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Preface

This standard was prepared by the Road Rail Vehicles Development Group, overseen by the RISSB Rolling Stock Standing Committee.

Objective

The objective of this Standard is to set the core requirements for the safe design, construction, testing, maintenance, decommissioning and modifications of road rail vehicles and to ensure compatibility with rail networks.

Compliance

There are four types of provisions contained within Australian Standards developed by RISSB:

(a) Requirements.

(b) Recommendations.

(c) Permissions.

(d) Constraints.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term ‘shall’.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred.
Recommendations are identified within the text by the term ‘should’.

Recommendations recognize that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied or other controls are more appropriate or better.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term ‘may’.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term ‘must’.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities or interfacing organisations where the risk may be shared.

RISSB Standards address known hazards within the railway industry. Hazards, and clauses within this Standard that address those hazards, are listed in Appendix B.

Appendices in RISSB Standards may be designated either “normative” or “informative”. A "normative" appendix is an integral part of a Standard and compliance with it is a requirement, whereas an "informative" appendix is only for information and guidance.

Commentary

Commentary *C Preface*

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

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Section 1 Scope and general

1.1 Scope

This standard applies to all road rail vehicles (RRVs).

The following items are not covered in this Standard:

(a) network registration of RRVs by RIMs;

(b) operation of RRVs with respect to network safe working rules and route standards;

(c) RRVs on cane railways; and

(d) remotely controlled RRVs.

Commentary *C1.1*

For clarity:

- An RRV that conforms to this Standard will not be rail capable if the rail guidance system is removed.

- An RRV which once the GROUND operating equipment (e.g., road wheels) is removed RESULTING IN A rail ONLY bound vehicle, is not conformant with the intent of this Standard.

1.2 Normative references

There are two specific sets of normative references for RRVs. The first set of references relate to all RRVs; The second relates to only those vehicles that are also required to operate on public roads and therefore must meet and/or have a legally approved exemption to the ADR requirements.

1.2.1 Normative standards applicable to all RRV units:

- AS 1210, *Pressure vessels*
- AS 1319, *Safety signs for the occupational environment*
- AS 1418, *Cranes, hoists and winches*
- AS 2729, *Roller bearings – Dynamic load ratings and rating life*
- AS 4100, *Steel structures*
- AS 7479, Track Maintenance and Road Rail Vehicles – Collision Avoidance *and Proximity Warning*
- AS 7501, *Rolling Stock Compliance Certification*
- AS 7503, *Rail Vehicle Identification and Markings*
- AS 7508, *Track Forces and Stresses*
- AS 7509, *Rolling Stock – Dynamic Behaviour*
- AS 7511, *Onboard Train Protection Systems*
- AS 7514, *Wheels*
- AS 7515, *Axles*
- AS 7518, *Rolling Stock Suspension*
- AS 7519, *Bogie structural requirements*
- AS 7520.4, *Australian railway rolling stock – Body structural requirement – Part 4 – Infrastructure maintenance*
- AS 7523.4, *Emergency Equipment - Part 4: Infrastructure Maintenance Rolling Stock*

- AS 7527, *Rolling Stock Event Recorders*
- AS 7531, *Rolling Stock Lighting and Visibility*
- AS 7533, *Driving Cabs*
- AS 7635, *Track Geometry*
- AS 7722, *EMC Management*
- AS/NZS 1200, Pressure equipment
- AS/NZS 1554, *Structural steel welding*
- AS/NZS 1664, *Aluminium structures*
- AS/NZS 1665, *Welding of aluminium structures*
- AS/NZS 1841, *Portable fire extinguishers*
- AS/NZS 1906.1, *Retroreflective materials and devices for road traffic control purposes, Part 1: Retroreflective sheeting*
- AS/NZS 2074, *Cast steel specifications*
- AS/NZS 2312, *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*
- AS/NZS 2671, *Hydraulic fluid power – General rules and safety requirements for systems and their components*
- AS/NZS 3788, *Pressure equipment in-service inspection*
- AS/NZS 3820, *Essential safety requirements for low voltage electrical equipment*
- AS/NZS 3990, *Mechanical equipment - steelwork*
- AS/NZS 4024, *Safety of machinery*
- BS 7608, *Guide to fatigue design and assessment of steel products*
- DIN 7716, *Rubber products; requirements for storage, cleaning and maintenance*
- EN 13749, *Railway applications - Wheelsets and bogies - Method of specifying the structural requirements of bogie frames*
- EN 13913, *Railway applications - Rubber suspension components - Elastomer-based mechanical parts*
- ISO 281, *Roller bearings – Dynamic load ratings*
- ISO 3449, *Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements*
- ISO 3471, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements*
- ISO 6721, *Plastics — Determination of dynamic mechanical properties*
- ISO 10262, *Earth-moving machinery - Hydraulic excavators - Laboratory tests and performance requirements for operator protective guards*
- ISO 12117, *Earth-moving machinery — Laboratory tests and performance requirements for protective structures of excavators*
- SAE J845, *Optical warning devices for authorised emergency, maintenance and service vehicles*
- *Tyre and rim association of Australia - Standards manual*

