# Engineering Standard

## Rolling Stock

# CRN RS 010

# VEHICLE ACCEPTANCE TEST AND INSPECTION REQUIREMENTS

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# Document control

| Revision | Date of Approval | Summary of change |
|---|---|---|
| 1.0 | 20/9/11 | For publication |
| 1.1 | 7/11/11 | Minor corrections |
| 2.0 | 7/12/16 | Review and update |
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# Summary of changes from previous version

| Section | Summary of change |
|---|---|
| 1 and 18 | Reference to trolleys and trailers removed |
| 4.5 | Twist test criteria update to the current requirements |
| 7.4 | Parking/handbrake holding test amended to include the drag test. |
| 18.2 | Note added regarding deceleration being a negative value |
| Appendix 2 | Twist Test packing table amended to cover current twist test and extended to cover long vehicles |
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# Contents

# 1 Vehicle acceptance test/inspection requirements

## 1.1 Introduction

This document is an Appendix C to each of the following rolling stock minimum operating standards and covers the testing/inspection requirements necessary for vehicles to gain acceptance for operation on the NSW Country Regional Network (CRN).

- Locomotives CRN RS 001
- Freight vehicles CRN RS 002
- Locomotive hauled passenger vehicles CRN RS 003
- Multiple unit trains CRN RS 004
- On-track infrastructure maintenance vehicles CRN RS 005
- Road/rail infrastructure maintenance vehicles CRN RS 006

## 1.2 Test/inspection requirements

The following sections cover the common acceptance test requirements for vehicle compatibility with the CRN infrastructure, other rolling stock and the environment.

The following table provides a complete list of vehicle acceptance test/inspections and the reference to the appropriate Clauses within this standard.

| Test Section No | Acceptance test/inspection | Reference | Static Test | Dynamic Test |
|---|---|---|---|---|
| 2 | Static rolling stock outline test | Section 2 | **X** | |
| 3 | Static vehicle weigh test | Section 3 | **X** | |
| 4 | Static vehicle twist test | Section 4 | **X** | |
| 5 | Static vehicle/bogie swing test | Section 5 | **X** | |
| 6 | Static vehicle/vehicle swing test | Section 6 | **X $** | |
| 7 | Static brake tests | Section 7 | **X** | |
| 8 | Safety equipment functionality test | Section 8 | **X** | |
| 9 | Signal visibility test | Section 9 | **X** | |
| 10 | Personnel safety inspection | Section 10 | **X** | |
| 11 | AEI tag installation inspection | Section 11 | **X** | |
| 12 | Reflective delineator inspection | Section 12 | **X** | |
| 13 | Vehicle recovery equipment inspection | Section 13 | **X** | |
| 14 | Kinematic rolling stock outline test | Section 14 | **X** | **X $** |
| 15 | Environmental tests | Section 15 | **X** | **X** |
| 16 | Signal compatibility test | Section 16 | | **X** |

**Table 1 - List of vehicle compatibility tests**

| Test Section No | Acceptance test/inspection | Reference | Static Test | Dynamic Test |
|---|---|---|---|---|
| 17 | Signal & communication system interference test | Section 17 | | **X** |
| 18 | Brake performance test | Section 18 | | **X** |
| 19 | Ride performance test | Section 19 | | **X** |
| 20 | Pitch & bounce performance test | Section 20 | | **X $** |
| 21 | Traction performance test | Section 21 | | **X** |
| 22 | Vehicle structural tests | Section 22 | | **X** |
| 23 | P2 Force wheel impact test | Section 23 | | **X** |
| 24 | Curve stability test | Section 24 | | **X** |

**Table 1 (Continued) - List of vehicle compatibility tests**

**$** This test may be conducted using a validated vehicle simulation package.

| Test Section No. | Static Acceptance Test/Inspection | Reference | Pre-requisite Static Tests Reference. No. |
|---|---|---|---|
| 2 | Static rolling stock outline test | CRN RS 008, Section 2 | |
| 3 | Static vehicle weigh test | CRN RS 008, Section 3 | |
| 4 | Static vehicle twist test | CRN RS 008, Section 4 | Section 3 |
| 5 | Static vehicle/bogie swing test | CRN RS 008, Section 5 | |
| 6 | Static vehicle/vehicle swing test | CRN RS 008, Section 6 | |
| 7 | Static brake test | CRN RS 008, Section 7 | |
| 8 | Safety equipment function test **#** | CRN RS 008, Section 8 | |
| 9 | Signal visibility test **#** | CRN RS 008, Section 9 | |
| 10 | Electrical safety inspection | CRN RS 008, Section 13 | |
| 11 | AEI tag installation inspection | CRN RS 008, Section 14 | |
| 12 | Reflective delineator inspection | CRN RS 008, Section 15 | |
| 13 | Vehicle recovery equipment inspection | CRN RS 008, Section 16 | |
| 14 | Environmental tests | CRN RS 008, Section 17 | |

**Table 2 - Sequencing of static tests**

**#** Tests 9 & 10 are for self-propelled vehicles only. These tests are not compulsory for the locomotive hauled movement of the vehicle.

## 1.3 Sequencing of tests

It is important that static tests be carried out in the above sequence to ensure that all necessary pre-requisite tests have been performed before subsequent testing is carried out.

Generally, static tests must be completed before any dynamic tests are undertaken.

Following successful completion of the above test/inspections, Parts A, B and C of the appropriate Vehicle Information Pack must be submitted as confirmation of vehicle's compliance.

### 1.3.1 Static test/inspections

The above static tests/inspections must be successfully carried out prior to any movements of the vehicle on the CRN:

### 1.3.2 Dynamic tests

The following dynamic tests are required before full operating approval is granted for the vehicle.

These tests can only be commenced after successful completion of all the static tests and a CRN TOC Waiver has been issued.

| Test Section No. | Dynamic compatibility test | Reference | Pre-requisite dynamic tests reference No. | Tests where monitoring is required See Section 1.3.4 |
|---|---|---|---|---|
| 15 | Kinematic rolling stock outline test | CRN RS 008, Section 18 | 16 and 17 unless test done in a possession | 18, 19 |
| 16 | Signal compatibility test | CRN RS 008, Section 19 | | 15, 18, 19 |
| 17 | Signal & communication system interference test | CRN RS 008, Section 20 | | 15, 18, 19 |
| 18 | Brake performance test | CRN RS 008, Section 21 | 16 and 17 unless test done in a possession | 15, 19 |
| 19 | Ride performance test | CRN RS 008, Section 22 | 16 and 17 unless test done in a possession | 15, 18 |
| 20 | Pitch & bounce performance test | CRN RS 008, Section 23 | 16 and 17 unless test done in a possession | 15, 19 |
| 21 | Traction performance test | CRN RS 008, Section 24 | | 15, 18, 19 |

**Table 3 - Dynamic tests**

The following tests are optional.

| Test Clause No. | Dynamic Compatibility Test | Reference | Pre-requisite Dynamic Tests Reference No. | Tests where monitoring is required See Section 1.3.4 |
|---|---|---|---|---|
| 22 | Vehicle structural tests | CRN RS 008, Section 25 | | |
| 23 | P2 Force wheel impact test | CRN RS 008, Section 26 | 16 and 17 unless test done in a possession | |
| 24 | Curve stability tests | CRN RS 008, Section 27 | | |

**Table 4 - Optional dynamic tests**

### 1.3.3 Movement of test vehicles on the CRN

The following requirements apply for the movement of test vehicles on the CRN until such time as the appropriate dynamic tests, for each vehicle type, have been completed and accepted:

- Self-propelled vehicle shall be locomotive hauled in the unpowered state.
- The maximum speed for the movement shall not exceed 70% of the maximum designed operating speed for the vehicle.
- The ride performance shall be monitored in real time to the requirements specified in Section 19 for each vehicle type involved.
- The maximum speed in curves shall be limited to 10% below the normal speed board.
- Except for freight vehicles, manual block working conditions shall apply for any movement of vehicles on the CRN.

Before any movement of a vehicle on the CRN, a CRN TOC Waiver must be issued. Where a set of vehicles are to be tested and individual vehicles in the set are different, such as motor and trailer cars, testing must be conducted for each vehicle type involved.

### 1.3.4 Monitoring vehicle dynamic performance during tests

When conducting dynamic on-track tests such as a brake performance test, a ride performance test or a kinematic rolling stock outline test, each of those vehicle performance parameters must be monitored to ensure that no one or more parameter/s exceeds their allowable limits.

Where a set of vehicles is to be tested and individual vehicles in the set are different, such as motor and trailer cars, the monitoring must be conducted on each vehicle type during the tests.

The allowable limits for each test parameter are the same as those which would apply for a particular performance parameter, if it were the principal test.

The principal test would be undertaken commencing at a low speed and increasing the speed in appropriate increments, whilst monitoring the other performance parameters, and only increasing the speed where all performance parameters remain within the allowable limits specified for each particular parameter.

Once the appropriate monitoring of tests has been undertaken for a particular vehicle configuration, successive testing can be undertaken without further monitoring of those test parameters. In this case the maximum vehicle speed for normal operation will be limited to 10/11ths of the maximum test speed at which the allowable limits were maintained during the ride performance monitoring tests.

For example, if a vehicle's ride is monitored to a maximum speed of 110 km/h, and its performance is within the limits specified in CRN Standard CRN RS 008, Section 22, then that vehicle's speed will be limited to a maximum of 100 km/h for operation without the need for further monitoring.

As an alternative to monitoring the kinematic rolling stock outline compliance, the vehicle speed can be limited to 10% below the normal speed boards, provided that the ride performance is satisfactory at 10% above this limited speed.

For example, a vehicle may be operated to a maximum speed of 90 km/h in an area where the posted speed sign is 100 km/h, and the kinematic rolling stock outline performance does not need to be monitored, provided the static part of the kinematic rolling stock outline test has been performed and meets the requirements of CRN Standard CRN RS 008 Section 18.

If the vehicle configuration has changed since the last monitored test, then further monitoring of tests will be required, to establish that the configuration change has not compromised the vehicle's performance and it remains within allowable limits for all parameters. Further monitoring of tests is

only required where a particular performance parameter has been adversely affected by the configuration change.

# 2 Static rolling stock outline test

## 2.1 Introduction

This test is required to ensure that the vehicle is constructed within the confines of the particular static rolling stock outline specified for that vehicle type and the corridor/s along which the vehicle is to operate. Refer to CRN Standard CRN RS 008 Section 2.

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

An infringement on the rolling stock outline is not acceptable unless specifically authorised in writing by a CRN Rolling Stock Standards Waiver or Exemption Certificate.

When an existing vehicle design has been modified, such that the modification results in an infringement of the rolling stock outline, the vehicle shall be re-assessed.

## 2.2 Test configuration

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

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

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

Vehicle length over headstocks/body and bogie centres shall also be measured.

Open and closed hopper discharge doors shall not infringe the rolling stock outline when the vehicle has a solid suspension and fully worn wheels.

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

## 2.3 Test site configuration

The test shall be carried out on a level track plane or simulated track on level flooring. The vehicle shall be measured to ensure that it is of equal width about its own centreline as well as the track centreline. The vehicle should be standing upright and not leaning in favour of any one side.

# 3 Static vehicle weigh test

## 3.1 Introduction

This test is covered in CRN Standard CRN RS 012 and is designed to ensure that the vehicle is constructed within the allowable axle load limits and axle load distribution for the particular type of rolling stock and the corridor/s along which the vehicle is to operate.

The mass distribution of a vehicle shall be within the limits specified in CRN Standard CRN-RS-012.

For maximum axle loads refer to CRN Standard CRN-RS-008, Section 3.3

## 3.2 Weighing test procedure

For consistency in the method of weighing vehicles, a recommended procedure for performing the weigh test is given in in the CRN Standard, CRN-RS-012.

# 4 Static vehicle twist test

## 4.1 Introduction

This test is designed to ensure that the vehicle is compatible with the track twist limits of the CRN, without exceeding an acceptable level of wheel unloading.

## 4.2 Twist test requirements

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

## 4.3 Vehicle configuration for twist test

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

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

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

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

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

For vehicles with moveable gantries, buckets, cranes or other plant, the twist test shall be performed with that plant positioned to give the maximum wheel unloading, for the operating configuration when set up for travel mode.

## 4.4 Test site configuration

The twist test shall be conducted on a level section of track or simulated track firmly supported by a concrete bed or by sleepers on hard packed soil or gravel. The ground support will depend on the mass of the vehicle being tested. The essential requirement is adequate ground support to permit the vehicle to be safely jacked without jack settlement. It may be necessary to use large base plates to assist in distributing the jacking loads.

A variety of steel/aluminium packing will be required to support the wheels on the rails.

