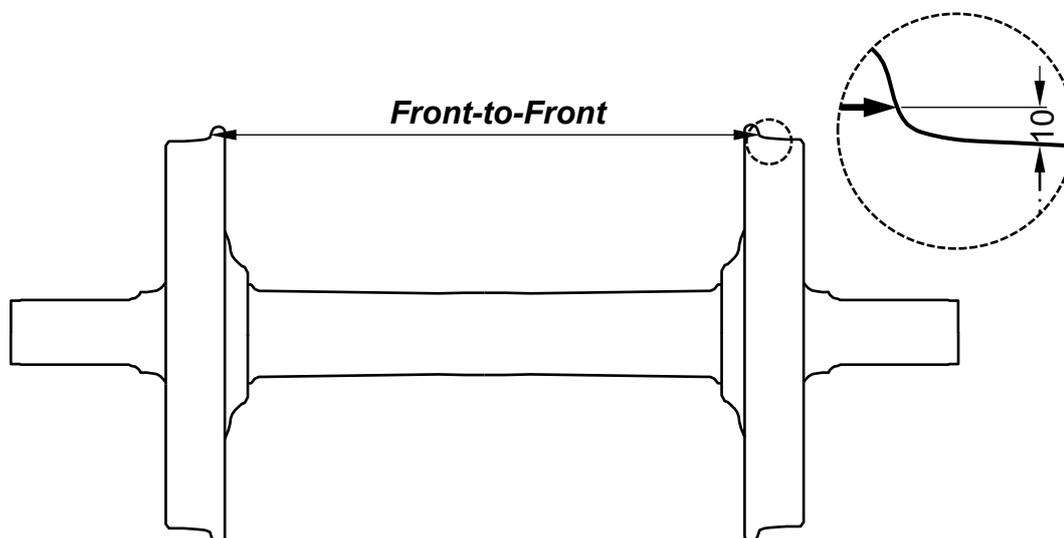


**Figure 8: Wheelset Back-to-Back Dimension (mm)**

- 8.1.2 Wheelset back-to-back shall be within the range 994.0 mm – 998.0 mm.
- Guidance: The nominal wheelset back-to-back dimension was reduced from 997 mm (-0 mm / + 1 mm) to 995 mm ( $\pm 1$  mm) in 2017. This requirement reflects both legacy and current wheelset practice.*
- Guidance: A wheelset's back-to-back dimension should remain relatively constant throughout its life. Significant change to this dimension normally indicates failure or damage (e.g., a wheel hub shifting or a bent axle).*

## 8.2 Front-to-Front

- 8.2.1 Wheelset front-to-front is defined as the wheelset back-to-back dimension +  $F_{w,Left}$  +  $F_{w,Right}$ . This equates to the dimension between opposing flange faces at 10 mm above the taping line.



**Figure 9: Wheelset Front-to-Front Dimension**

- 8.2.2 Wheelset front-to-front shall not exceed 1062.0 mm.

*Rationale: This sets a lower limit for flangeway clearance, to avoid potential instability associated with 'tight gauge' running.*

*Guidance: For wheelset back-to-back dimensions of 996 mm or less, this requirement is met by compliance with clause 6.1.4 ( $F_w \leq 33$  mm). For wheelsets with greater back-to-back dimensions, flange width upper limits must be adjusted accordingly.*

- 8.2.3 For wheelsets with a wheel rim width,  $W$ , less than 127.0 mm wheelset front-to-front shall be maintained above 1035.0 mm.

*Rationale: This represents a minimum  $F_w$  dimension of 19 mm on the historic minimum back-to-back dimension 997.0 mm. Narrow wheel rim widths with reduced back-to-back present a risk when combined with wide gauge track.*

## 9. In-Service Limits & Wheelset Management

9.1.1 Table 1 below provides a summary of in-service limits for wheelset dimensions, as defined in Sections 6 – 8.

9.1.2 Wheelset management shall be implemented so that maintenance intervention (e.g., re-profiling on a wheel lathe) occurs before limits are exceeded.

*Guidance: Trend monitoring of actual wheelset dimensions enables greater precision in maintenance scheduling. Go/no-go and other basic gauging techniques should factor in potential wear before next maintenance interval.*

9.1.3 Vehicles with small wheelset dimensional exceedances may run on the Controlled Network for the purposes of relocation to wheel maintenance facilities. Associated risk is the responsibility of the Rail Operator in these instances.