Normative standards applicable to RRV units that operate on public roads:

- *Australian Design Rules (ADR) 3rd Edition*
- *National Heavy Vehicle Regulations*
- *Vehicle Standards Bulletin 6*
- *Vehicle Standards Bulletin 14*

NOTE:

Documents for informative purposes are listed in a Bibliography at the back of the Standard.

1.3 Competency

Competence of all persons verifying designs of, or modifications to RRVs shall be in accordance with AS 7501 independent competent person (ICP).

In accordance with the Rail Safety National Law, all:

(a) designers;
(b) design verifiers;
(c) constructors;
(d) construction validators;
(e) operators;
(f) maintainers; and
(g) certifiers

of RRVs shall have relevant competencies to undertake their work.

1.4 Defined terms and abbreviations

For the purposes of this document, the following terms and definitions apply:

1.4.1

Australian design rules (ADR)
Australian design rules applied to motor vehicles

1.4.2
base vehicle
a road-based vehicle which has been modified to operate on railway. Also known as a host vehicle

1.4.3
bogie
structure incorporating suspension elements and fitted with wheels and axles, used to support rail vehicles at or near the ends and capable of rotation in the horizontal plane. It may have one, two or more axle sets, and may be the common support of adjacent units of an articulated vehicle

1.4.4
driving supervisory system
a system fitted to a vehicle that can monitor the driver (or train) condition or performance and apply the train brakes when a measured condition or performance parameter violates a required state or limit

1.4.5
elastomeric torsion spring (ETS)
a type of torsion spring. Also known as flexitors

1.4.6
event recorder
a device installed on a RRV capable of recording multiple input parameters, in digital or analogue format, related to the operation of the road rail vehicle. Also known as a ‘data logger' or ‘data recorder’

1.4.7
fail-safe
the capability of an item or a system to ensure that any failure in a predictable or specified mode will result only in that item or system reaching and remaining in a safe condition

1.4.8
falling object protection (FOP)
a safety device fitted plant or machinery that provides the operator/s with protection from accidental falling objects

1.4.9
fatigue limit
the maximum stress below which a cyclically applied load will not result in fatigue failure. Also known as the endurance limit

1.4.10
gross vehicle mass (GVM)
a term used in the automotive industry to refer to the maximum permissible weight of a vehicle when fully loaded

1.4.11
gross vehicle mass (road)
the maximum permitted on-road mass, specified by the OEM, of the vehicle including the driver, passengers, fluids and loads and the load cargo. This will be found indelibly marked on the vehicles compliance plate and often clearly displayed prominently on the side of the vehicle where it may also have a prefix or subscript of ‘road’

1.4.12
gross vehicle mass (rail)
as per the GVM (road) but also varied, as required, in order to successfully comply with all necessary on-rail performance requirements including brake performance, twist and other dynamic performance requirements without exceeding the maximum working load of any RGE or base vehicle component. This will be found indelibly marked prominently on the RRV and may have a prefix or subscript of ‘rail’

1.4.13
heavy vehicle
a vehicle weighing more than 4.5 tonnes GVM. Note that this definition does not apply to those RRVs/machines that are not road registerable

1.4.14
independent competent person (ICP)
a person accepted by the RSO and the RIM as having practical and theoretical knowledge and experience in specified areas to critically and capably examine, determine and record compliance of new or modified rolling stock against the referenced standards

1.4.15
national heavy vehicle regulations (NHVR)
a set of regulations for the application of the heavy vehicle national laws applied in Australia

1.4.16
original equipment manufacturer (OEM)

1.4.17

off-tracking
the process whereby a RRV changes from on-rail operation to off-rail operation. Deemed to commence the instant the vehicle operator initiates retraction (raising) of the first set of rail wheel equipment and ends when all rail wheel equipment on the vehicle is fully stowed

1.4.18
overhead line equipment (OLE)
the structures and overhead equipment necessary for the traction power supply for electric rolling stock

1.4.19
rail guidance equipment (RGE)
structures and equipment enabling a road/ground-based vehicle/machine to mount and travel on rail. Also commonly referred to as rail guidance gear and rail guidance system

1.4.20
rail infrastructure manager (RIM)
the person who has effective control and management of the rail infrastructure, whether or not the person: owns the rail infrastructure; or has a statutory or contractual right to use the rail infrastructure or to control, or provide, access to it