## 4.5 Twist test criteria

A local twist of 1 in 77 over 2.7 metres, in combination with a general twist of 1 in 250, shall be applied to the vehicle overall wheelbase, as shown in the Figures below. All ramps are relative to the horizontal.

The maximum permitted wheel unloading is 60%. Where the wheel unloading exceeds 58%, a sample of other vehicles of the same type of build shall be tested to ensure consistency of result.

Vehicle wheels shall be packed and wheel loads measured as shown in the Figures below:

For articulated vehicles, the combined twist shall be applied in accordance with figures 3, 4 and 5 below.

For vehicles with other wheel configurations, such as steam locomotives, the twist parameters shown in Figure 2 shall be used.

Refer to Appendix 2 of this standard for twist test packing requirements.

### 4.5.1 Four wheel vehicle

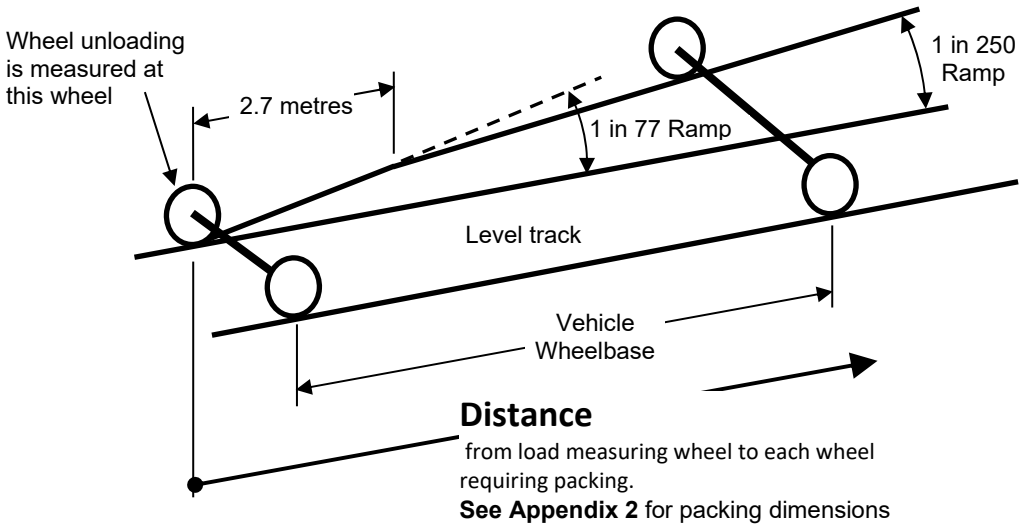



**Figure 1 – Four wheeled vehicle twist**

### 4.5.2 Conventional bogie vehicle

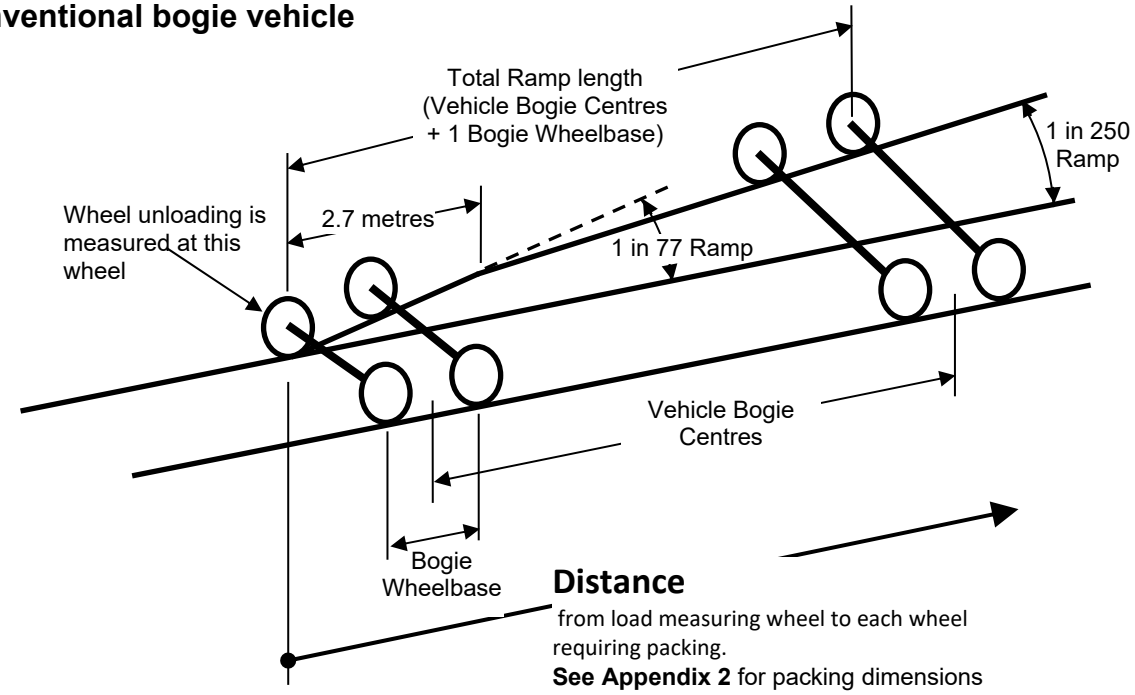



**Figure 2 – Conventional bogie vehicle twist**

### 4.5.3 Articulated bogie vehicle

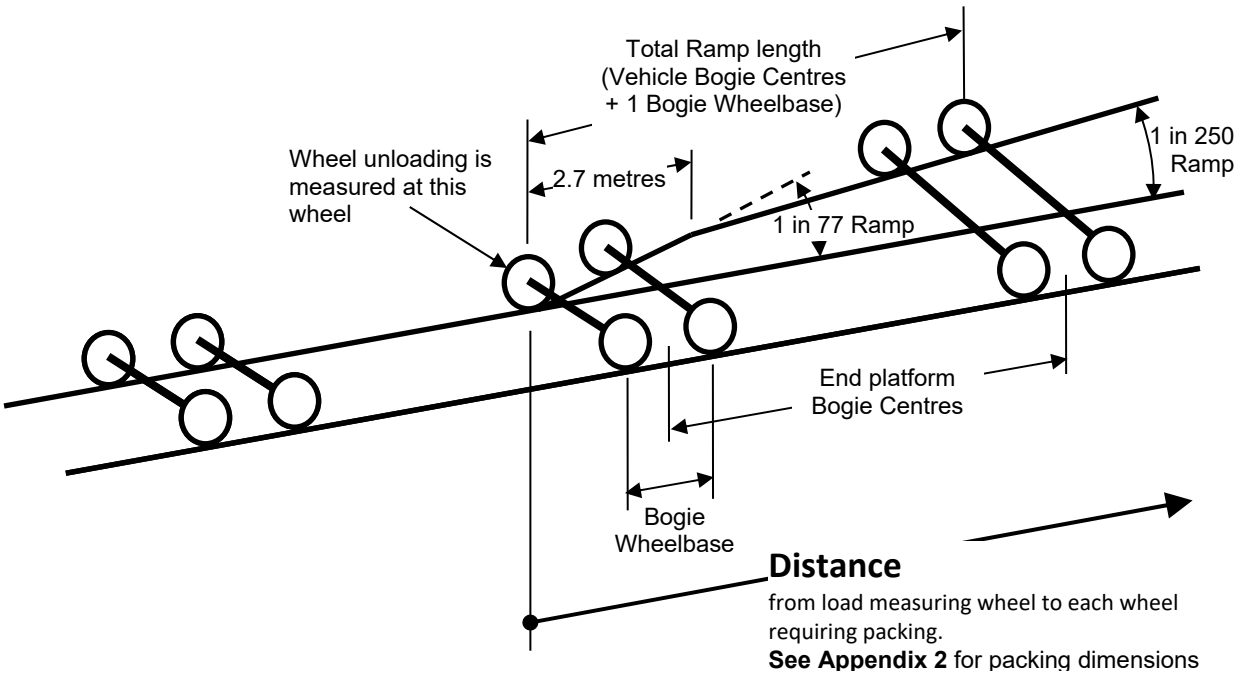



**Figure 3 – Articulated bogie, end platform twist**

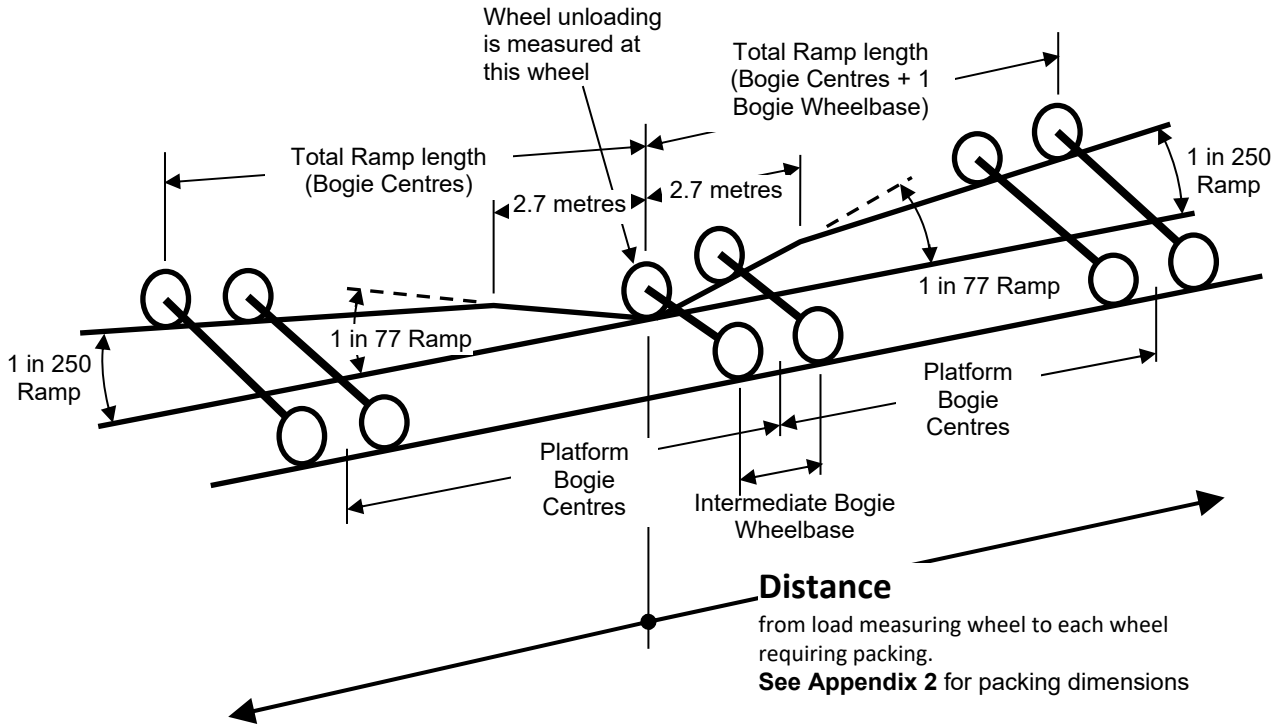



**Figure 4 – Articulated intermediate bogie twist**

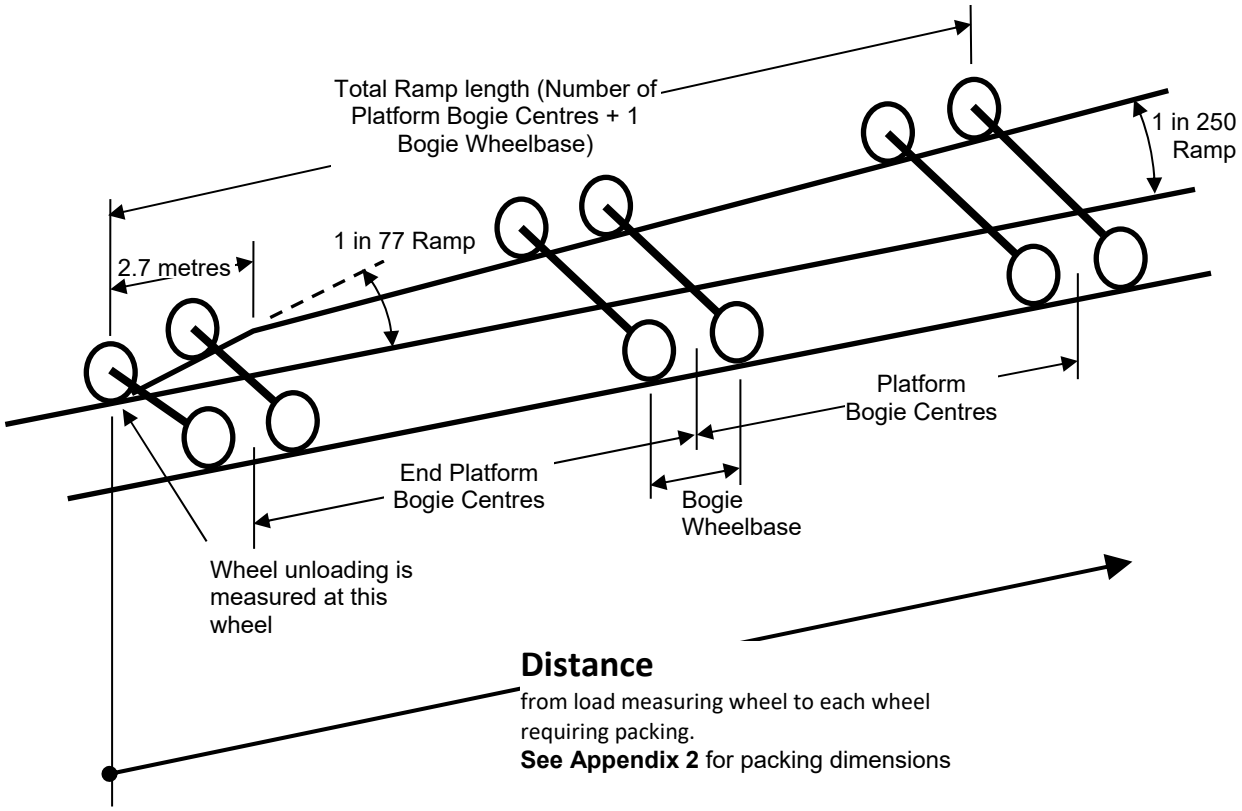



**Figure 5 – Terminal bogie, maximum vehicle length twist**

### 4.5.4 Road/rail vehicle

Road/rail vehicles shall be tested in accordance with Figures 6 or 7 below. **NOTE:** If the front and/or rear road wheels are lifted clear of the track then no packing is required at those wheels

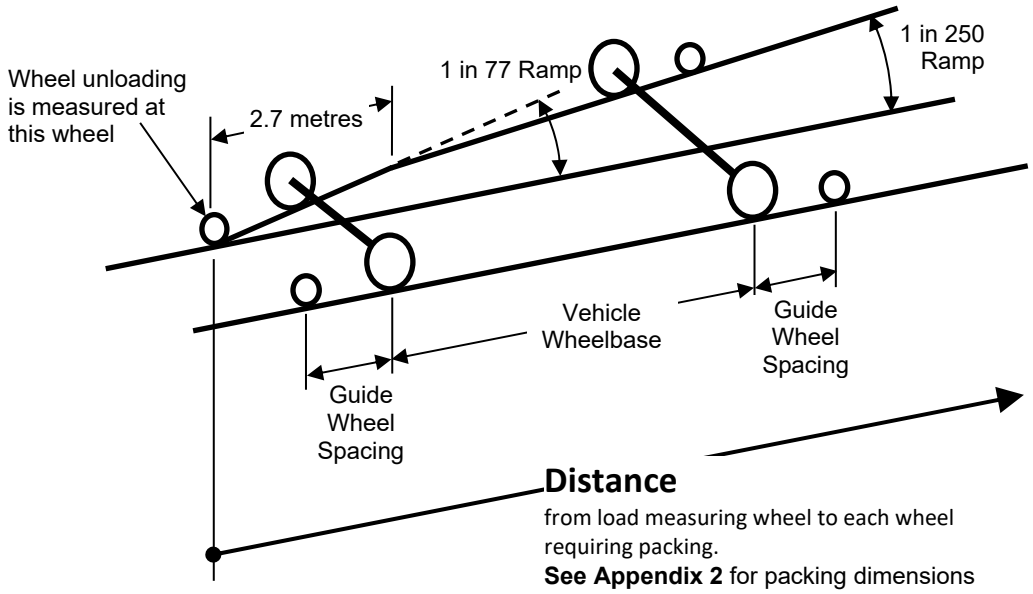



**Figure 6 – Road/rail vehicle twist**

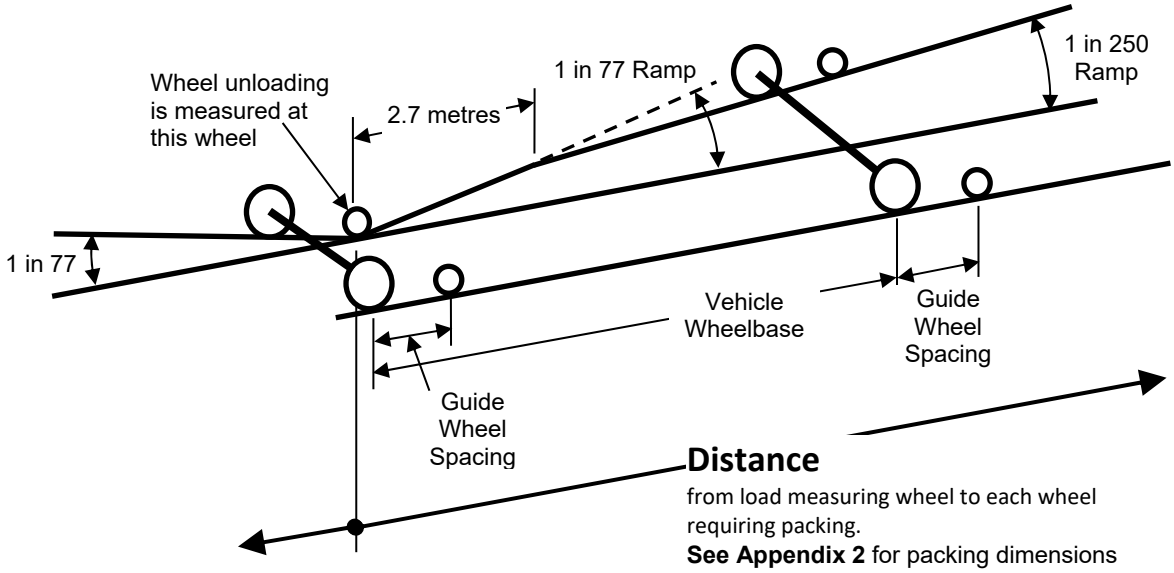



**Figure 7 – Road/rail vehicle twist**

# 5 Static vehicle/bogie swing test

## 5.1 Introduction

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

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

This is a type test only.

The vehicle is not expected to negotiate the curve radius specified for this test while in service. Refer to CRN Standard CRN CS 210 for actual track geometry limits.

## 5.2 Vehicle configuration

Before conducting the swing test, check that the coupler height is within the allowable range. Refer to Standard CRN-RS-008, Section 6.10.

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

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

The vehicles shall be tested complete with all equipment such as brake rigging, hoses, etc and new wheel condition (full diameter wheels).

CAD simulation may be used provided the owner/operator is confident that the vehicle construction complies with CAD design drawings.

## 5.3 Minimum horizontal curve radius

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

## 5.4 Minimum clearance

There shall be minimal or no interference between any bogie component and any vehicle underframe/body/structure component when subjected to the minimum curve test, after allowances for all possible modes of vehicle bogie/body relative movement . These allowances will depend on the vehicle design.

The travel of brake rigging shall be taken into account when estimating clearances.

## 5.5 Calculation of swing deflection

The vehicle/bogie swing test can be performed by moving one end of the vehicle laterally to rotate the vehicle body relative to the bogie at the opposite end to simulate the vehicle/bogie relationship on a 70 metre curve. The lateral movement can be calculated using the diagrams in CRN Standard CRN RS 008 Section 5.

# 6 Static vehicle/vehicle swing test

## 6.1 Introduction

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

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

This test is a type test only.

The test may be conducted as a practical test or by CAD simulation. The CAD simulation must take into account coupler length, draft gear displacement, body lateral displacements, air brake coupling hose lengths, jumper coupling length, diaphragms, etc.

## 6.2 Vehicle configuration

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

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

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

## 6.3 Minimum horizontal curve radii

All vehicles shall be capable of successfully negotiating a 90 metre simple curve and a 120 metre reverse curve without any fouling or binding of inter-vehicle connections:

## 6.4 Minimum vertical curve radius

All vehicles shall be capable of successfully negotiating a vertical curve (both convex and concave) of 300 m radius, while coupled to a base vehicle (see definition in Section 6.5 below). Allowance shall be made for a difference in coupler height between the two vehicles of 75mm, on level track, plus a vertical displacement at the coupling line of +/- 35mm due to deflection of the vehicle suspensions.

## 6.5 Base vehicle dimensions

The base freight vehicle for the purpose of assessing vehicle to vehicle compatibility and determining the optimum couple length is defined by the following dimensions:

