FRONZ / ONTRACK APPROVED CODE OF PRACTISE FOR HERTIAGE NETWORK OPERATORS

Mechanical Task Instruction B3.4.4.01

Inspection and Gauging of Wheelsets

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Reference Material

Source	Description	Date
NRSS 6	Engineering Interoperability Standards	9/07/2004
Tranz Rail	M6000 Wheelset Manual, Issue 3	9/5/2001
Tranz Rail	Wheelset Manual	10/6/1997
Queensland Rail	Wheel Defect Identification And Rectification	27/8/2001
NZ Rail	Wear & Tyre Limits chart	29/8/1991
NZ Rail	Drawing Y/X 7601/4 - Standard Tyres; Last	
	Turning and Condemning Sizes	

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Amendment History

Version	Section	Amendment

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1.0 Introduction

1.1 Purpose

The purpose of this Mechanical Code give guidance on identifying and rectifying wheelset faults.

Faults fall into 2 categories:-

- Damage
- Wear exceeding the allowable limits

Inspection methods used include: -

- Visual inspection
- Crack testing
- Use of gauges

1.2 Wheelset Description



A wheelset is the interface between a rail vehicle and the rail. It is required to withstand the static and dynamic loads imposed on it and provide guidance for the rail vehicle.

It is an assembly consisting of axle, wheels, tyres and bearings and, where applicable, brake disks, generator pulley, traction gears, traction motor support bearings or gearbox.

Definitions of Parts of a Wheel

Flange	That part of the wheel rim that runs inside and below the top of the rails to assist with guidance of the wheelset on the track.
Gibson ring	A ring fitted into a groove on the back of a tyre to prevent it moving.
Hub	The centre portion of the wheel which is bored to fit over the axle.

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Plate	The part of the wheel which connects the rim to the hub
Rim	The outside part of the wheel that runs on the track or, for a tyred wheel, the part that supports the tyre.
Tread	That part of the wheel rim which is in contact with the top of the rail
Tyre	The rim of wheel comprising a rolled or cast ring shrunk onto a wheel centre.
Wheel	Any railway wheel, be they solid wheel or a tyred wheel with solid or spoked wheel centre.
Wheel centre	Comprising the hub, plate and rim of a tyred wheel.

1.2.1 Tyred Wheels



A tyred wheelset consists of an axle, wheel centre pressed onto the axle and a shrink fitted tyre. The wheel centre is designed for strength and resilience while the tyre is hardened to provide good wear characteristics.

When fitting tyres they are heated, placed over the wheel centre and allowed to cool. A Gibson ring (basically a large circlip) is fitted in the groove at the back of the tyre and the tyre edge rolled to firmly grip the ring.

If the tyre overheats and stretches (usually under repeated heavy braking) the Gibson ring will stop the tyre moving on the wheel centre until it cools and shrinks. If the heating is excessive the tyre will stretch permanently (permanent stretching can also occur with a very thin tyre). In this case the tyre will turn on the wheel centre, wear the Gibson ring and eventually fall off.

On some locomotives Gibson rings are not used. Set screws (screwed through the wheel centre into the tyre) may be used to secure the tyres.

When the tyre reaches condemning limits it can be cut off and a new tyre fitted.

1.2.2 Solid Wheels

A solid wheelset consists of an axle and a solid wheel, with the wheel centre, rim and flange cast as one piece. They have replaced tyred wheels because of the problems which can occur with the latter.

Some early difficulties occurred in the construction of solid wheels in making the tread sufficiently hard to resist wear while ensuring that the disc retained strength and resilience, but modern casting techniques have overcome these.

When a solid wheel reaches condemning limits it can be pushed off the axle and a new wheel fitted.

2.0 Wheelset Defects

2.1 Axles

No axle may be cracked or broken. Ultrasonic crack testing should be done at specified intervals to ensure there are no internal cracks. Inspectors should verify that crack testing has been carried out in accordance with the rail operator's safety system. (See "B3.1.4.01 - Task Instruction – Corrosion, Crack and Structural Inspection" for guidance on crack testing of axles.)

No axle may have a gouge in the surface that is between the wheels and is more than 3 mm deep. The most common reason for gouging is fouling by the brake rigging or bogie frame.

2.2 Back-to-Back Measurement

The back-to-back measurement between wheels on the wheelset must be between 997 mm and 998 mm, as checked with back to back gauge Y/X 4603/10.