1.4.21
road rail vehicle (RRV)
a road vehicle fitted with retractable rail guidance wheels

1.4.22
roll over protection (ROP)
a system or structure intended to protect equipment operators from injuries caused by vehicle overturns or rollovers

1.4.23
rolling stock operator (RSO)
a person who has effective control and management of the operation or movement of rolling stock on rail infrastructure for a railway, but does not include a person by reason only that the person drives the rolling stock or controls the network or the network signals

1.4.24
stub axle
on RGE, an axle connected to a single rail wheel only

1.4.25
transition
the act of the RRV moving from a road to rail, rail to road or from one rail mode to another rail mode

1.4.26
type test
a test conducted on one vehicle that will be assumed to be typical of all vehicles constructed to the same specifications

1.4.27
wheel pair
two wheels which oppose each other on the same end of a vehicle, often but not always connected by an axle

1.4.28
working load limit (WLL)
the maximum weight or force that a piece of plant/equipment is designed to handle during normal use. It is also sometimes referred to as the safe working load (term is no longer used), rated capacity, or working load

General rail industry terms and definitions are maintained in the RISSB Glossary. Refer to: https://www.rissb.com.au/glossary/

Section 2 RRV Classifications

See Appendix A for classifications/types of RRVs.

Section 3 Road registration and compliance of RRVs

Where a vehicle and/or plant type which is required to meet the ADR requirements for road registration, or otherwise registered under alternative legislative provisions such as local state and/or safety legislation, is selected to have RGE attached, all necessary actions shall be taken so far as is reasonably practicable, to ensure compliance requirements are not compromised by the RGE fitment.

Road registration/certification requirements may include:

(a) *Australian Design Rules (ADR) 3rd Edition*;

(b) *National Heavy Vehicle Regulations*;

(c) *Vehicle Standards Bulletin 6*; and/or

(d) *Vehicle Standards Bulletin 14*.

Alternatively, where strict compliance with requirements cannot be achieved, appropriate steps shall be taken to obtain the necessary derogations from the relevant authorities for the vehicle/plant to have the RGE fitted and maintain compliance with the road registration and/or other requirements.

Derogations shall be fully supported by a suitable and sufficient risk assessment in relation to the RGE fitment, the specific risks and proposed controls in respect of the non-compliance in line with a formal change management process.

Derogations do not apply to some statutory requirements such as the vehicle GVM which may be higher for on-rail operations than is legally permitted for on-road use. In all circumstances, the RRV shall comply with the certified GVM and axle loads at all times when operating on road.

Section 4 Rail compliance certification

It shall be a precondition for compliance certification that the RRV will have an engineering report to ensure the integrity of the RGE and its attachment to the vehicle as well as the integrity of the vehicle structure to carry and operate with nominated maximum load capacity on rail.

Rail compliance certification shall be undertaken on all RRV types prior to operation on a railway in accordance with AS 7501 or the respective RIM's accredited SMS rolling stock compliance certification process, as relevant and applicable to the vehicle type. This shall include any additional requirements deemed necessary by the RIM.

Verification of compliance with the requirements of this Standard shall be undertaken by calculation, inspection, measurement, and testing.

RRVs shall have appropriate engineering documentation which covers the configuration, chassis and RGE.

Verification of compliance with the requirements of this Standard shall include the full range of variations in RRV conditions that are likely to be experienced so far as is reasonably practicable. This includes the following:

(a) track gauge;

(b) rail guidance configuration;

(c) maximum speed(s);

(d) loading; and

(e) movable elements e.g. booms, jibs, etc.

Where validation of the analysis by physical testing is undertaken, a correlation between the analysis and test results shall be carried out.

Where demonstration of compliance is exclusively by calculation, a load factor shall be applied to the proof load cases defined within this Standard to allow for possible inaccuracies in the assessment.

Section 5 Transitioning between operating modes

At all stages during any transition from road to rail, rail to rail or rail to road, RRVs shall be incapable of uncontrolled movement.

When transitioning, it shall not be possible to transition both front and rear rail guidance equipment at the same time.

RRVs shall have at least one braked wheel pair or crawler tracks in contact with the rail at all times, sufficient to hold the vehicle stationary on the maximum grade of the operating network, when undergoing a transition (See section 14 of this Standard).

Rail wheel brakes may be released to prevent skidding of rail wheels during on and off-tracking. Rail wheel brakes must automatically re-apply no more than 60 s after the operator's last deploy or retract command.

Commentary C5-*1*

The notional 60 s time is to permit the release of the brake to enable the vehicle to be safely transitioned and the time may be varied as appropriate for the vehicle AND ITS RGE RATE of deployment/retraction operation.