- Length over headstocks: 12 600mm
- Length over coupling lines: 13 490mm
- Bogie centres: 9 500mm
- Coupler length: 680mm (centre of pin to the coupling line)

The base vehicle for passenger vehicles and locomotives is the shortest vehicle that the test vehicle is likely to couple to during its service life. In the case of multiple unit trains the vehicles will normally work with like vehicles.

## 6.6 Minimum clearance

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

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

Clearance around inter-car connectors, diaphragms, gangways, etc shall also be checked.

# 7 Static brake tests

## 7.1 Introduction

A static brake test shall be conducted in accordance with CRN Standard CRN RS 008 Section 7.

Static brake tests include the following, where applicable, for each type of vehicle and in some cases, each individual vehicle.

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

## 7.2 Brake block force and net brake ratio

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

The brake block forces are measured using a load cell placed between the brake block and the wheel or alternatively it is possible to obtain a brake block load cell insert that replaces the brake block.

Net brake ratios are specified for locomotives and locomotive hauled vehicles in the appropriate Standard for that type of vehicle.

- Locomotives CRN RS 001
- Freight vehicles CRN RS 002
- Locomotive hauled passenger vehicles CRN RS 003

## 7.3 Single car air test

All locomotive hauled freight and passenger vehicle brake systems shall have a single car test conducted on the automatic brake system to confirm the correct brake operation, in accordance with operator's procedures and CRN Standard CRN RS 008, Section 7.

During a single car test, the following items would normally be checked for correct operation:

- Brake pipe leakage
- Main reservoir leakage
- Sensitivity on brake application

- Sensitivity on brake release
- Accelerated release operation (where fitted)
- Grade control valve operation (where fitted)
- Load compensation operation (where fitted)
- Slack adjuster operation
- Brake cylinder leakage
- Auxiliary reservoir leak back
- Main reservoir leak back
- Independent brake (where fitted)
- Double check valve leakage
- Independent brake over automatic brake
- Independent control pipe leakage

## 7.4 Parking/hand brake holding test on a grade

This test can be carried out with the parking/hand brake applied, using either of the following methods:

- With the vehicle parked on an available 1 in 30 grade
- Parked on a simulated 1 in 30 grade using wedges under each wheel, OR
- By performing a drag load test where a drag (tensile) load is applied to the vehicle along the centreline of the track. The drag load shall be at least equivalent to 5% of the vehicle weight. The drag force shall be recorded.

During the test there shall be no tendency for the vehicle to move or for the wheels to rotate. In any case the parking/hand brake shall be capable of holding the vehicle secured indefinitely under the imposed gravitational or mechanical loads.

## 7.5 Static brake valve operation test

The brake valve functionality can be tested by making service applications of varying brake pipe reductions. The brake system shall be tested by moving the brake valve handle to all positions and checking the following:

- the brakes apply and release (ie the brake blocks/brake disc pads are forced onto the wheels/discs and then force released)
- the brake pipe, brake cylinder and reservoir pressures meet the specification

# 8 Safety equipment functionality test

## 8.1 Introduction

A safety equipment function test is required to ensure that all critical items of safety equipment are functioning correctly.

## 8.2 Driver safety system

Driver safety equipment shall comply with the requirements specified in CRN Standard CRN RS 013.

### 8.2.1 Vigilance control system.

- Test the operation of the vigilance control system. Time the interval from acknowledgement to visual warning, audible warning, penalty brake application and the minimum time before the vigilance control system can be reset.
- Check that each acknowledgment button/pedal resets the vigilance cycle.
- Check that when each button/pedal is depressed continuously that this does not reset the vigilance cycle.
- For task linked systems, check that each task linked function resets the vigilance cycle.

### 8.2.2 Driver enable system.

Test the operation of the operator enable system. Release the pedal/hand controller and ensure the brakes apply.

### 8.2.3 Trip gear system.

Test the operation of the trip gear lever. Apply sufficient force on the trip gear lever to active a trip action and ensure that the brakes apply.

### 8.2.4 ATP system.

Test the operation of the ATP system. Operators and/or owners shall have procedures to test the operation of the ATP system.