*Guidance: Small exceedances can be broadly defined as not being greater than typical wear experienced over a vehicle's basic maintenance interval.*

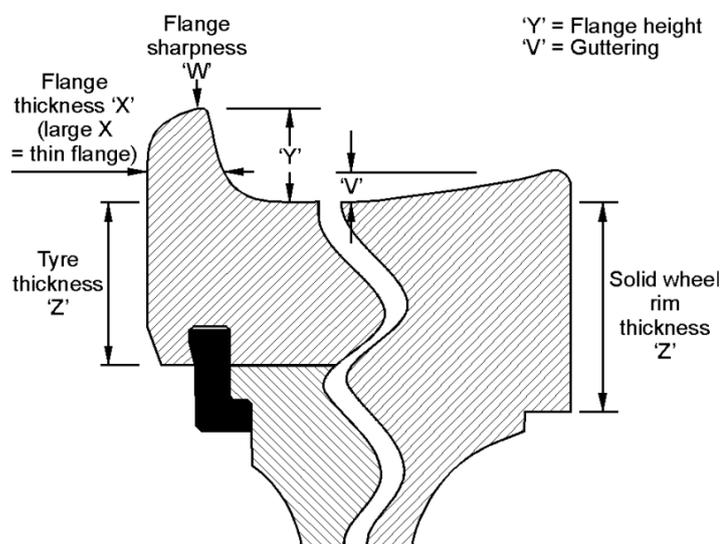
**Table 1: Wheelset Dimensions & In-Service Limits**

Wheelset Dimension	Minimum (mm)	Maximum (mm)
Flange Height, $F_h$	26	34
Flange Width, $F_w$	19	33
Flange Width Top, $F_{wt}$	15 *	N/A
Flange Gradient, $qR$	6.5 *	10.5 *
Flange Angle, FAI	N/A	N/A
Tread Hollow, HT	N/A	2 1 * (Passenger)
Wheel Rim Width, W	114 127 (preferred)	145
Roll Over, RO	N/A	3 0 (Passenger)
W + RO	N/A	145
Back-to-Back	994	998 (996 preferred)
Front-to-Front	$W \geq 127$ mm	1032
	$W < 127$ mm	1035

\* Recommended limits – Rail Operators to determine appropriate management of wheel profiles for vehicle risk profile.

## Appendix 1 Legacy Wheelset Gauging

Historically, wheelsets on New Zealand's National Rail System have been measured with physical gauges using a dimensioning scheme that generally quantifies worn material rather than remaining unworn material. I.e., measurements nominally start at zero for a new wheel profile and then increase with wheel wear. These dimensions are denoted as 'V'/'W'/'X'/'Y'/'Z'.



**Figure 10: Legacy Wheel Profile Dimensions**

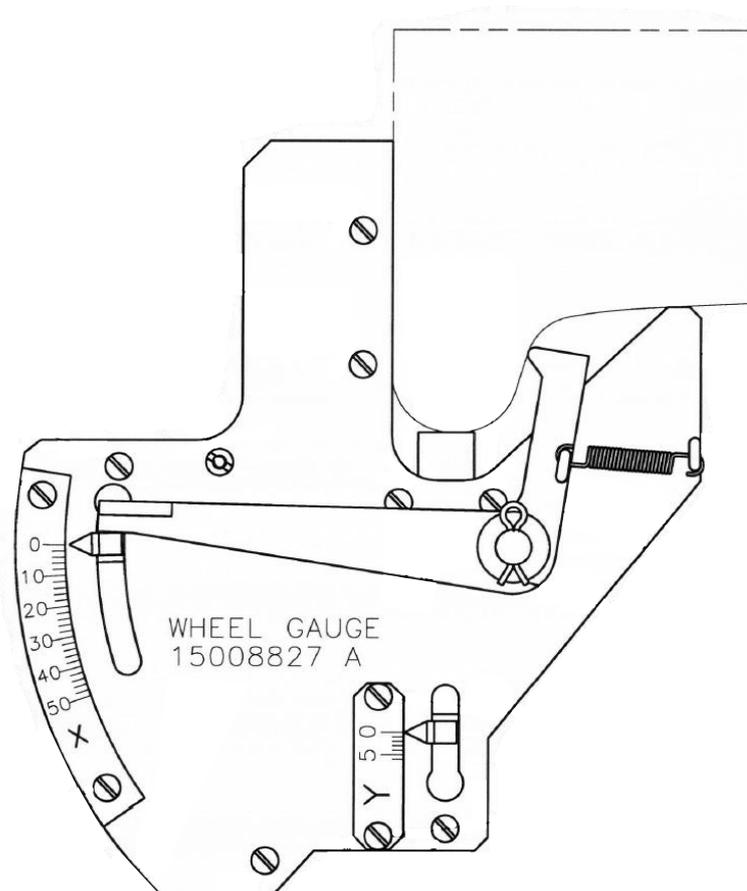
Historic limits for these dimensions typically only considered the predominant wear mechanism. E.g. An upper 'X' dimension limit imposed to control for thin flanges caused by flange face wear, but no limit for thick flanges.