For vehicles that do not have road wheels or crawler tracks on rail (e.g., type 1 – self powered rail wheels and type 2 – friction drive), or vehicles where it is possible to lift or unload road wheels off rail, the hydraulic system or transfer sequence shall be interlocked so that at least one braked axle shall be in contact with the rail at all times. This shall be sufficient to hold the vehicle stationary, when raising or lowering the RGE.

RRVs with active road or rail suspension systems shall have interlocks to ensure sufficient load share on braking systems is maintained at all times during transition.

RRVs shall be capable of transitioning on a grade of up to 1 in 30 safely without runaway in all permissible loading configurations.

Commentary *C5-2*

For some networks, including light rail and metros, which have some limited track sections with grades as steep as 1 in 22, the RIM may impose alternative increased grade restrictions subject to assessment of the local operational conditions. These restrictions need to be advised to the RSO prior to mobilisation or engagement.

The transition system shall be interlocked such that the transitioning system is isolated if the vehicle is in motion and the transition system controls shall be located such that they cannot be inadvertently operated.

Section 6 Emergency off-tracking system

RRVs shall have a mechanism by which they can be safely removed from the track in a failed state.

RRVs shall have the ability to retract the RGE to accommodate emergency recovery as a result of the following failure modes:

(a) damaged RGE;

(b) complete loss of engine power; and

(c) loss of power to vehicle control systems.

Commentary *C6*

Emergency recovery is generally achieved by way of a handpump to raise the RGE to road mode.

Signage containing instructions for use of emergency off-tracking equipment shall be installed in the vicinity of such equipment.

Emergency off-tracking equipment shall be located such that it is only operated from a safe position on the vehicle or at a safe distance from the vehicle.

Emergency recovery procedures shall be included in the operator's manual.

Section 7 Vehicle design

7.1 General

The load on the rail wheels of RRVs shall be maintained continually when in the on-track position by use of one of the following:

(a) mechanical locking or over centre design;

(b) suspension system; or

(c) hydraulic holding valves.

Rail wheel guidance equipment on road registered RRVs shall be mechanically locked in the raised position when in road travel mode.

For non-automatic systems, mechanical locking for the rail wheel assemblies on RRVs shall be:

(d) readily accessible; and

(e) operated from outside the vehicle clear of any 'trap/pinch' points and preferably from the side of the vehicle.

RRVs shall be designed to minimise the variation in vehicle mass side to side. The rail wheel loads on all rail axles shall be balanced as evenly as is reasonably practicable.

Alignment between the RGE and the base vehicle shall not be more than 5mm.

7.2 Analysis of the vehicle chassis

The designer shall conduct a thorough analysis of the vehicle chassis to establish that it is able to withstand the loads applied as a result of the RGE installation and operation.

The analysis shall include the loads applied both in the on-road and on-rail configurations and transition between configurations.

The static stresses shall not exceed the permissible proof stresses for the material of construction.

7.3 Fatigue loads of RGE and vehicle chassis

A fatigue assessment for both road and rail performance shall be performed for all new RGE structures.

Commentary *C7.3-1*

This section relies upon the vehicle designer having access to some generic standards to facilitate assessment of the fatigue performance of the rail guidance equipment and vehicle chassis.

A fatigue assessment shall be performed for all new installations to the vehicle chassis.

Where available, load spectra that reflect the anticipated operating condition shall be used.

Vehicles shall comply with fatigue assessment processes in structural standards such as AS 4100 (for steel) and AS 1664 (for aluminium), or international equivalents such as BS 7608 and EN 13749.

Commentary *C7.3-2*

An example of the fatigue assessment process is provided below:

a) The fatigue loading spectrum is determined from direct measurement, simulation, from other standards, or sinusoidal approximation.

b) A suggested track induced loading spectrum of the rail guidance equipment is +/-0.2g in the lateral (y direction) for 107 cycles and (1+/-0.3) g in the vertical (z direction) for 107 cycles.

c) A suggested fatigue loading spectrum of equipment attached to the vehicle chassis is +/-0.3 g in the longitudinal (x direction) for 107 cycles, +/-0.4 g in the lateral (y direction) for 107 cycles and (1+/-0.3) g in the vertical (z direction) for 107 cycles.

d) The designer identifies all locations that are susceptible to fatigue loading and records these locations in the maintenance manual provided to the user.

e) For non-welded details and fusion welded fabrications BS 7608 is used to determine relevant classification and associated allowable stress at 107 cycles.

f) Miner's rule is used to add cumulative damages from each load case at each critical location (miner's rule is a cumulative damage hypothesis used in engineering, especially fatigue analysis. It states that the sum of individual damage fractions occurring at different stress levels equals the total damage, treating each fraction as a proportion of material failure).

g) Minimum level of confidence for fatigue life acceptance is the mean – 2 standard deviation data (i.e. 97.7 % probability of survival).