### 8.2.5 Alternate safety systems.

Where other types of Driver Safety Systems are fitted to rolling stock, the operation of these systems shall be tested. Operators and/or owners shall have procedures to test the operation of any Driver Safety Systems.

## 8.3 Driver's emergency cock

Open each driver's emergency cock in turn to ensure that the brake pipe is exhausted and the brakes apply.

## 8.4 Lights

Check that all required lights are fitted in accordance with CRN Standard CRN RS 008, Section 8.3, positioned correctly and operate as required.

## 8.5 Horns

Horns shall be tested for functionality and noise levels checked for compliance with that specified in Table 5 in CRN Standard CRN RS 008.

The horn sound shall be measured with the vehicle stationary in an unobstructed location with no significant reflecting infrastructure within 50 metres of the line of sight between the horn and the sound level measuring device. Ambient wind speed shall not exceed 10 metres/second whilst measurements are being recorded.

The horn shall maintain the level specified in CRN Standard CRN RS 008, Section 8.4 for a 30 second continuous horn operation. Tonality requirements do not apply to horn sound evaluations.

# 9 Signal visibility test

## 9.1 Introduction

The signal visibility test is designed to ensure that drivers or operators of all self-propelled vehicles including locomotives, multiple unit trains and infrastructure maintenance vehicles can clearly see trackside signals from their driving positions.

## 9.2 Visibility test

The signal visibility test shall be conducted on all driven vehicle types in order to gain approval to operate on the CRN. Refer to CRN Standard CRN RS 008, Section 9, Figures 10, 11 and12.

Type testing will apply to all rolling stock of the same vehicle type provided there have been no substantial modifications to any single vehicle.

The driver should be positioned on the left hand side of the vehicle and when seated, shall have direct line of sight to each of the signal types used on the NSW rail network.

Vehicles where the driver is positioned on or to the right of the vehicle centre line shall still be positioned to enable the driver to meet the above signal visibility requirements.

In the case of vehicles where the driver is not seated at the front of the vehicle, such as in locomotives running long end leading, steam locomotives, or some track maintenance vehicles the driver must be accompanied by a second person who is qualified in safeworking and has the appropriate road knowledge.

# 10 Personnel safety inspection

## 10.1 Introduction

Rail vehicles required to work under overhead electrical wiring do present a risk to personnel and must be provided with sufficient mitigation to prevent or minimise the risk of personnel or equipment coming into contact with or entering the electrical safe clearance zone. Refer to CRN Standard CRN RS 008, Section 10, for sample overhead wiring electrical safety signs.

Any rail vehicle, including a locomotive, which has the potential to permit equipment or personnel to come into contact or come within the safe clearance limit of electrical equipment and/or wiring shall have appropriate warning signs. Height limiting equipment shall be installed on any vehicles with elevating equipment, such as cranes, elevated work platforms, backhoes, etc.

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

## 10.2 Electrical safety inspection

The inspection must ensure the following requirements are met:

- “Danger” warning signs are appropriately displayed and securely fixed to vehicles and clearly visible, in locations adjacent to any track-side controls, ladders or equipment which may allow personnel to elevate equipment to within 3 metres or climb to within 1 metre of the overhead wiring.
- Controls for elevating equipment are clearly labelled for their intended function and the appropriate “Danger” warning sign is located within the operator’s field of vision.

- The vehicle is fitted with height limiting equipment to prevent unintended elevation of such equipment whilst the vehicle is in work mode.
- The vehicle is fitted with a lock-out mechanism which prevents unintended elevation of equipment whilst the vehicle is in travel mode.

## 10.3 Hazardous working environment

Rolling stock, depending on its type and functionality can expose personnel to a hazardous environment. For example, high pressure air, high pressure hydraulic fluids, mechanisms which have a crush zone, stored energy with compressed springs, etc.

Such hazardous zones/equipment shall be labelled with appropriate warning signs.

# 11 AEI tag installation inspection

All rail-bound vehicles shall be fitted with automatic equipment identification (AEI) tags, one (1) on each diagonal right hand corner.

The AEI tags and their installation shall comply with CRN Standard CRN RS 014.

# 12 Reflective delineator inspection

Reflective delineators and their application to all rail vehicles shall comply with the requirements of CRN Standard CRN RS 008 Section 12.

# 13 Vehicle recovery interface requirements

## 13.1 General

To ensure vehicles are recovered with minimal consequential damage and delay following an incident, such as a derailment, they should be equipped for, or have attachments suitable for use with the recovery equipment used by the Emergency Response Groups.

It is the owner/operator's responsibility to have incident recovery plans in place.

Vehicles shall have the following equipment fitted to assist in vehicle recovery:

- Lifting brackets
- Towing fixture

## 13.2 Lifting brackets and towing fixtures

Refer to CRN Standard CRN RS 008 Section 13 for details on the lifting bracket and towing fixture.

## 13.3 Specialised recovery equipment

Vehicle owner/operators shall familiarise themselves with vehicle recovery equipment such as jacks and other lifting appliances. This may entail actually trialling the equipment prior to vehicle commissioning and acceptance tests in order to ensure that the vehicle is recoverable in the event of an incident during on-track tests.

Vehicles with traction equipment shall be checked for compatibility with pony bogie recovery equipment to ensure the equipment can be installed and operate satisfactorily without fouling other vehicle components. Refer to CRN Standard CRN RS 008, Section13.

# 14 Environmental tests

## 14.1 Introduction

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

## 14.2 Noise tests

All rolling stock shall comply with the noise requirements as specified in CRN Standard CRN-RS-008, Section 14 and reporting shall comply with CRN Standard CRN RS 017.

Type testing will apply to all rolling stock of the same vehicle type provided there have been no substantial modifications to any one vehicle, in which case, that vehicle shall also be tested..

The results of noise tests must be recorded on the standard noise test reporting form. Refer to the following:

- Noise Test Data Recording Form CRN RF 009
- Locomotive Noise Test Recording Spredsheet.xls CRN RF 010

## 14.3 Vibration tests

All rolling stock shall comply with the vibration requirements as specified in CRN-RS-008, Section 14.

Type testing will apply to all rolling stock of the same vehicle type provided there have been no substantial modifications to any one vehicle, in which case, that vehicle shall also be tested.

## 14.4 Air quality emission tests

All powered rolling stock shall comply with the emission requirements as specified in CRN-RS-008, Section 14.

Type testing will apply to all rolling stock of the same vehicle type provided there have been no substantial modifications to any vehicle, in which case, that vehicle shall also be tested.

Emission testing shall include:

- Visible smoke
- Nitrogen oxides (NOx)
- Particulates
- Carbon monoxide
- Hydrocarbons (VOC)
- Exhaust flow
- Sulphur Dioxide (SO2).

## 14.5 Waste management inspection

Waste handling equipment fitted to vehicles shall be inspected to ensure all waste material is retained and not discharged to track.

Waste material includes brown water and grey water on passenger vehicles as well as fuel, oil, coolant water and sand leakage/overflow from locomotives and other engine powered vehicles.

# 15 Kinematic rolling stock outline tests

## 15.1 Introduction

These tests are designed to ensure that the vehicle operates safely within the confines of the relevant kinematic rolling stock outline specified for that vehicle type and on the corridor/s along which the vehicle is to operate.

No part of the vehicle shall infringe the kinematic rolling stock outline under all conditions of loading, wear and dynamic behaviour unless otherwise approved by the CRN Manager.

Refer to CRN-RS-008, Section 2.2 for details of the kinematic rolling stock outline.

## 15.2 Rolling stock outline static displacement test

The static kinematic outline test is designed to determine the vehicle roll and lateral displacement coefficients.

The purpose of this test is to plot the angular roll and lateral displacement of the vehicle body with respect to the track centre and rail plane.

For the static displacement test, the track should be level or if not level, then measured to determine the degree of incline.

This test is to be conducted on both sides of the vehicle by incrementally packing the wheels on one side of the vehicle until the vehicle is sitting on a simulated 160 mm of superelevation and then incrementally lowering the vehicle. The angular and lateral displacement can be measured with a plumb string line and rule or by a theodolite at a convenient datum point.

The progressive displacements are to be plotted against the track superelevation or lateral component of gravitational acceleration. The plots should show a hysteresis loop when completed.

The loading condition of the vehicle shall be such as to give the maximum expected centre of gravity height above rail.

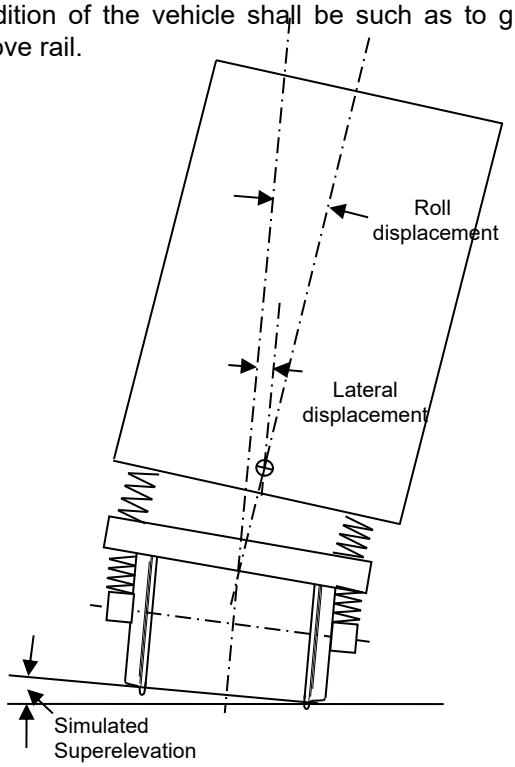



**Figure 8 – Simulated cant deficiency**

## 15.3 Kinematic outline test requirements

The kinematic outline dynamic test can be conducted in conjunction with the ride performance test and as with the ride test the test speeds shall be incrementally increased whilst the performance parameters are monitored as required in Section 1.3.4.

The vehicle shall be instrumented to determine roll relative to the rail plane and the lateral displacement of the vehicle body relative to the wheels. Refer to CRN-RS-008, Section 2.2 for the displacement limits.

The loading of the vehicle for test purposes shall be such as to give the maximum expected centre of gravity height above rail.

The test shall be conducted with the vehicle negotiating an agreed test track site as specified in section 19.4 below with 'x' per cent of the vehicle design cant deficiency.

Where 'x' = 160 % for freight vehicles

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

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

## 15.4 Test track configuration

As with the ride quality test, the test track length shall be such as to provide 3 km of operation at the maximum test speed. The recording of kinematic outline test data shall be over at least a minimum track sample of 500 metres with a TCI less than or equal to 50 and with no significant defects, or as mutually agreed between the owner/operator and the CRN Manager. The test track section quality should represent at least 60 per cent of the routes on which the vehicle would be normally operating.

## 15.5 Simulation of kinematic outline test

As an alternative to conducting the kinematic rolling stock outline test, a computer-simulated test may be acceptable provided the simulation model is validated using data from actual on-track measured dynamic responses of a similar vehicle.

# 16 Signal compatibility test

## 16.1 Introduction

Signal compatibility testing is designed to ensure that vehicles operating on the NSW rail network operate the trackside signalling equipment.

Vehicles that do not satisfactorily operate the signalling system, such as road/rail vehicles and some track maintenance vehicles, shall only operate under special operating conditions.

Refer to CRN Standard CRN SD 026, Signal Design Principles - Rolling Stock Interface Requirements

## 16.2 Signal compatibility tests

Signal compatibility tests shall be conducted in accordance with that specified in CRN Standard CRN SD 026, Signal Design Principles - Rolling Stock Interface Requirements

# 17 Signal & communication system interference test

## 17.1 Introduction

Interference testing is designed to ensure that electrical equipment operating on a vehicle does not interfere with the operation of trackside signalling and communication equipment.

## 17.2 When a signal and communication system interference test is required

The signal and communication system interference tests shall be conducted on all vehicle types which have equipment that could potentially interfere with signal and communication systems, for approval to operate on the CRN.

A signal and communication system interference test shall be conducted on any vehicle that is suspected of interfering with signalling or communications equipment.

## 17.3 Interference tests

Interference tests shall be conducted in accordance with the requirements specified in CRN Standard CRN SD 026, Signal Design Principles - Rolling Stock Interface Requirements.

# 18 Brake performance tests

## 18.1 Introduction

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

The following brake performance tests shall be conducted on all self-propelled vehicles and multiple unit trains in order to gain approval to operate on the CRN.