This distance must be checked:-

- After derailment
- If any tyred wheel shows signs of overheating.
- After fitting of new tyres, solid wheels. etc

This may be measured using the appropriate "back to back" gauge (eg gauge Y/X 4603/10) at four equidistant positions around the circumference of the wheels. On axles that are under vehicles, measure the back-to-back dimension at the 9 o'clock and 3 o'clock positions then turn the wheel a quarter of a turn and repeat the measurements. (If other positions are used, the deflection of the axle under load will give incorrect readings.)



Back to back gauge (997 mm long)

The gauge must not wedge between wheels, or slack by more than 1 mm. The gauge fit should be consistent around the circumference of the wheelset.

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Issue 1

2.3 Cracks in Tyre or Rim

No wheel rim, flange, or tread may have a break. Cracking shall be limited to the following;

Description of defect	Action
Wheels with any crack;	Okay to
Less than 25mm long in tread area, or	run
Not extending onto the chamfer area or front face of the rim, or	
• Less than 10mm and located partially or totally within the flange	
area or chamfer area	
Wheels with any crack;	Not to run
Greater than 25mm long, or	
 Extending onto the chamfer area or front face of the rim, or 	
Greater than 10mm and located partially or totally within the flange area or chamfer area	

Note - applicable definitions for table are;

- Flange area extends 30mm from back face of the wheel
- Chamfer area extends 12mm from the front face of the wheel
- Tread area area contained between flange and chamfer areas





Cracked rim



Thermal cracks in tread area

2.4 Cracks in Plate or Hub

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No wheel plate, or hub area may have a crack or break.



Cracked or broken plate

2.5 Cracked Spokes

No wheel spoke shall be cracked.

2.6 Chips or Gouge in Flange

No wheel or tyre may have a chip or gouge in the flange that is greater than 2 mm deep and that is also greater than 40 mm in length and greater than 12 mm in width.



Scrape, dent or gouge

2.7 Shelling and Spalling

No wheel or tyre may have a shelled spot or spalling that is more than 40 mm in length or 2 mm in depth.



Shelled Tread

Protrusion "B" on field gauge 13090426 can be used to check the depth of a shell or spall. Any defect deeper than the protrusion (2 mm) indicates that attention is required from a wheel lathe. (See below.)

Likewise section "A" " on field gauge 13090426 can be used to check the length of a shell or spall. Any spalls longer than the straight edge (40 mm) indicates that attention is needed from a wheel lathe. (See below.)



2.8 Flats

No wheel or tyre may have a skid flat that is more than 40 mm in length.



Single flat area

Multiple flat areas

Section "A" " on field gauge 13090426 can be used to check the length of a flat. Any flats longer than the straight edge (40 mm) indicates that attention is needed from a wheel lathe. (See photo above.)

If the flat has a metal build-up at the edge this should be removed by grinding to provide a smooth lead-in to the flat. The ground flat must not exceed 40 mm in length.



2.9 Circumferential Grooves

No wheel or tyre may have any groove running circumferentially that is greater than 3 mm deep.

Circumferential grooves are usually caused by objects jammed in the brake blocks or the exposed steel reinforcing wire of brake blocks that have been allowed to wear below limits.

2.10 Metal Build Up

Issue 1

No wheel or tyre may show a build up of metal on the tread.



Build up on tread

Any build up must be removed by grinding or turning at a wheel lathe.

2.11 Tread Edge Rollover



Any vehicle running on services carrying passengers must not have any tread edge rollover. (Note: this includes service wagons, etc.)

Otherwise edge rollover shall not exceed 3 mm.

2.12 Loose Wheels

No wheel may show evidence of being loose on the axle. Signs indicating a loose wheel include rust or oil seeping from the interface between wheel and axle. These signs are not infallible as they could be caused by:

- Oil from the axlebox seeping along a keyway.
- Rust build-up in the undercut bevel at the interface.

If movement is suspected it may be verified by either

- Removing wheelset and back-pressing in a wheel press
- Thoroughly cleaning the interface between wheel and axle and painting with enamel paint. The paint should be examined frequently for signs of cracking.

2.13 Loose Tyres

No tyre may show any clear evidence of having moved on the wheel.

Where such recent movement is suspected on wheel, but without clear evidence:

- The tyre and wheel centre must be marked.
- The vehicle must be clearly labelled.
- The wheel must be inspected before each journey.
- The vehicle must be stopped if any clear evidence of movement is found.



Marked tyre and wheel centre

To mark a tyre and wheel centre emery a section of the interface back to bare metal. Paint the area with a paint that will give a good contrast (eg white) and scribe lines at right angles across the interface. Any displacement between the lines indicates movement.

2.14 Gibson Rings and Set Screws

Except for certain steam locomotives, every tyre must be secured by a Gibson ring that is not loose. A low pitched or dull ring from a hammer tap indicates a loose Gibson ring. If there is any suspicion of movement between a tyre and disk the wheel must be removed from service.