Legacy gauging and its associated dimensioning is being phased out and should not be adopted for new vehicles. It may however continue to be used for existing rail vehicles where the adoption of modern wheelset gauging is not practical.

**Wheel Flange Parameters – ‘X’ & ‘Y’**

The ‘X’ dimension is nominally equivalent to flange width,  $F_w$ , but uses a tapping line at 61 – 66 mm and measures through an arc rather than horizontally. ‘X’ is nominally zero for a new wheel profile and increases as the wheel flange becomes thinner.

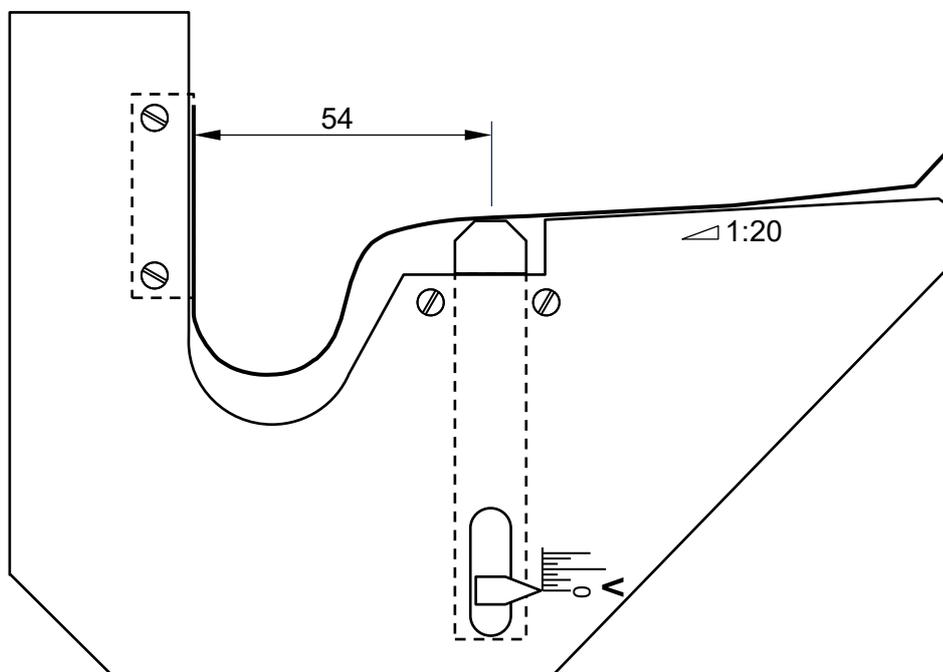
The ‘Y’ dimension is nominally equivalent to flange height,  $F_h$ , but uses a tapping line at 61 – 66 mm. ‘Y’ is nominally zero for a new wheel profile and increases as the wheel flange becomes taller.



**Figure 11: Wheel Flange Gauge – Legacy Dimensions ‘X’ & ‘Y’**

### Tread Guttering – ‘V’

The ‘V’ dimension describes wheel tread guttering and is nominally equivalent to tread hollow, HT. It differs however in being measured at a fixed dimension of 54 mm from the wheel flange back face, and relative to a 1:20 wheel tread taper. ‘V’ is nominally zero for a new wheel profile and then increases with wheel tread wear.