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

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

- Stopping distance tests for individual vehicles or trains
- Deceleration tests for infrastructure maintenance vehicles
- Brake functionality test for infrastructure maintenance vehicles limited to operation within protected worksites.
- Infrastructure maintenance vehicles that are operated as locomotives must also be tested as specified in CRN Standard CRN RS 005

For specific brake performance tests applying to different vehicle types refer to the relevant standard for those vehicles:

| | |
|---|---|
| - Locomotives | CRN-RS-001 |
| - Freight vehicles | CRN-RS-002 |
| - Locomotive hauled passenger vehicles | CRN-RS-003 |
| - Multiple unit trains | CRN-RS-004 |
| - Rail bound infrastructure maintenance vehicles | CRN-RS-005 |
| - Road-rail vehicles | CRN-RS-006 |

## 18.2 Track configuration

The stopping distance test should be conducted on level tangent track or track with a slight falling grade. If tests have to be conducted on a grade, the grade should be constant for the length of the stopping distance test and the measured test results shall be corrected for level track.

The following formula should be used when correcting measured deceleration for track gradient:

- **For falling grades**:

  Corrected deceleration = measured deceleration + 9.81 / G

- **For rising grades:**

  Corrected deceleration = measured deceleration – 9.81 / G

Where the gradient is expressed as a 1 in G grade, that is for a 1 in 40 grade, G = 40.

**NOTE:** The measured deceleration is to be recorded as a negative value.

## 18.3 Stopping distance test procedure

The vehicle/train is accelerated up to test speed and allowed to coast (with power cut out) up to the brake test start point. The brakes are immediately applied to the agreed braking level and must remain applied until the vehicle/train comes to a stand.

The speed at which the brakes were applied is recorded.

The distance from the test start point to the location where the vehicle/train came to a stand is measured.

In the case of an emergency brake application, the emergency brake can be applied by:

- moving the driver's brake valve to the emergency position, or
- the on board trip gear trip arm contacting a trackside train stop, or
- the driver releasing the operator enable system foot pedal or hand control, or
- initiating a vigilance control penalty application.

Information to be recorded during the test includes:

- Speed at which brakes were applied
- Location of test starting point
- Type of brake application
- Direction of travel
- Distance from brake test start point to where vehicle/train came to a stand

**NOTE:** If it is possible to record and plot the speed verses time during the braking test, then the distance travelled is equal to the area under curve from the start time to the time the vehicle/train comes to a stand.

If the test area is not level, then the gradient of the track must be determined and included in the deceleration calculations.

It is customary to conduct three (3) stops at each speed and brake application type combination.

## 18.4 Brake functionality test

Instead of a deceleration test, a brake functionality test is carried out on infrastructure maintenance vehicles that are restricted to an operation wholly within protected worksites. The maximum speed permitted within a worksite is 15 km/h.

The brakes on the vehicle shall be tested to demonstrate that they operate and bring the vehicle to a stand within 20 metres from 15 km/h. If the maximum speed of the vehicle is less than 15 km/h, then the vehicle shall stop from its maximum speed within 20 metres.

# 19 Ride performance test

## 19.1 Introduction

A ride performance test is designed to ensure vehicle compatibility with the track and to establish the optimum vehicle operating conditions to provide minimum damage to the track and meet acceptable train pathing requirements.

This standard covers ride test requirements. For specific ride performance requirements refer to the following standards.

| | | |
|---|---|---|
| - | Ride index algorithm and base ride performance | CRN-RS-008, Section 19 |
| - | Locomotives | CRN-RS-001, Section |
| - | Freight vehicles | CRN-RS-002, Section |
| - | Locomotive hauled passenger vehicles | CRN-RS-003, Section |
| - | Multiple unit trains | CRN-RS-004, Section |
| - | Rail bound infrastructure maintenance vehicles | CRN-RS-005, Section |
| - | Road/rail infrastructure maintenance vehicles | CRN-RS-006, Section |

## 19.2 Test vehicle configuration

Tests are to be conducted with the vehicle in the tare or minimum mass condition.

For vehicles, such as locomotives, equipped with vibration isolated cabs, the base ride performance specified shall be measured using accelerometers positioned outside the cab, but as near as possible to the trailing bogie centre.

For vehicles, such as locomotives and track maintenance vehicles, with vibration isolated cabs, it is recommended that the comfort ride index be measured using accelerometers positioned inside the cab, as close as possible to the bogie centre.

Self-powered vehicles such as locomotives or track maintenance vehicles shall be tested alone. In the case of locomotive hauled vehicles, where possible, the test vehicle is to be the trailing vehicle in the test train consist. It is desirable to have an intermediate vehicle marshalled between the test vehicle and the locomotive to isolate the test vehicle from any dynamic effects from the locomotive.

For bogies equipped with air springs, the above ride performance also applies for vehicles with deflated air springs. A reduction in design speed may be required to achieve this.

The CRN Manager reserves the right to request and have the vehicle tested by the owner/operator in the fully loaded condition.

## 19.3 Wheel profile for vehicles undergoing ride tests

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

Alternatively, the agreed wheel test profile may initially be the “as new” profile, provided that the owner/operator is prepared to conduct ride tests at a later date with an agreed field worn wheel profile.

In the case where tests are initially conducted with an “as new” wheel profile:

- Interim approval to operate will be granted following successful completion of these tests but final approval to operate will not be granted until all required tests with the agreed field worn wheel profiles have been successfully completed.
- John Holland reserves the right to request and have the owner/operator conduct further tests prior to the wheels reaching the agreed field worn wheel profile.
- These later tests on the vehicle when equipped with the agreed field worn wheel profile shall be conducted prior to any vehicles of that type reaching a state of wheel wear equivalent to, or exceeding that of the agreed field worn wheel profile.

## 19.4 Test track configuration

Ride performance testing shall be tested on a minimum length of track such that the maximum test speed can be maintained for at least 3 km. The track quality shall have a TCI less than or equal to 45 and with no significant defects, or as mutually agreed between the owner/operator and John Holland. The test track should represent at least 60 per cent of the routes on which the vehicle would be normally operating.

Hunting shall be assessed on tangent track over a minimum distance of 3 km.

# 20 Pitch & bounce performance test

## 20.1 Introduction

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

## 20.2 Test vehicle configuration

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

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

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

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

If the critical acceleration levels specified CRN Standard CRN RS 08 Table 6 are exceeded, the vehicle is regarded as unsuitable for the proposed operation, but may be relegated to a lower maximum speed of at least 10 percent less than the critical speed.

## 20.3 Pitch and bounce test track configuration

The test track configuration for the pitch and bounce test shall consist of three (3) cycles, with phase, wavelength and amplitude as defined in figure 9.

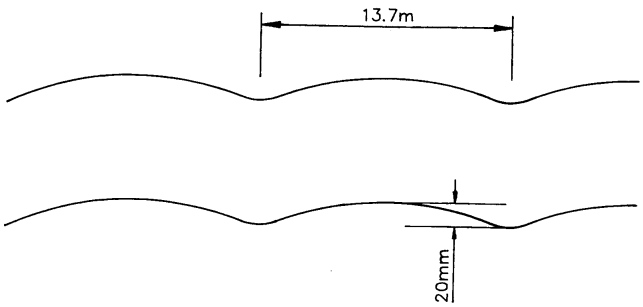



**Figure 9 - Pitch and bounce test track configuration**

In addition, the test track shall include a single bump as defined in figure 10

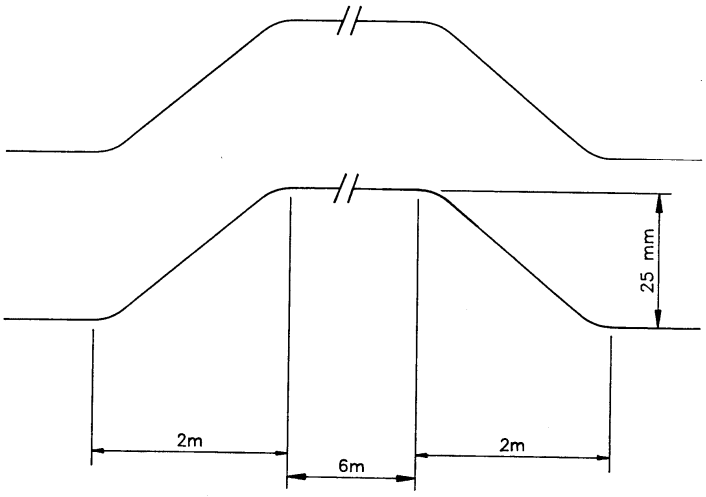



**Figure 1 - Single bump test track configuration**

Where an instrumented wheelset is not available to measure vertical wheel forces, the vertical acceleration in CRN Standard CRN RS 008, Section 19, table 6 shall be taken as the test limit.

## 20.4 Simulation of pitch and bounce test

As an alternative to conducting the pitch and bounce test, a computer-simulated test may be acceptable provided the simulation is validated by comparing the ride results with that of an actual on-track ride test.

# 21 Traction performance test

## 21.1 Introduction

To determine through practical testing, under varying track conditions, a safe maximum train load that can be hauled by a given locomotive up a known grade under all weather conditions.

References: Locomotive manufacturer's tractive effort speed curve.

Once determined from practical tests, the tractive effort, delivered at the locomotive wheels can then be expressed as a percentage of the total weight of the locomotive, usually given as the all-weather adhesion level (AWAL). The AWAL can then be used to determine a suitable load for that class of locomotive on any grade on the network.

## 21.2 Test equipment required

1. A typical locomotive, representing the locomotive class to be tested.
2. A suitable trailing load, preferably pre-weighed to determine total train mass.
3. A strain gauged coupler (if available).
4. A suitable recording instrument such as a computer and/or chart recorder, unless the locomotive is fitted with data logger. The following parameters shall be recorded during the test:
   - Speed
   - Sectional running time
   - Wheel slip
   - Traction motor current.
   - Throttle notch
   - Sanding
5. Suitable water-spraying equipment. The water spraying equipment shall have the following characteristics:
   - The water tank capacity shall be sufficient to last for the duration of testing.
   - The water spraying equipment shall pump water at a flow rate of 3 L/min, using CROPLANDS QUICK TEEJET nozzle housings with fan spray jets. The pump used shall be a FLOJET, model 2135-568, or equivalent, capable of delivering 6.4 Litres / minute (Max), with a pressure of 520 kPa (75 psi) maximum.
   - Water spraying equipment is to be applied such that the water spray is directed to the head of both rails vertically from an approximate height of 250mm, and 1 metre in front of the leading wheels of the leading locomotive of the test train.

## 21.3 Test train preparation

As a starting point, determine from the manufacturer's tractive effort speed curve, the tractive effort level available at the manufacturer's recommended continuous adhesion level and from this determine an estimated train load.

1. Assemble a suitable train consist, incorporating a train consist as close as practicable to the estimated continuous load.
2. Include in the train consist a suitable locomotive that can be utilised to clear the track if the locomotive under test fails to perform adequately. The assist locomotive must be shutdown (unless required to assist in the event of test failure), and should preferably be marshalled directly behind the locomotive under test.

**Note:** When testing AC traction locomotives, the assist locomotive MUST also be an AC traction locomotive, unless it is independently crewed.

3. The test site shall be nominated by the Network Manager and should contain a section of track with a continuous nominal grade of at least 900 metres long.
4. Conduct an inspection of the proposed site, paying particular attention any rail greasers in the area and to the railhead condition on the grade. Note any evidence of rail burns, grease contamination and general rail profile condition.
5. Indicate to the appropriate train operations area that an adhesion test is to be performed in their area. The test plan should include allowances for several passes of the test train over the test site.
6. Conduct a safety site inspection and safety briefing in accordance with the Network manager's Test Site Safety Evaluation.
7. Prepare the locomotive for test, check and record fuel level and sand, check wheel profiles, install water-spaying equipment to the leading wheel set of the test locomotive as described above.

## 21.4 Train test method

The train test is conducted in the following manner:

- Commence the grade ascent from the test start location at the base of the grade with sufficient distance before the grade such that the grade is approached at a normal speed for that location.
- The leading locomotive is the test vehicle and it must be powering during the test.
- Simulated wet weather conditions are to be applied using installed water spraying equipment, as described in Clause 5 of Section 21.2 above, with sufficient capacity for the duration of the testing. **Note:** Windscreen washer equipment is not acceptable for supplying the test water spray.
- The water spraying equipment shall be operating continuously on the grade under test. For example, if testing on Cowan Bank, this means between Hawkesbury River and Cowan.
- The water spraying equipment shall be deployed regardless of the ambient weather conditions.
- Air blowers shall not be used.
- The train speed shall not exceed the posted speed boards.
- The data specified in Clause 4 of Section 21.2 above is to be recorded for the duration of the test.

# 22 Vehicle structural tests

## 22.1 Introduction

Vehicle structural tests are carried out on vehicles to investigate and confirm that they have the structural capacity to perform their intended use in rail operations.