For all new RGE installations a structural assessment of the chassis shall be undertaken to ensure design stresses are not exceeded.

Commentary *C7.3-3*

These suggested fatigue loads account for accelerations due to vehicle dynamics plus any additional loading resulting from the equipment itself.

7.4 Shock and minor impact loads

Components and their mountings connected to the RRV shall comply with the load cases specified in section 8 of this Standard.

Section 8 Rail guidance system load cases

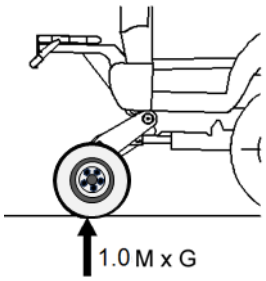
8.1 General

The following load cases shall be the minimum used for design analysis of the RGE, in both work and travel modes.

The designer shall provide certification documentation in accordance with AS 7501 including the determination of the forces and the results from each load case in an engineering design report. The report shall clearly identify areas of concentrated stress and/or areas subject to fatigue.

8.2 Load case #1: Road to rail transition

Road to rail transition shall be calculated by the following:



Pt (N) = 1.0G x Peak load applied to the rail gear during transition

Where:

M = Mass on rail wheels (kg) with vehicle at WLL of RGE

Commentary *C8.2-1*

Stresses in the transition phase can cause damage that could later result in a failure on-rail. The load applied during transition can often be higher than that applied during use on-rail, particularly for designs that utilise over-centre swinging frames.

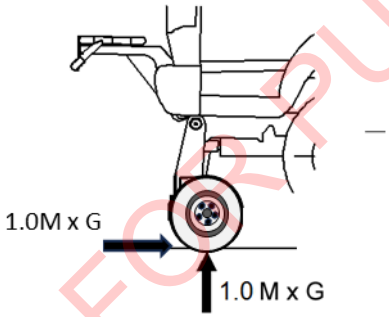
The designer shall demonstrate how the peak load has been determined. Consideration shall be given to instances where the rail head may be above the height of the surrounding road surface.

Commentary *C8.2-2*

The rail head being above the height of the surrounding road surface may have an adverse effect on the geometry and an increased level of stress during transition.

8.3 Load case #2: Longitudinal load whilst driving forward on rail

This load case shall be calculated to represent the loading that can be applied when the RRV is either driven into a static object on-track (blocked flangeways etc.) or under heavy braking whilst travelling forward.



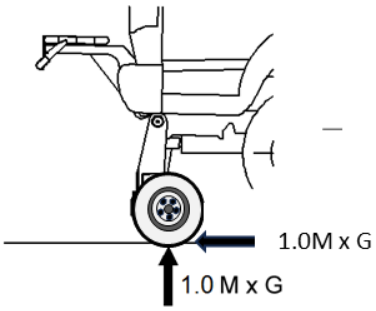
Pf (N) = (1.0G x M Longitudinal) + (1.0G x M Vertical)

Where:

M = Mass on rail wheels (kg) with vehicle at WLL of RGE

8.4 Load case #3: Longitudinal load whilst driving backward on rail

This load case shall be calculated to represent the loading that can be applied when the RRV is either driven into a static object either on-track (blocked flangeways etc.) or under heavy braking whilst travelling in reverse.



Pb (N) = (1.0G x M Longitudinal) + (1.0G x M Vertical)

Where:

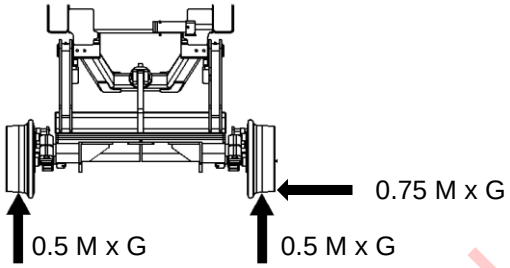
M = Mass on rail wheels (kg) with vehicle at WLL of RGE

8.5 Load case #4: Lateral loading whilst driving on rail

This load calculation shall be carried out with the load applied at the rail/wheel contact point, with the top of the rail guidance frame fixed at the point it is attached to the base vehicle chassis.

Commentary *C8.5*

This ensures it is the lateral strength of the rail guidance system that is being assessed and not the vehicle tipping point.



Pl (N) = (0.75G x M) + (1.0G x M Vertical)

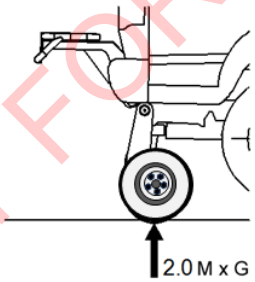
Where:

M = Mass on rail wheels (kg) with vehicle at WLL of RGE

Vertical load should be divided equally between supporting wheels.