Locking screws securing locomotive tyres must secure.

2.15 Welding or Gas Cutting

No wheel or tyre may be welded or gas cut.

If any evidence is discovered of welding or gas cutting, the wheelset must be immediately removed from service.

2.16 Overheating

- (a) A wheel must not show signs of having been overheated as evidenced by a reddish brown discoloration, on the face of the rim, i.e., extending on the face more than 100 mm into the plate area measured from the inner edge of the rim.
- (b) A tyred wheel that shows signs of overheating must not run in service before the tyre is inspected and
 - Confirmed as secure and
 - The back-to-back measurement between wheels on the wheelset is between 997 mm and 998 mm, as checked with back to back gauge Y/X 4603/10. (See 2.2 Back-to-Back Measurement)



Hot wheel

2.17 Derailments

Any wheelset that has been in a derailment must be examined as follows before returning to service.

- Check of back-to-back measurement (See 2.2, Back To Back Measurement).
- Examination of roller bearings for damage (See B3.1.1.01 Mechanical Code of Practice; Section 3.4.5 Derailment Damage).
- Examination of the tyres for chips, gouges etc (See 2.6, Chips or Gouge in Flange)

2.18 Wheel Diameters

- (a) The diameters of two wheels on the same axle must not differ by more than 1 mm, as measured on a wheel lathe comparator (Z gauges are not used for this purpose). The difference in wheel diameter is usually only checked after wheel lathe attention.
- (b) Unless allowed for in the vehicle design, the diameters of un-powered wheels on the same bogie must not differ by more than 20 mm (10 mm in Z readings).
- (c) The diameters of driving wheels on the same vehicle must not differ by more than 13 mm (6 mm in Z readings).
- (d) The diameters of wheels connected by rods or drive-shafts must not differ by more than 1 mm, as measured on a wheel lathe comparator (Z gauges are not used for this purpose).



Wheel comparator (dial gauge normally mounted on right hand bracket)

3.0 Wheel Profiles



3.1 Gauges

See Section 4 for identification of the various gauges used for measuring wheel profiles.

<u>Care</u>

Use care when handling wheel gauges. They must not be knocked or dropped.

Taking Measurements

- Clean the front and back of the wheel at the point where the measurement is to be taken.
- Fit the gauge(s) over the flange and point it to the centre of the axle.
- Hold the gauge firmly against the inside of the flange at all times. (Care may be needed when the tyre thickness is small due to the small area available and/or when the inside of the flange has not been turned flat.)

<u>Tips</u>

- Be consistent. Adopt a standard sequence for taking the readings. (eg A side before B side. X, Y, V, W and Z readings in order.)
- Start at No 1 axle and the A side wheel and work along the vehicle. (For other than steam locomotives the No 1 end is the hand brake end and the A side is the hand brake side.)
- Preferably use an assistant for recording the readings. This reduces mistakes and keeps the paper work cleaner.
- Check that the readings make sense. Widely varying readings should be rechecked. You may have made a mistake or there may be a problem with the vehicle setup which is causing the wheels to wear unevenly.

3.2 Flange Thickness ("X")

Flange thickness ("X" reading) is expressed as % wear.

A wheel flange must not show an 'X' reading of more than 40 as indicated by Gauge 13090426 or PD100766.

To avoid material wastage when turning wheels they should be programmed for attention at a wheel lathe when the "X" reading exceeds 24, except when the tyre has had its last turn.

Locomotive wheelsets should not have a difference in 'X' readings from side to side of more than 10 $\,$

3.3 Flange Height ("Y")

Flange height ("Y" reading) is measured in mm above a datum.

A wheel must not have flange height, 'Y' reading of more than 6 mm as indicated by Gauge 13090426 or PD100766.



Using Gauge PD100766 to measure "X" and "Y".

To use gauge

- Set the "Y" indicator to maximum and the "X" indicator to 0.
- Place against the back of the wheel and slide until the datum point contacts the tread.
- Move the "X" lever until it touches the side of the flange and release.
- Slide the "Y" indicator until it touches the flange.
- Remove the gauge from the wheel without disturbing the indicators and record the measurements. (Note that the "X" indicator reads in 2% increments and the "Y" in 1 mm increments.)