These tests are optional for an owner/operator, however the CRN Manager reserves the right to request and have a vehicle tested by the owner/operator, where, in the CRN Manager's opinion, there is doubt or adverse evidence questioning the structural integrity of the vehicle.

## 22.2 Jacking point vertical load test

A vertically upward force to prove the structural integrity of the vehicle frame shall be applied to the coupler head immediately adjacent to the striker face of the draft gear body, or jacking point, at one end of the vehicle, sufficient in magnitude to lift the fully loaded vehicle free of the bogie nearest the applied load, and held for sixty seconds.

Platforms of articulated vehicles, that are not the end units of an articulated vehicle, do not need to be tested, as they do not have any bogie overhang.

## 22.3 Static end compression test

The single vehicle impact may be performed as an alternative to this test.

A longitudinal compressive end load of 4500 kN shall be applied to the couplers and held for sixty seconds minimum. The load shall be applied over an area equal to the contact area between the draft lugs and draft gear. The vehicle as tested shall simulate an axially loaded beam having ball end restraints ie the loading fixture shall be constrained from lateral and vertical motion. See Figure 11.

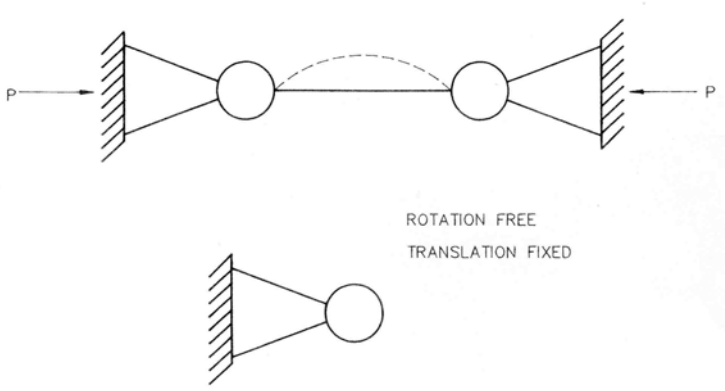



**Figure 11 - Loading fixtures for static end compression**

The vehicle shall be tested under the adverse stress conditions (empty and/or loaded) and shall withstand the applied loads without permanent deformation of any component.

## 22.4 Single vehicle impact test

The test vehicle shall be loaded to its maximum gross mass on rail and impacted by a rake of vehicles, consisting of three 50 tonne nominal capacity open or hopper cars. These cars shall be loaded to their allowable maximum gross mass on rail with sand or other granular material, and should be equipped with AAR M-901E rubber-friction draft gear or equivalent at the striking end. A metal plate may be placed on top of the granular material to stop load shift.

The test vehicle shall be stationary at the start of each test with the handbrake and air-brake released. It shall be located between, but not in contact with, the striking consist described above and a similar consist used as a buffer. The hand-brake on the buffer vehicle furthest from the vehicle under test shall be firmly applied. No restraint other than the handbrake on the last vehicle shall be used. The track shall, therefore, be level.

A series of impacts shall be made on tangent track by the striking consist starting at 10 km/h. The speed should be increased in small increments of approximately 3 km/h. For freight vehicles the impacts shall continue until either a coupler force of 5500 kN or a speed of 22 km/h has been reached, whichever occurs first. For other vehicles, the vehicle owner or operator shall specify the maximum coupler force and maximum impact speed.

A vehicle consisting of two or more permanently coupled units shall also undergo impact testing as outlined above with the struck unit of the test vehicle being empty for a two-unit vehicle, or with the first two units being empty for a three (or more) unit vehicle.

# 23 P2 force wheel impact test

This section is not complete. Refer to CRN Standard CRN RS 008 for a calculation method of P2 force.

# 24 Curve stability test

The CRN Manager reserves the right to request and have a vehicle tested by the owner/operator, where in the CRN Manager's opinion, there is doubt regarding the stability of the vehicle during curve negotiation under draft and/or buff forces.

Where required, curve stability shall be tested as follows:

- The test consist shall be subjected to a squeeze and draft load of 750 kN without vehicle body-suspension separation or wheel lift. The load application, firstly static and then at a nominal speed of 5 km/h, shall be sustained for a minimum of 20 seconds duration. The static case evaluates the rail stability, the dynamic case evaluates the vehicle's tendency to derail. Articulated vehicles consisting of more than two (2) platforms shall be tested with a minimum of three (3) platforms in the test consist. The number of platforms used shall generate maximum load in the critical L/V location of the vehicle.
- For the purpose of this test the test vehicle shall be fitted with new full flange wheel profiles.
- The empty vehicle shall be subjected to squeeze and draft load on a curve of not greater than 175 metre radius. The curve shall have 12 mm maximum superelevation. The test vehicle shall be coupled to a 'base vehicle' as defined in Section 6.5 and a 'long vehicle' having a length over strikers of 25 metres, long shank couplers and conventional draftgear.

# 25 Elevating work platform (EWP) stability test

Rail vehicles forming part of or carrying an attached EWP shall be tested for stability on rail. The vehicle EWP shall be fully loaded to its maximum design capacity and be tested in accordance with Australian Standard AS1418, Parts 1 &10.

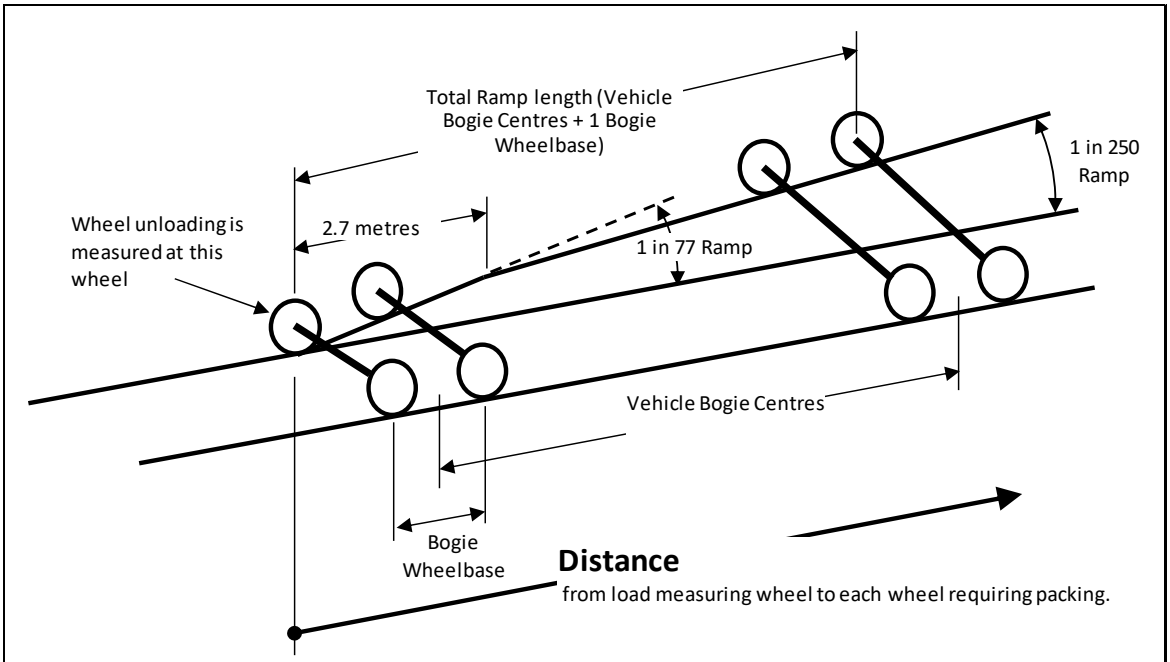
# Appendix 1 CRN Rolling Stock Glossary

This appendix defines words that are used in the CRN Rolling Stock Standards

| | |
|---|---|
| Agreed | Agreed between the Owner/Operator and the CRN Manager. |
| Approved | Approved by the CRN Manager. |
| Authorised person | Person authorised to travel in the cab of an infrastructure maintenance vehicle/train and stop the vehicle/train in the event of an emergency. |
| Cant deficiency | The difference in superelevation between:<br>· that required to balance the actual vehicle centrifugal force due to curve negotiation such that there is equal wheel loading on the high and low rail, (equilibrium or balancing speed), and<br>· the actual superelevation existing in the curve.<br>Cant deficiency is a function of superelevation, curve radius and vehicle speed. |
| Continuous tractive effort | The tangential force that can be applied at the wheel/rail interface by a self powered vehicle for an indefinite period without causing wheel spin or overheating of the traction equipment. |
| Curved wheel web | Wheel web or plate which is domed such that its cross section is curved. |
| Design speed | The maximum speed at which a vehicle is expected to operate on the CRN. |
| Flat top trolley or trailer | A small non-powered infrastructure maintenance vehicle which is used for conveying tools and equipment along the track and which can be easily removed from the track. |
| Freight Train | A train predominantly consisting of freight vehicles. |
| Full supplies, Fully provisioned | Locomotive with all equipment and full of fuel, oil, water, coolant and sand. |
| Handbrake | A mechanical device provided on a train/vehicle in order to secure the train or an individual vehicle so as to prevent it from moving.<br>Note: Where the term “handbrake” is used, it will also mean “parking brake”. |
| Heritage vehicle | Locomotive, passenger vehicle, freight vehicle or trolley that has historical significance and/or is not used in regular revenue service but used in special interest operations, such as steam tours. |
| Infrastructure maintenance vehicle | A rail bound self propelled vehicle which is used to carry out inspection and/or maintenance on railway infrastructure. Some of these vehicles may be removed from the railway track by the use of special take-offs or portable turnouts. |
| Light locomotive | One or more locomotives coupled together without hauled vehicles attached. |
| Locomotive | A self propelled vehicle, powered by any form of energy, which does not convey passengers or freight but which is used to move one or more other vehicles thus forming a train. |
| Multiple unit train | A distributed power train made up of similar electric or diesel powered vehicles and non-powered vehicles operating as a unit. |

| | |
|---|---|
| Net brake ratio | The ratio of the sum of the actual measured brake block forces divided by the total vehicle weight. |
| On-track infrastructure maintenance vehicle | Any infrastructure maintenance vehicle which operates exclusively on railway track. |
| Overhead wiring vehicle | An infrastructure maintenance vehicle with an elevating platform or equipped for maintenance of the overhead traction wiring system. |
| Power car | A self propelled vehicle, which may or may not convey passengers and/or freight, and operates in conjunction with similar vehicles in a multiple unit consist. |
| Quadricycle | A small self propelled rail-bound track vehicle which can be easily removed from the track. |
| Qualified worker | A worker certified as competent to carry out the relevant task. |
| Rail-bound infrastructure maintenance vehicle | An on-track infrastructure maintenance vehicle that cannot be removed from track without the use of a heavy crane. These vehicles are transferred around the network by rail. |
| Road/rail vehicle | Any type of track vehicle which can travel on either road or rail and can readily transfer from one mode of operation to the other. |
| Rolling Stock Exemption Certificate | A Certificate issued to a vehicle owner/operator covering vehicle non-conformances which are technically acceptable. These certificates remain in place for the life of the vehicle. |
| Rolling Stock Standards Waiver | A Waiver issued for a vehicle covering non-conformances that are deemed acceptable for a limited time period, until corrected. |
| Starting tractive effort | The tangential force applied at the wheel/rail interface that can be applied by self powered vehicle, to move itself and its trailing load from a stationary state without causing excessive wheel slip. |
| Straight wheel web | Wheel web consisting of a flat plate with no curvature such that its cross section is straight. Used primarily with wheel cheek mounted disc brakes |
| S-plate wheel | Wheel with a web such that its cross section forms an S shape, designed to provide low wheel rim stresses |
| Substantially modified vehicle | Vehicle modified to accommodate its use for a different purpose. Vehicle undergoing major refurbishment with updated equipment which can alter the braking, traction or suspension system performance.<br><br>Vehicle being moved with equipment removed resulting in a reduction of vehicle mass that could alter the vehicle performance.<br><br>Vehicle modified such that it may be incompatible with the infrastructure. |
| TOC Waiver | An authority issued for the movement of a vehicle for which there are no published operating conditions, or for which the operating conditions are different from those published in the CRN Train operating Conditions Manual. |
| Track maintenance vehicle | Infrastructure maintenance vehicle used for the maintenance, construction or inspection of track. |
| Train | One or more rail vehicles operating singularly or coupled together, hauled or self powered and capable of operating track signal circuits |