8.6 Load case #5: Vertical loading whilst driving on rail

This case shall be calculated for the vertical loading applied to the rail wheels when in the on-rail position.



Pv (N) = 2.0G x M

Where:

M = Mass on rail wheels (kg) with vehicle at Working WLL of RGE

Section 9 Road rail vehicle outlines

The maximum permitted size of RRVs vary for different networks and routes in Australia, and the relevant static and kinematic outline shall not be infringed, without permission of the RIM.

The RIM shall specify the appropriate reference rolling stock outline for each route.

The RSO shall ensure that their RRV complies with the appropriate reference rolling stock outline or seek exemption from the RIM.

Commentary *C9*

AS 7507 provides guidance for rolling stock outlines.

Commonly the base vehicle road tyres (or tracks) infringe the rolling stock outline, either due to not being sufficiently lifted (type 1, 2) or when used for traction/braking purposes on rail (type 3). These are considered separately and have limits associated with the inner and outer widths, and have subsequent operating conditions based on these widths. Refer to RIM requirements/limits.

Section 10 Track forces and stresses

10.1 Rail stress during track work

The designer shall determine the maximum forces which will be applied to rail during operation of the RRV, during travel and/or during work mode. This may include any asymmetric loading that may arise from payload or other vehicle functions (i.e., cranes, lifts, elevated work platforms, etc).

The designer shall provide documentation to the RSO regarding the maximum forces applied to rail during operation of the RRV.

Commentary *C10.1*

Setting the axle loads would be a routine function as part of the RRV manufacture/assembly, even for a fleet of vehicles of the same type.

10.2 Axle load and overall vehicle mass

The maximum axle load and overall vehicle mass determined by a static weight test shall not exceed limits set by the RIM for the routes over which approval is sought for the RRV to operate.

For RRVs without axles connecting rail wheels, wheel pair load shall be calculated.

When type testing, unless testing of the first vehicle demonstrates a margin of at least 10 % of the maximum axle load specified by the RIM, this test shall be conducted as a routine test.

Commentary *C10.2*

The static weight test is designed to ensure that each vehicle is constructed within the allowable wheel load, axle load and overall vehicle mass limits.

10.3 Calculations

Total vehicle mass is calculated by summing the individual wheel load measurements.

(a) Maximum axle load is the highest wheel pair load with vehicle at GVM.

(b) The percentage load distribution between road wheels and rail wheels at the ends of the vehicle load sharing on type 3 RRVs is calculated by the sum of all the rail wheel loads at end being assessed divided by the sum of all the road and all rail wheel at the same end multiplied by 100. This gives percentage load taken by the rail wheels (See section 12.8 of this Standard).

Commentary *C10.3*

For the purposes of this section, the GVM is the GVM (rail) which may be higher or lower than the GVM (road).

10.4 Rail contact stresses

10.4.1 Wheel diameter

Unless otherwise approved by the RIM, the minimum wheel diameter shall be determined by the P/D ratio according to Equation 1.

Equation 1 Maximum P/D ratio for non-conformal contact

$$Maximum\ \frac{P}{D}\ ratio = \frac{125kN}{m}$$

Where:

P = Static load on wheel (kN)
D = minimum [worn] wheel diameter (m)

Commentary *C10.4.1*

The P/D ratio is applicable to wheels giving non-conformal contact with the rail running on tracks with no regular rail grinding to maintain profile. Non-conformal profiles include those having a tapered tread blending into a single radius in the flange throat such as ANZR1.

When considering the rail wheel diameter in addition to the above also refer to section 15.3 of this Standard and AS 7508.

For consideration of alternative validation methods reference may be made to EN 15746.

10.5 P2 forces

An assessment of the P2 force exerted by the rail guidance wheels of an RRV shall be conducted if the static load exerted on any of these wheels exceeds 100 kN, or if the vehicle travels faster than 50 km/h and has rail axle loads greater than 10 t.

It shall not be necessary to assess the P2 force exerted by a correctly inflated pneumatic tyred driving wheel of a road rail vehicle as the tyre effectively isolates the wheel hub and drive from rail impacts.

P2 Forces shall be calculated and assessed in accordance with AS 7508.

Section 11 Dynamic vehicle behaviour

11.1 General

The dynamic behaviour of new or modified RRVs weighing less than or equal to 5 t GVM and travelling at speeds more than 50 km/h; or weighing greater than 5 t GVM travelling at more than 30 km/h, shall be evaluated for:

(a) lateral instability as per section 11.2 of this Standard; and
(b) base ride accelerations as per section 11.3 of this Standard.