Using Gauge 13090426 to indicate "X"

To use gauge

- Hold the Z scale flat against rear of wheel with "X24" (wide) slot over flange.
- Slide gauge down over flange
 - If point "S" does not touch tread then "X" < 24% (OK to run)
 - If point "S" touches the tread then "X" > 24%
- If "X" > 24 then repeat the test using the "X40" (narrow) slot
 - If point "P" does not touch tread then "X" < 40% (Programme for turning unless on last turn.)
 - If point "P" touches the tread then "X" > 40% (Condemn)



Using Gauge 13090426 to indicate "Y"

To use the gauge:

- Apply the gauge to the wheel with the Z scale flush with the inside of the wheel, and either the point marked V on the tread, or the curve marked Y on the flange.
- If the curve marked Y touches the top of the flange the "Y" > 6 mm (fail)
- "Y" < 6 mm if the point marked V touches the tread. (OK to run)

3.4 Guttering ("V")

Tread guttering ("V" reading) is measured in mm below a datum line.

A wheel must not have guttering depth, 'V' reading, of more than 6 mm as indicated by Gauge PD100766/4.

Passenger wheels should be programmed for attention when "V" exceeds 3 mm in the interest of ride comfort.



Using Gauge PD100766/4 to measure "V"

To use gauge

- Set the indicator to maximum.
- Place against the back of the wheel and slide until the datum edge contacts the tread.
- Slide the indicator until it touches the tread.
- Remove the gauge from the wheel without disturbing the indicator and record the measurement. (Note that the gauge measures in 1 mm increments.)

3.5 Flange Sharpness ("W")

Flange sharpness is measured on the diagonal through the top corner of the flange.

A wheel flange must not show sharpness that allows rocking as indicated by Gauge 13090426 or shows a "W" reading more than 14 on gauge PD 100991.

A wheel with a "W" reading of more than 12 should be programmed for attention.

A wheel with a "W" reading of more than 14 must be ground or turned in a wheel lathe.



Using Gauge PD 100991 to measure "W".

To use gauge

- Open the gauge to the maximum and set the indicator to maximum (i.e., 20).
- Place the gauge over the flange with frame flush with the back of the wheel and the slide touching the top of the flange, slide the gauge in until the gauge touches the outside of the flange, then move the indicator towards the flange until it touches.
- Remove the gauge from the wheel without disturbing the indicator and record the measurement.



Using Gauge 13090426 to indicate "W"

To use gauge

- Apply the gauge at W to the corner of the flange
- Excessive sharp flange is indicated if the gauge can rock.
- No sharp flange is indicated if the gauge cannot rock.

3.6 Tyre or Wheel Thickness ("Z")

Tread or tyre thickness as measured by the Z reading shall not to be less than the tread condemning limits specified in the following table as measured by Gauge 13090426 or Y/X 7601/13 or Y/X 7601/12

- a) For tyred wheelsets the thickness ['Z' reading] of both tyres on an axle must be checked before turning since discs of different diameters may be fitted to the same axle. The wheelset condition is then determined by the smaller of the two Z readings. Likewise some passenger car wheel centres have been turned off centre and the tyre thickness varies around the wheel. The wheelset condition is then determined by the smallest Z reading.
- b) A number of classes of steam locomotives have shrink fit tyres without Gibson rings to secure tyres to the wheels. On these the inside of the wheel has to be scraped and cleaned with emery paper to show the joint between the wheel and the tyre. Extreme care is required when measuring the Z reading on these tyres as the lathe tool turning marks on the back of the tyre require good lighting and eye sight to pick out the tyre and wheel joint.
- c) Tread or tyre thickness limits are determined by either:-
 - (1) the safe operating thickness, or
 - (2) limits on brake rigging travel with worn brake blocks. (This applies on Da /Dc / Dbr locomotives and type 25140 car bogies, unless the brake rigging has been modified, and may also apply to other vehicles.)

Tread Condemning Limits (Z Reading in mm)			
Vehicle	Wheel or Bogie Type	Tyres	Solid Discs
Steam Locomotives	A, Aa, B, Ba, Bb, C, F, Fa, H, Q, U, Ub, Uc, W, Wa, Wb, We, Wf, Ww, X, Y	32	
	Ab, J, Ja, Jb, K, Ka, Kb, Wab - driving	35	
	Ab, J, Ja, Jb, K, Ka, Kb, Wab - bogies	32	
	Tenders	32	
Electric	Ea, Ed, Ec, Eo, Ew	32	
	D, Dm	35	
Diesel	Da, Dc, Dbr - driving	32	40
Locomotives	Da, Dc, Dbr - idling	32	32
	De	32	
	Df (original), Dg, Dh (original)	32	
	Di	32	29
	Dj	32	
	Ds. Dsa, Dsb	32	
	Dsc	32	29
	Tr	29	
Railcars	49 Seater Railcar (Ld'g & rear wheels)	29	
	66 ft, Vulcan & Twin Car Railcars		38
	Vulcan Railcar Power Bogie Carrying Wheel	32	