# Appendix 2 – Twist test packing selection




**NOTE:** Where the distance falls between the dimensions shown, round the packing up to the next available size

| Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| 300 | 4 | 1700 | 22 | 3100 | 36.5 | 4500 | 42 | 5900 | 48 | 7300 | 53.5 |
| 350 | 4.5 | 1750 | 22.5 | 3150 | 37 | 4550 | 42.5 | 5950 | 48 | 7350 | 53.5 |
| 400 | 5 | 1800 | 23.5 | 3200 | 37 | 4600 | 42.5 | 6000 | 48 | 7400 | 54 |
| 450 | 6 | 1850 | 24 | 3250 | 37 | 4650 | 43 | 6050 | 48.5 | 7450 | 54 |
| 500 | 6.5 | 1900 | 24.5 | 3300 | 37.5 | 4700 | 43 | 6100 | 48.5 | 7500 | 54 |
| 550 | 7 | 1950 | 25.5 | 3350 | 37.5 | 4750 | 43 | 6150 | 49 | 7550 | 54.5 |
| 600 | 8 | 2000 | 26 | 3400 | 38 | 4800 | 43.5 | 6200 | 49 | 7600 | 54.5 |
| 650 | 8.5 | 2050 | 26.5 | 3450 | 38 | 4850 | 43.5 | 6250 | 49 | 7650 | 55 |
| 700 | 9 | 2100 | 27.5 | 3500 | 38 | 4900 | 44 | 6300 | 49.5 | 7700 | 55 |
| 750 | 9.5 | 2150 | 28 | 3550 | 38.5 | 4950 | 44 | 6350 | 49.5 | 7750 | 55 |
| 800 | 10.5 | 2200 | 28.5 | 3600 | 38.5 | 5000 | 44 | 6400 | 50 | 7800 | 55.5 |
| 850 | 11 | 2250 | 29 | 3650 | 39 | 5050 | 44.5 | 6450 | 50 | 7850 | 55.5 |
| 900 | 11.5 | 2300 | 30 | 3700 | 39 | 5100 | 44.5 | 6500 | 50 | 7900 | 56 |
| 950 | 12.5 | 2350 | 30.5 | 3750 | 39 | 5150 | 45 | 6550 | 50.5 | 7950 | 56 |
| 1000 | 13 | 2400 | 31 | 3800 | 39.5 | 5200 | 45 | 6600 | 50.5 | 8000 | 56 |
| 1050 | 13.5 | 2450 | 32 | 3850 | 39.5 | 5250 | 45 | 6650 | 51 | 8050 | 56.5 |
| 1100 | 14.5 | 2500 | 32.5 | 3900 | 40 | 5300 | 45.5 | 6700 | 51 | 8100 | 56.5 |
| 1150 | 15 | 2550 | 33 | 3950 | 40 | 5350 | 45.5 | 6750 | 51 | 8150 | 57 |
| 1200 | 15.5 | 2600 | 34 | 4000 | 40 | 5400 | 46 | 6800 | 51.5 | 8200 | 57 |
| 1250 | 16 | 2650 | 34.5 | 4050 | 40.5 | 5450 | 46 | 6850 | 51.5 | 8250 | 57 |
| 1300 | 17 | 2700 | 35 | 4100 | 40.5 | 5500 | 46 | 6900 | 52 | 8300 | 57.5 |
| 1350 | 17.5 | 2750 | 35 | 4150 | 41 | 5550 | 46.5 | 6950 | 52 | 8350 | 57.5 |
| 1400 | 18 | 2800 | 35.5 | 4200 | 41 | 5600 | 46.5 | 7000 | 52 | 8400 | 58 |
| 1450 | 19 | 2850 | 35.5 | 4250 | 41 | 5650 | 47 | 7050 | 52.5 | 8450 | 58 |
| 1500 | 19.5 | 2900 | 36 | 4300 | 41.5 | 5700 | 47 | 7100 | 52.5 | 8500 | 58 |
| 1550 | 20 | 2950 | 36 | 4350 | 41.5 | 5750 | 47 | 7150 | 53 | 8550 | 58.5 |
| 1600 | 21 | 3000 | 36 | 4400 | 42 | 5800 | 47.5 | 7200 | 53 | 8600 | 58.5 |
| 1650 | 21.5 | 3050 | 36.5 | 4450 | 42 | 5850 | 47.5 | 7250 | 53 | 8650 | 59 |

## PACKING TABLE (Continued)

| Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| 8700 | 59 | 11050 | 68.5 | 13400 | 78 | 15750 | 87 | 18100 | 96.5 | 20450 | 106 |
| 8750 | 59 | 11100 | 68.5 | 13450 | 78 | 15800 | 87.5 | 18150 | 97 | 20500 | 106 |
| 8800 | 59.5 | 11150 | 69 | 13500 | 78 | 15850 | 87.5 | 18200 | 97 | 20550 | 106.5 |
| 8850 | 59.5 | 11200 | 69 | 13550 | 78.5 | 15900 | 88 | 18250 | 97 | 20600 | 106.5 |
| 8900 | 60 | 11250 | 69 | 13600 | 78.5 | 15950 | 88 | 18300 | 97.5 | 20650 | 107 |
| 8950 | 60 | 11300 | 69.5 | 13650 | 79 | 16000 | 88 | 18350 | 97.5 | 20700 | 107 |
| 9000 | 60 | 11350 | 69.5 | 13700 | 79 | 16050 | 88.5 | 18400 | 98 | 20750 | 107 |
| 9050 | 60.5 | 11400 | 70 | 13750 | 79 | 16100 | 88.5 | 18450 | 98 | 20800 | 107.5 |
| 9100 | 60.5 | 11450 | 70 | 13800 | 79.5 | 16150 | 89 | 18500 | 98 | 20850 | 107.5 |
| 9150 | 61 | 11500 | 70 | 13850 | 79.5 | 16200 | 89 | 18550 | 98.5 | 20900 | 108 |
| 9200 | 61 | 11550 | 70.5 | 13900 | 80 | 16250 | 89 | 18600 | 98.5 | 20950 | 108 |
| 9250 | 61 | 11600 | 70.5 | 13950 | 80 | 16300 | 89.5 | 18650 | 99 | 21000 | 108 |
| 9300 | 61.5 | 11650 | 71 | 14000 | 80 | 16350 | 89.5 | 18700 | 99 | 21050 | 108.5 |
| 9350 | 61.5 | 11700 | 71 | 14050 | 80.5 | 16400 | 90 | 18750 | 99 | 21100 | 108.5 |
| 9400 | 62 | 11750 | 71 | 14100 | 80.5 | 16450 | 90 | 18800 | 99.5 | 21150 | 109 |
| 9450 | 62 | 11800 | 71.5 | 14150 | 81 | 16500 | 90 | 18850 | 99.5 | 21200 | 109 |
| 9500 | 62 | 11850 | 71.5 | 14200 | 81 | 16550 | 90.5 | 18900 | 100 | 21250 | 109 |
| 9550 | 62.5 | 11900 | 72 | 14250 | 81 | 16600 | 90.5 | 18950 | 100 | 21300 | 109.5 |
| 9600 | 62.5 | 11950 | 72 | 14300 | 81.5 | 16650 | 91 | 19000 | 100 | 21350 | 109.5 |
| 9650 | 63 | 12000 | 72 | 14350 | 81.5 | 16700 | 91 | 19050 | 100.5 | 21400 | 110 |
| 9700 | 63 | 12050 | 72.5 | 14400 | 82 | 16750 | 91 | 19100 | 100.5 | 21450 | 110 |
| 9750 | 63 | 12100 | 72.5 | 14450 | 82 | 16800 | 91.5 | 19150 | 101 | 21500 | 110 |
| 9800 | 63.5 | 12150 | 73 | 14500 | 82 | 16850 | 91.5 | 19200 | 101 | 21550 | 110.5 |
| 9850 | 63.5 | 12200 | 73 | 14550 | 82.5 | 16900 | 92 | 19250 | 101 | 21600 | 110.5 |
| 9900 | 64 | 12250 | 73 | 14600 | 82.5 | 16950 | 92 | 19300 | 101.5 | 21650 | 111 |
| 9950 | 64 | 12300 | 73.5 | 14650 | 83 | 17000 | 92 | 19350 | 101.5 | 21700 | 111 |
| 10000 | 64 | 12350 | 73.5 | 14700 | 83 | 17050 | 92.5 | 19400 | 102 | 21750 | 111 |
| 10050 | 64.5 | 12400 | 74 | 14750 | 83 | 17100 | 92.5 | 19450 | 102 | 21800 | 111.5 |
| 10100 | 64.5 | 12450 | 74 | 14800 | 83.5 | 17150 | 93 | 19500 | 102 | 21850 | 111.5 |
| 10150 | 65 | 12500 | 74 | 14850 | 83.5 | 17200 | 93 | 19550 | 102.5 | 21900 | 112 |
| 10200 | 65 | 12550 | 74.5 | 14900 | 84 | 17250 | 93 | 19600 | 102.5 | 21950 | 112 |
| 10250 | 65 | 12600 | 74.5 | 14950 | 84 | 17300 | 93.5 | 19650 | 103 | 22000 | 112 |
| 10300 | 65.5 | 12650 | 75 | 15000 | 84 | 17350 | 93.5 | 19700 | 103 | 22050 | 112.5 |
| 10350 | 65.5 | 12700 | 75 | 15050 | 84.5 | 17400 | 94 | 19750 | 103 | 22100 | 112.5 |
| 10400 | 66 | 12750 | 75 | 15100 | 84.5 | 17450 | 94 | 19800 | 103.5 | 22150 | 113 |
| 10450 | 66 | 12800 | 75.5 | 15150 | 85 | 17500 | 94 | 19850 | 103.5 | 22200 | 113 |
| 10500 | 66 | 12850 | 75.5 | 15200 | 85 | 17550 | 94.5 | 19900 | 104 | 22250 | 113 |
| 10550 | 66.5 | 12900 | 76 | 15250 | 85 | 17600 | 94.5 | 19950 | 104 | 22300 | 113.5 |
| 10600 | 66.5 | 12950 | 76 | 15300 | 85.5 | 17650 | 95 | 20000 | 104 | 22350 | 113.5 |
| 10650 | 67 | 13000 | 76 | 15350 | 85.5 | 17700 | 95 | 20050 | 104.5 | 22400 | 114 |
| 10700 | 67 | 13050 | 76.5 | 15400 | 86 | 17750 | 95 | 20100 | 104.5 | 22450 | 114 |
| 10750 | 67 | 13100 | 76.5 | 15450 | 86 | 17800 | 95.5 | 20150 | 105 | 22500 | 114 |
| 10800 | 67.5 | 13150 | 77 | 15500 | 86 | 17850 | 95.5 | 20200 | 105 | 22550 | 114.5 |
| 10850 | 67.5 | 13200 | 77 | 15550 | 86.5 | 17900 | 96 | 20250 | 105 | 22600 | 114.5 |
| 10900 | 68 | 13250 | 77 | 15600 | 86.5 | 17950 | 96 | 20300 | 105.5 | 22650 | 115 |
| 10950 | 68 | 13300 | 77.5 | 15650 | 87 | 18000 | 96 | 20350 | 105.5 | 22700 | 115 |
| 11000 | 68 | 13350 | 77.5 | 15700 | 87 | 18050 | 96.5 | 20400 | 106 | 22750 | 115 |