The dynamic behaviour of new or modified RRVs shall be evaluated for:

(c) minimum negotiable rail radius (on advice of the RIM);
(d) vehicle to RGE clearance as per section 11.4 of this Standard;
(e) transition curve negotiation as per section 11.5 of this Standard; and
(f) wind loading, where the road rail vehicle falls within the scope of AS 1418.

Commentary *C11.1*

Evaluations for dynamic behaviour are intended as type tests.

11.2 Lateral instability

Commentary *C11.2*

This section describes how to evaluate whether an RRV will suffer from lateral instability.

11.2.1 Evaluation conditions

11.2.1.1 RRV conditions

An RRV being evaluated for lateral instability shall be in tare condition.

Commentary *C11.2.1.1*

If the RRV has a substantial imbalance, then the test may be required to be repeated in the loaded condition. Noting that in tare condition the rail wheels and suspension are at their least loaded condition potentially affecting RRV on-rail performance.

The RRV shall be fitted with suitable wheel profiles for ride testing. This includes field worn wheels approaching condemning limits, new WPR 2000 or other test profile as specified by the RIM.

11.2.1.2 Track conditions

Any track geometry irregularities in the test track section which are more severe than ‘Response Code P2’ in accordance with AS 7635 (appendix C), or equivalent values for narrow gauge or broad gauge track, should be spaced no closer than the distance travelled in 10 s at the testing speed.

Commentary *C11.2.1.2-1*

Track geometry irregularities can trigger the onset of lateral instability which may then continue on perfect track. Such irregularities can also interfere with lateral instability and prevent it building up to its potential acceleration amplitude.

The gauge corner of the rails within the test track section should have minimal grinding so that contact with the wheel tread occurs over the full distance between the tread line and the throat of the flange as the wheel moves towards flange contact.

Commentary *C11.2.1.2-2*

Low effective conicity, discouraging lateral instability, occurs when the rail gauge corner is relieved sufficiently so that the contact point on the wheel stays close to the tread line rather than moving towards the flange as the wheel moves laterally towards flange contact.

The track gauge within the test track section should not be more than 3 mm wider or 3 mm tighter than nominal gauge.

Commentary *C11.2.1.2-3*

Tight gauge shifts the contact points on the wheels closer to the flange where the tread gradient is steeper.

Lateral instability shall be evaluated under dry weather conditions.

Commentary *C11.2.1.2-4*

Wet wheels and rail head (during or shortly after rain) will result in a reduced co-efficient of friction between wheel and rail suppressing any lateral instability tendency.

As curves can suppress lateral instability behaviour, an RRV being evaluated for lateral instability shall travel over tangent track for a continuous distance of at least 2 km.

11.2.1.3 Operating conditions

An RRV being evaluated for lateral instability shall travel as a single vehicle or hauled in a trailing position.

An RRV being evaluated for lateral instability should travel at a speed of 110 % of its intended maximum service operating speed.

11.2.2 Measurements

Accelerometers shall be placed on the RRV body as near as practicable to the leading rail wheels at the centre of the RRV.

Accelerations obtained for lateral instability should be:

(a) first filtered using a low pass filter with cut-off frequency of 10 Hz and a filter-roll off of 24 dB/octave; then

(b) filtered using a band pass filter set to ±2 Hz each side of the dominant frequency with a filter roll-off of 24 dB/octave; then

(c) a sliding root mean square of acceleration is calculated for a window length of 100 m and a step length of 10 m.

11.2.3 Acceptance criteria

An RRV during lateral instability evaluation shall not experience a root mean square value of lateral underframe accelerations that exceeds 0.25 g over any 100 m window.

11.3 Base ride accelerations

Commentary *C11.3*

This section describes how to evaluate whether an RRV will ride satisfactorily over track at the lower end of the quality expected to be encountered in service at the RRV's rated maximum service speed.

Note that this section considers ride safety only and does not consider ride comfort for persons on the RRV.

11.3.1 Evaluation conditions

11.3.1.1 Exclusions

Assessment for base ride acceleration is not required for RRVs that:

(a) weigh less than or equal to 5 t GVM and travel at speeds up to 50 km/h; or

(b) weigh greater than 5 t GVM and travel at speeds less than 30 km/h.

11.3.1.2 RRV conditions

An RRV being evaluated for base ride accelerations shall be in tare condition.

The RRV shall be fitted with suitable wheel profiles for testing. This includes field worn wheels approaching condemning limits, new WPR 2000 or other test profile as specified by the RIM.

11.3.1.3 Track conditions

The track quality should be at the lower end of the quality range expected to be encountered in service at the RRV's rated maximum service speed.

Details should be obtained from the RIM of irregularities in track geometry, within the nominated test track section, which are more severe than those requiring inspection within 7 days based on the RRV's rated maximum service speed or the track speed limit, whichever is the lesser.