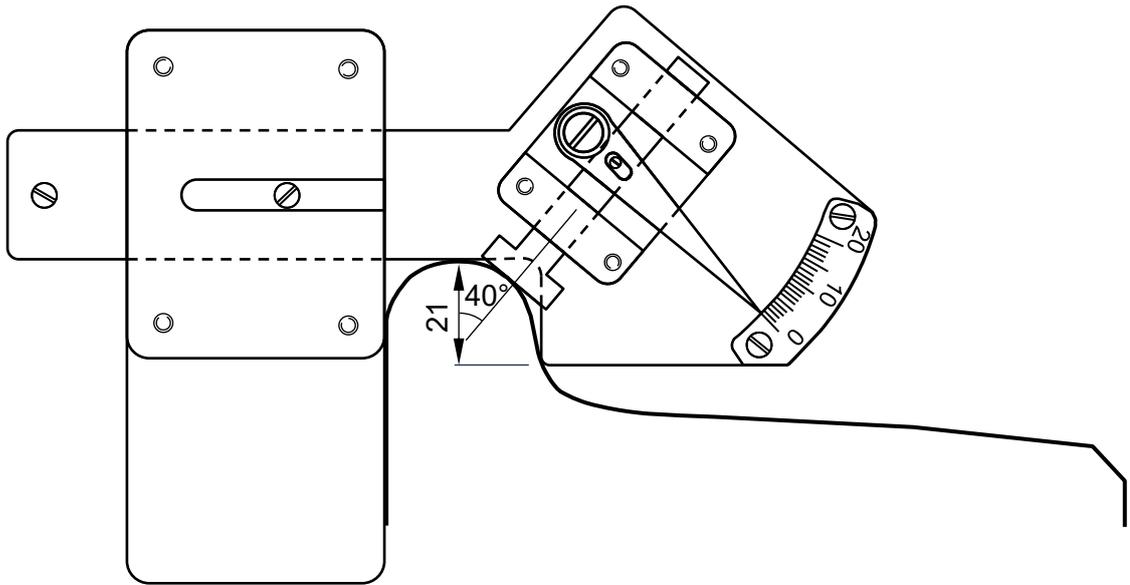


**Figure 12: Tread Hollow Gauge – Legacy Dimension ‘V’ (mm)**

### Flange Sharpness – ‘W’

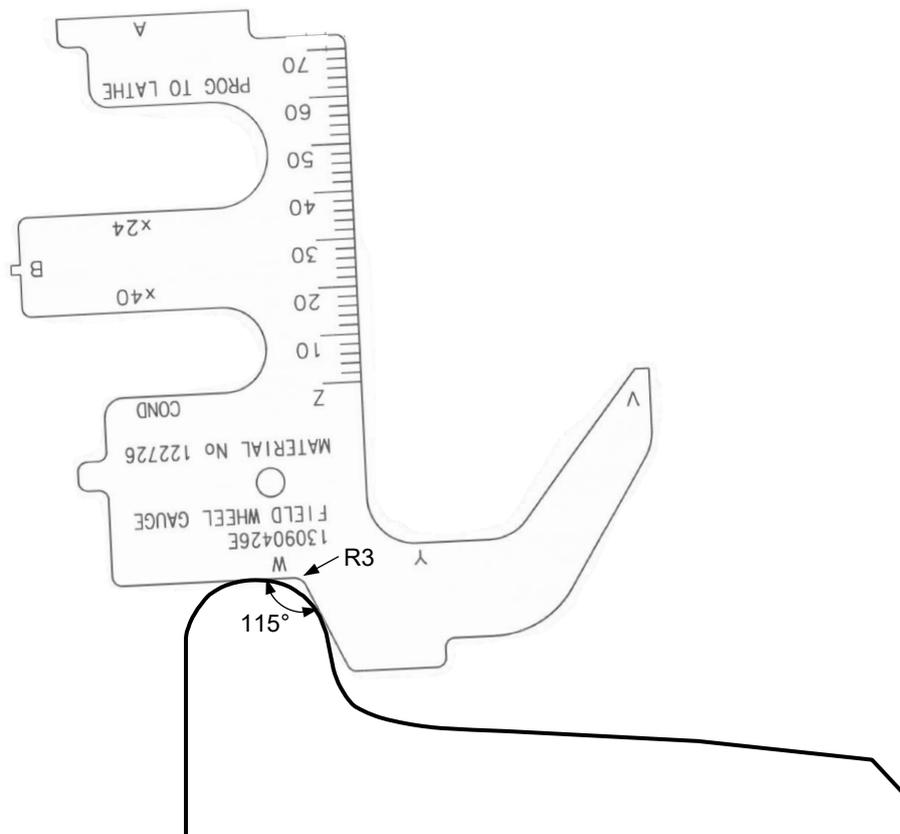
The ‘W’ dimension describes wheel flange sharpness by measuring the furthest protrusion of the flange surface at an angle of 40 degrees from the wheel’s radial plane and relative to the flange face at a dimension 21 mm below the flange tip. ‘W’ is nominally zero for a new wheel profile and increases as the wheel flange tip becomes more protruded.

‘W’ quantifies similar parameters to flange gradient, qR, and flange face angle, FAI, dimensions but is not directly analogous to either. In terms of flange defects, a high ‘W’ reading is also more typical of a square top flange rather than the archetypical sharp flange condition.