## PACKING TABLE (Continued)

| Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| 22800 | 115.5 | 25150 | 125 | 27500 | 134 | 29850 | 143.5 | 32200 | 153 | 34550 | 162.5 |
| 22850 | 115.5 | 25200 | 125 | 27550 | 134.5 | 29900 | 144 | 32250 | 153 | 34600 | 162.5 |
| 22900 | 116 | 25250 | 125 | 27600 | 134.5 | 29950 | 144 | 32300 | 153.5 | 34650 | 163 |
| 22950 | 116 | 25300 | 125.5 | 27650 | 135 | 30000 | 144 | 32350 | 153.5 | 34700 | 163 |
| 23000 | 116 | 25350 | 125.5 | 27700 | 135 | 30050 | 144.5 | 32400 | 154 | 34750 | 163 |
| 23050 | 116.5 | 25400 | 126 | 27750 | 135 | 30100 | 144.5 | 32450 | 154 | 34800 | 163.5 |
| 23100 | 116.5 | 25450 | 126 | 27800 | 135.5 | 30150 | 145 | 32500 | 154 | 34850 | 163.5 |
| 23150 | 117 | 25500 | 126 | 27850 | 135.5 | 30200 | 145 | 32550 | 154.5 | 34900 | 164 |
| 23200 | 117 | 25550 | 126.5 | 27900 | 136 | 30250 | 145 | 32600 | 154.5 | 34950 | 164 |
| 23250 | 117 | 25600 | 126.5 | 27950 | 136 | 30300 | 145.5 | 32650 | 155 | 35000 | 164 |
| 23300 | 117.5 | 25650 | 127 | 28000 | 136 | 30350 | 145.5 | 32700 | 155 | 35050 | 164.5 |
| 23350 | 117.5 | 25700 | 127 | 28050 | 136.5 | 30400 | 146 | 32750 | 155 | 35100 | 164.5 |
| 23400 | 118 | 25750 | 127 | 28100 | 136.5 | 30450 | 146 | 32800 | 155.5 | 35150 | 165 |
| 23450 | 118 | 25800 | 127.5 | 28150 | 137 | 30500 | 146 | 32850 | 155.5 | 35200 | 165 |
| 23500 | 118 | 25850 | 127.5 | 28200 | 137 | 30550 | 146.5 | 32900 | 156 | 35250 | 165 |
| 23550 | 118.5 | 25900 | 128 | 28250 | 137 | 30600 | 146.5 | 32950 | 156 | 35300 | 165.5 |
| 23600 | 118.5 | 25950 | 128 | 28300 | 137.5 | 30650 | 147 | 33000 | 156 | 35350 | 165.5 |
| 23650 | 119 | 26000 | 128 | 28350 | 137.5 | 30700 | 147 | 33050 | 156.5 | 35400 | 166 |
| 23700 | 119 | 26050 | 128.5 | 28400 | 138 | 30750 | 147 | 33100 | 156.5 | 35450 | 166 |
| 23750 | 119 | 26100 | 128.5 | 28450 | 138 | 30800 | 147.5 | 33150 | 157 | 35500 | 166 |
| 23800 | 119.5 | 26150 | 129 | 28500 | 138 | 30850 | 147.5 | 33200 | 157 | 35550 | 166.5 |
| 23850 | 119.5 | 26200 | 129 | 28550 | 138.5 | 30900 | 148 | 33250 | 157 | 35600 | 166.5 |
| 23900 | 120 | 26250 | 129 | 28600 | 138.5 | 30950 | 148 | 33300 | 157.5 | 35650 | 167 |
| 23950 | 120 | 26300 | 129.5 | 28650 | 139 | 31000 | 148 | 33350 | 157.5 | 35700 | 167 |
| 24000 | 120 | 26350 | 129.5 | 28700 | 139 | 31050 | 148.5 | 33400 | 158 | 35750 | 167 |
| 24050 | 120.5 | 26400 | 130 | 28750 | 139 | 31100 | 148.5 | 33450 | 158 | 35800 | 167.5 |
| 24100 | 120.5 | 26450 | 130 | 28800 | 139.5 | 31150 | 149 | 33500 | 158 | 35850 | 167.5 |
| 24150 | 121 | 26500 | 130 | 28850 | 139.5 | 31200 | 149 | 33550 | 158.5 | 35900 | 168 |
| 24200 | 121 | 26550 | 130.5 | 28900 | 140 | 31250 | 149 | 33600 | 158.5 | 35950 | 168 |
| 24250 | 121 | 26600 | 130.5 | 28950 | 140 | 31300 | 149.5 | 33650 | 159 | 36000 | 168 |
| 24300 | 121.5 | 26650 | 131 | 29000 | 140 | 31350 | 149.5 | 33700 | 159 | 36050 | 168.5 |
| 24350 | 121.5 | 26700 | 131 | 29050 | 140.5 | 31400 | 150 | 33750 | 159 | 36100 | 168.5 |
| 24400 | 122 | 26750 | 131 | 29100 | 140.5 | 31450 | 150 | 33800 | 159.5 | 36150 | 169 |
| 24450 | 122 | 26800 | 131.5 | 29150 | 141 | 31500 | 150 | 33850 | 159.5 | 36200 | 169 |
| 24500 | 122 | 26850 | 131.5 | 29200 | 141 | 31550 | 150.5 | 33900 | 160 | 36250 | 169 |
| 24550 | 122.5 | 26900 | 132 | 29250 | 141 | 31600 | 150.5 | 33950 | 160 | 36300 | 169.5 |
| 24600 | 122.5 | 26950 | 132 | 29300 | 141.5 | 31650 | 151 | 34000 | 160 | 36350 | 169.5 |
| 24650 | 123 | 27000 | 132 | 29350 | 141.5 | 31700 | 151 | 34050 | 160.5 | 36400 | 170 |
| 24700 | 123 | 27050 | 132.5 | 29400 | 142 | 31750 | 151 | 34100 | 160.5 | 36450 | 170 |
| 24750 | 123 | 27100 | 132.5 | 29450 | 142 | 31800 | 151.5 | 34150 | 161 | 36500 | 170 |
| 24800 | 123.5 | 27150 | 133 | 29500 | 142 | 31850 | 151.5 | 34200 | 161 | 36550 | 170.5 |
| 24850 | 123.5 | 27200 | 133 | 29550 | 142.5 | 31900 | 152 | 34250 | 161 | 36600 | 170.5 |
| 24900 | 124 | 27250 | 133 | 29600 | 142.5 | 31950 | 152 | 34300 | 161.5 | 36650 | 171 |
| 24950 | 124 | 27300 | 133.5 | 29650 | 143 | 32000 | 152 | 34350 | 161.5 | 36700 | 171 |
| 25000 | 124 | 27350 | 133.5 | 29700 | 143 | 32050 | 152.5 | 34400 | 162 | 36750 | 171 |
| 25050 | 124.5 | 27400 | 134 | 29750 | 143 | 32100 | 152.5 | 34450 | 162 | 36800 | 171.5 |
| 25100 | 124.5 | 27450 | 134 | 29800 | 143.5 | 32150 | 153 | 34500 | 162 | 36850 | 171.5 |

## PACKING TABLE (Continued)

| Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing | Distance | Packing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| 36900 | 172 | 39250 | 181 | 41600 | 190.5 | 43950 | 200 | 46300 | 209.5 | 48650 | 219 |
| 36950 | 172 | 39300 | 181.5 | 41650 | 191 | 44000 | 200 | 46350 | 209.5 | 48700 | 219 |
| 37000 | 172 | 39350 | 181.5 | 41700 | 191 | 44050 | 200.5 | 46400 | 210 | 48750 | 219 |
| 37050 | 172.5 | 39400 | 182 | 41750 | 191 | 44100 | 200.5 | 46450 | 210 | 48800 | 219.5 |
| 37100 | 172.5 | 39450 | 182 | 41800 | 191.5 | 44150 | 201 | 46500 | 210 | 48850 | 219.5 |
| 37150 | 173 | 39500 | 182 | 41850 | 191.5 | 44200 | 201 | 46550 | 210.5 | 48900 | 220 |
| 37200 | 173 | 39550 | 182.5 | 41900 | 192 | 44250 | 201 | 46600 | 210.5 | 48950 | 220 |
| 37250 | 173 | 39600 | 182.5 | 41950 | 192 | 44300 | 201.5 | 46650 | 211 | 49000 | 220 |
| 37300 | 173.5 | 39650 | 183 | 42000 | 192 | 44350 | 201.5 | 46700 | 211 | 49050 | 220.5 |
| 37350 | 173.5 | 39700 | 183 | 42050 | 192.5 | 44400 | 202 | 46750 | 211 | 49100 | 220.5 |
| 37400 | 174 | 39750 | 183 | 42100 | 192.5 | 44450 | 202 | 46800 | 211.5 | 49150 | 221 |
| 37450 | 174 | 39800 | 183.5 | 42150 | 193 | 44500 | 202 | 46850 | 211.5 | 49200 | 221 |
| 37500 | 174 | 39850 | 183.5 | 42200 | 193 | 44550 | 202.5 | 46900 | 212 | 49250 | 221 |
| 37550 | 174.5 | 39900 | 184 | 42250 | 193 | 44600 | 202.5 | 46950 | 212 | 49300 | 221.5 |
| 37600 | 174.5 | 39950 | 184 | 42300 | 193.5 | 44650 | 203 | 47000 | 212 | 49350 | 221.5 |
| 37650 | 175 | 40000 | 184 | 42350 | 193.5 | 44700 | 203 | 47050 | 212.5 | 49400 | 222 |
| 37700 | 175 | 40050 | 184.5 | 42400 | 194 | 44750 | 203 | 47100 | 212.5 | 49450 | 222 |
| 37750 | 175 | 40100 | 184.5 | 42450 | 194 | 44800 | 203.5 | 47150 | 213 | 49500 | 222 |
| 37800 | 175.5 | 40150 | 185 | 42500 | 194 | 44850 | 203.5 | 47200 | 213 | 49550 | 222.5 |
| 37850 | 175.5 | 40200 | 185 | 42550 | 194.5 | 44900 | 204 | 47250 | 213 | 49600 | 222.5 |
| 37900 | 176 | 40250 | 185 | 42600 | 194.5 | 44950 | 204 | 47300 | 213.5 | 49650 | 223 |
| 37950 | 176 | 40300 | 185.5 | 42650 | 195 | 45000 | 204 | 47350 | 213.5 | 49700 | 223 |
| 38000 | 176 | 40350 | 185.5 | 42700 | 195 | 45050 | 204.5 | 47400 | 214 | 49750 | 223 |
| 38050 | 176.5 | 40400 | 186 | 42750 | 195 | 45100 | 204.5 | 47450 | 214 | 49800 | 223.5 |
| 38100 | 176.5 | 40450 | 186 | 42800 | 195.5 | 45150 | 205 | 47500 | 214 | 49850 | 223.5 |
| 38150 | 177 | 40500 | 186 | 42850 | 195.5 | 45200 | 205 | 47550 | 214.5 | 49900 | 224 |
| 38200 | 177 | 40550 | 186.5 | 42900 | 196 | 45250 | 205 | 47600 | 214.5 | 49950 | 224 |
| 38250 | 177 | 40600 | 186.5 | 42950 | 196 | 45300 | 205.5 | 47650 | 215 | 50000 | 224 |
| 38300 | 177.5 | 40650 | 187 | 43000 | 196 | 45350 | 205.5 | 47700 | 215 | 50050 | 224.5 |
| 38350 | 177.5 | 40700 | 187 | 43050 | 196.5 | 45400 | 206 | 47750 | 215 | 50100 | 224.5 |
| 38400 | 178 | 40750 | 187 | 43100 | 196.5 | 45450 | 206 | 47800 | 215.5 | 50150 | 225 |
| 38450 | 178 | 40800 | 187.5 | 43150 | 197 | 45500 | 206 | 47850 | 215.5 | 50200 | 225 |
| 38500 | 178 | 40850 | 187.5 | 43200 | 197 | 45550 | 206.5 | 47900 | 216 | 50250 | 225 |
| 38550 | 178.5 | 40900 | 188 | 43250 | 197 | 45600 | 206.5 | 47950 | 216 | 50300 | 225.5 |
| 38600 | 178.5 | 40950 | 188 | 43300 | 197.5 | 45650 | 207 | 48000 | 216 | 50350 | 225.5 |
| 38650 | 179 | 41000 | 188 | 43350 | 197.5 | 45700 | 207 | 48050 | 216.5 | 50400 | 226 |
| 38700 | 179 | 41050 | 188.5 | 43400 | 198 | 45750 | 207 | 48100 | 216.5 | 50450 | 226 |
| 38750 | 179 | 41100 | 188.5 | 43450 | 198 | 45800 | 207.5 | 48150 | 217 | 50500 | 226 |
| 38800 | 179.5 | 41150 | 189 | 43500 | 198 | 45850 | 207.5 | 48200 | 217 | 50550 | 226.5 |
| 38850 | 179.5 | 41200 | 189 | 43550 | 198.5 | 45900 | 208 | 48250 | 217 | 50600 | 226.5 |
| 38900 | 180 | 41250 | 189 | 43600 | 198.5 | 45950 | 208 | 48300 | 217.5 | 50650 | 227 |
| 38950 | 180 | 41300 | 189.5 | 43650 | 199 | 46000 | 208 | 48350 | 217.5 | 50700 | 227 |
| 39000 | 180 | 41350 | 189.5 | 43700 | 199 | 46050 | 208.5 | 48400 | 218 | 50750 | 227 |
| 39050 | 180.5 | 41400 | 190 | 43750 | 199 | 46100 | 208.5 | 48450 | 218 | 50800 | 227.5 |
| 39100 | 180.5 | 41450 | 190 | 43800 | 199.5 | 46150 | 209 | 48500 | 218 | 50850 | 227.5 |
| 39150 | 181 | 41500 | 190 | 43850 | 199.5 | 46200 | 209 | 48550 | 218.5 | 50900 | 228 |
| 39200 | 181 | 41550 | 190.5 | 43900 | 200 | 46250 | 209 | 48600 | 218.5 | 50950 | 228 |