Tread Condemning Limits (Z Reading in mm)			
Vehicle	Wheel or Bogie Type	Tyres	Solid
		-	Discs
Cars & Vans	25140*, 25330 bogies (Type 75A tyres)	32	38
	28020 (Type 75 tyres)	32	44
	X27250		44
	X28250		44
Wagons	Bogie wagons on passenger trains ‡	32	29
	Other bogie wagons (50 km/h max on passenger	29	16
	trains) ‡		
	4 wheel	19	16

* See para (c) above

‡ Not type 16, 18, 22

- Note 1 The above limits have been sourced from:-Drawing Y/X 7601/4 - Standard Tyres; Last Turning and Condemning Sizes NZ Rail Wear & Tyre Limits chart stamped 29/8/1991 Tranz Rail Wheelset Manual, 10 June 1997 Tranz Rail M6000 Wheelset Manual, Issue 3 (9/5/2001) Current Toll Rail practices.
- Note 2 The above limits have been determined by the FRONZ Heritage Technical Committee as being applicable to rail vehicles used by National Rail System Heritage Operators. Other rail operators, operating at lower speeds and weights, may wish to adopt lower limits that reflect their operating conditions. Attention is drawn to Plan Y 21192 (Revised 7/10/1966), which permitted lower limits for steam locomotives at the end of the steam era.



Using Gauge Y/X 7601/12 to measure "Z" on tyred wheel,

- Place the gauge against the inside of the tyre.
- Move the gauge down until it touches the tread.
- Take the reading at the bottom inside of the flange.



Using Gauge Y/X 7601/13 to measure "Z" on solid wheel.

- Place the flat of the gauge against the • outside of the wheel.
- Move the gauge down until the top • rests on the tread.
- Take the reading at the bottom of the • outside of the rim.



Using Gauge 13090426 to measure "Z"

Use as above for tyred wheels or solid wheels.



asure "Z" Using a small straight edge to assist with "Z" readings. Hold at right angle to scale edge. or solid

Gauge is used when there is insufficient room to use the normal "Z" gauges (eg because of traction motor gear cases, brake rigging etc.)

To use gauge:-

- Clean all debris, grease etc from the groove between the tyre and Gibson ring.
- Move indicator slide to maximum.
- Loosen lock screw holding rod and turn rod so it will clear obstructions.
- Place gauge against back of tyre and slide until the datum point contacts the tread.
- Push rod in and turn until it stops and the point is in line with the tyre / ring groove.
- Ensure that the finger on the rod is behind the indicator (high side).
- Pull rod out until point is firmly seated in the bottom of tyre / Gibson ring groove.
- Release the rod by reversing the above movements.
- Remove gauge and read the indicator (in 1 mm increments).

Using Gauge PD100766 Type 1 to measure "Z".



4.0 Tyre Gauge Photographs



Gauge PD100766 Type 2 Used to measure flange thickness ("X") and flange height ("Y")





Gauge PD100766/4 Used to measure tread guttering ("V")



Gauge PD100766 Type 1 (front and rear views)

Used to measure flange thickness ("X") and flange height ("Y") as for Type 1 and tyre thickness ("Z") when other gauges cannot be used.

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Gauge PD10991 Used to measure flange sharpness ("W")



Field Gauge 13090426 Used to measure tyre or solid wheel thickness ("Z") and give "NO/NO GO" indications for flange thickness ("X"), flange height ("Y"), flange sharpness ("W"), spall or flat length ("A") and spall depth ("B").



Gauge Y/X 7601/12 Used to measure tyre thickness ("Z") on tyred wheel.



Gauge Y/X 7601/13 Used to measure tread thickness ("Z") on solid wheel,

5.0 Testing of gauges

All gauges are to be tested with the relevant test piece or following the relevant instructions.

Gauges PD100766 types 1&2, PD 100766/4 and PD100991 are to be tested every 12 months, or at any time after the gauge has been dropped, or damage is suspected, with the test plate 34100051A. Scales X, Y, V, and W on these gauges should register zero on the test plate; Z should register 62 on PD100766 type 1. These gauges must be re-calibrated when the scale readings are inaccurate by more than 0.5 mm.

Wheel profile gauge 13090426 for use in the field is to be checked every 12 months against a master gauge. There should be no variation greater than 0.5 mm at any gauging point on the profile between the two gauges.

Back-to-back gauge Y/X 4603/10 must be 997 + 0.1, -0 mm when checked with appropriate vernier callipers or micrometer.