**Figure 13: Flange Sharpness Gauge – Legacy Dimension ‘W’ (mm)**

Wheel flange sharpness, ‘W’, is also checked in a go/no-go manner by legacy field wheel gauges. This inspects for flange tip protrusions with a radius of < 3 mm by checking the gauge for rocking. This is not directly analogous to the measured ‘W’ dimension, as shown in Figure 13 above, but is sensitive to similar defects and more typical sharp flange conditions.



**Figure 14: Flange Sharpness Check (Pass) – Legacy Field Wheel Gauge**

### Wheel Rim Thickness – ‘Z’

Wheel rim thickness, ‘Z’, measures remaining wheel tread depth and indirectly measures the wheel diameter (with limited accuracy). ‘Z’ is a direct measurement and decreases with wheel wear rather than being nominally zero for a new wheel. The measurement datum and in-service limits for ‘Z’ differ between vehicles and wheel designs.

Wheel diameter and tread depth limits are not within the scope of this standard, legacy dimension ‘Z’ is included in this appendix for completeness only.

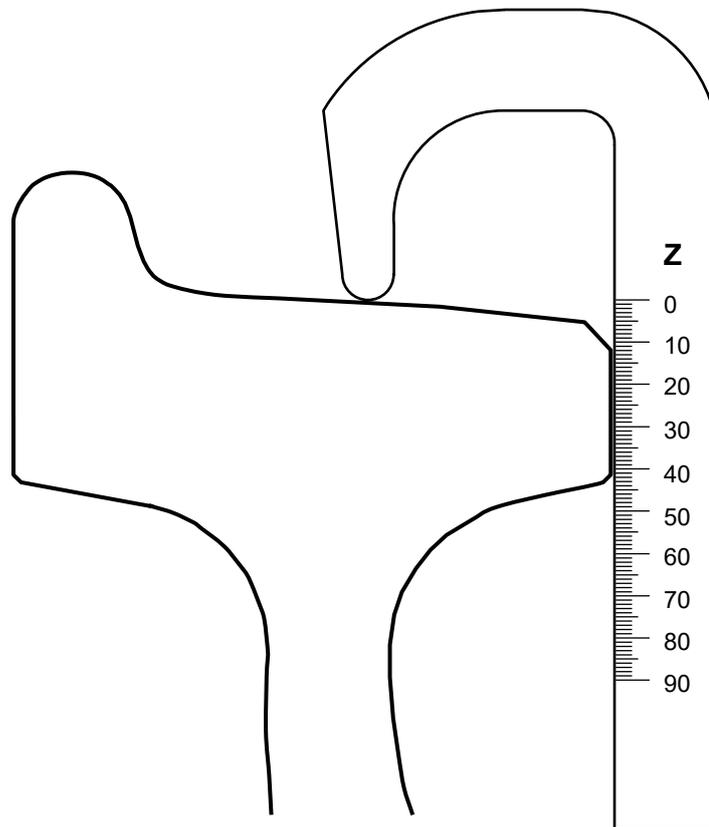


Figure 15: Wheel Tread Thickness – Legacy Dimension ‘Z’

### In-Service Limits – Legacy Wheelset Gauging

Table 2 below provides in-service limits for legacy wheelset dimensions, as they translate from the dimensional limits given in this standard. Rail Operators

**Table 2: Legacy Dimensions - Gauges & Translated In-Service Limits**

Legacy Dimension	Valid Gauge Types	Upper Limit	Lower Limit
'V'	PD10076-4	3	N/A
'W'	-	N/A	N/A
	PD 100991	14*	-
'X'	PD100766	34	-3
	15008826	(for nominal 997	
	15008827	mm back-to-back)	
'Y'	PD100766	6	-2
	15008826		
	15008827		
	13090426		
'Z'	-	N/A	N/A

\* An upper limit of 14 has historically been used for 'W' but is rare to encounter as a condemning limit. Sharp flanges should be managed as a wheel defect and in most instances can be identified without a gauge.

## Document History

**Note** page numbers relate to the document at the time of amendment and may not match page numbers in current document.

Issue No.	Section	Description	Page(s)
1.0		First Issue	
1.1	3 (prev.)	Review & Revision Procedure section removed – replaced by Document History (this table) in current template	5 (prev)
	6 (prev)	Deleted – formatting error, repeating Scope from Section 2.	
	6.1	Wording for flange height and width limits change from “not exceed” to “remain within” to improve clarity of requirements.	8