Commentary *C11.3.1.3*

If the irregularity is severe enough, the RRV's performance may not satisfy the acceptance criteria nominated in section 11.3.3 of this Standard. In order that the RRV response is not unfairly penalised under such a condition, the locations of significant irregularities may be identified so that any anomaly in vehicle response can be qualified. The 7-day inspection criterion is known as a 'response code P2' in described in AS 7635 (appendix C).

11.3.1.4 Operating conditions

An RRV being evaluated for base ride acceleration shall travel as a single vehicle or hauled in a trailing position.

An RRV being evaluated for base ride acceleration should travel at a speed of 110 % of its intended maximum service operating speed.

11.3.2 Measurements

Accelerometers shall be placed on the RRV body as near as practicable to the leading rail wheels at the centre of the RRV. Vertical accelerations shall also be measured at the same physical locations on the RRV.

Accelerations obtained for lateral instability should be:

(a) first filtered using a low pass filter with cut-off frequency of 10 Hz and a filter-roll off of 24 dB/octave; then

(b) filtered using a 10 Hz low-pass filter with a filter roll-off of 24 dB/octave is applied to the lateral and vertical accelerations; then

(c) sliding root mean square values of lateral acceleration and vertical acceleration are calculated for a window length of 100 m and a step length of 10 m.

11.3.3 Acceptance criteria

Over any time period during the base ride accelerations test:

(a) the maximum lateral acceleration developed under test conditions shall be within +/-0.5 g, except in response to a track irregularity as described in section 11.3.1.3 of this Standard;

(b) the root mean square value of lateral acceleration shall not exceed 0.25 g over any 100 m window;

(c) the maximum vertical acceleration developed under test conditions shall be within +/-0.8 g, except in response to a track irregularity as described in section 11.3.1.3 of this Standard; and

(d) the root mean square value of vertical acceleration shall not exceed 0.35 g over any 100 m window.

11.4 RRV to rail guidance equipment clearance

11.4.1 Method

An inspection shall be conducted to ensure that adequate clearance exists between the RRV underframe and its RGE or wheels in all operating conditions.

This may be achieved by physical testing, a design validation using graphical means, or mock ups which faithfully represent the actual RRV.

RRV to RGE clearance checks shall evaluate the effects of:

(a) the vehicle yawed in both directions simulating travel into opposite handed track geometries;

(b) the handbrake applied and released;

(c) brake blocks at new and fully worn condition;

(d) maximum underframe roll relative to RGE expected in service;

(e) maximum suspension compression; and

(f) RGE pitching.

All underframe equipment and associated pipework or cabling and all underframe to RGE or wheel connections including hoses, control cables and power cables (if used) shall be fitted and coupled during the test.

11.4.2 Acceptance limit

There shall be no interference or fouling between the RGE wheel and any underframe component at any time during assessment.

The underframe to RGE or wheel connections including hoses, control cables and power cables shall not be kinked or pulled apart at any time during assessment nor shall they contact any other item with a force likely to cause damage to any component.

11.5 Transition curve negotiation

The RRV's ability to safely exit a curve transition, without the leading wheel flange climbing the rail, shall be assessed by investigating wheel unloading during a routine twist test, in conjunction with RGE or wheel rotational resistance determined by testing.

11.5.1 Twist test

A static twist test shall be carried out on all RRVs other than for RRVs fitted with pivoting axles that are horizontal and aligned to the vehicle centre longitudinally and are not fitted with springs, lockouts, buffers or dampers are not required to undergo a twist test. These RRVs shall however demonstrate that they have sufficient free travel to successfully negotiate the test transition curve (twist test) without bottoming out.

A static twist test shall be carried out in both tare and most unfavourable travel conditions.

Where RRVs have multiple rail modes or settings, the twist test shall be confirmed in all configurations.

Commentary *C11.5.1-1*

A twist test assesses the wheel unloading performance and underframe behaviour of RRVs on a track geometry that replicates the twist conditions that could occur on the railway network.

This test is intended to evaluate the capability of RRVs to accommodate track twist without unacceptable reductions in the wheel load at rail. High twist is found in the transitions leading into and out of curves but may occur anywhere in the track. The change in cant (superelevation) that occurs within a cant ramp produces a twist between the vehicle's axles that tends to create unloading of some wheels.

During a static twist test, RRVs are simulated to be travelling down a cant ramp that includes an unintended dip that is superimposed on the cant ramp as shown in Figure 1.

Commentary *C11.5.1-2*

In the example shown in Figure 1, the leading wheel on the high rail side is the wheel of interest. Its wheel unloading will be a maximum when the road rail vehicle moves down the cant ramp and reaches point A.

Angled pivoting axles and pivoting axles fitted with springs, buffers or dampers shall require a twist test to confirm wheel unloading.

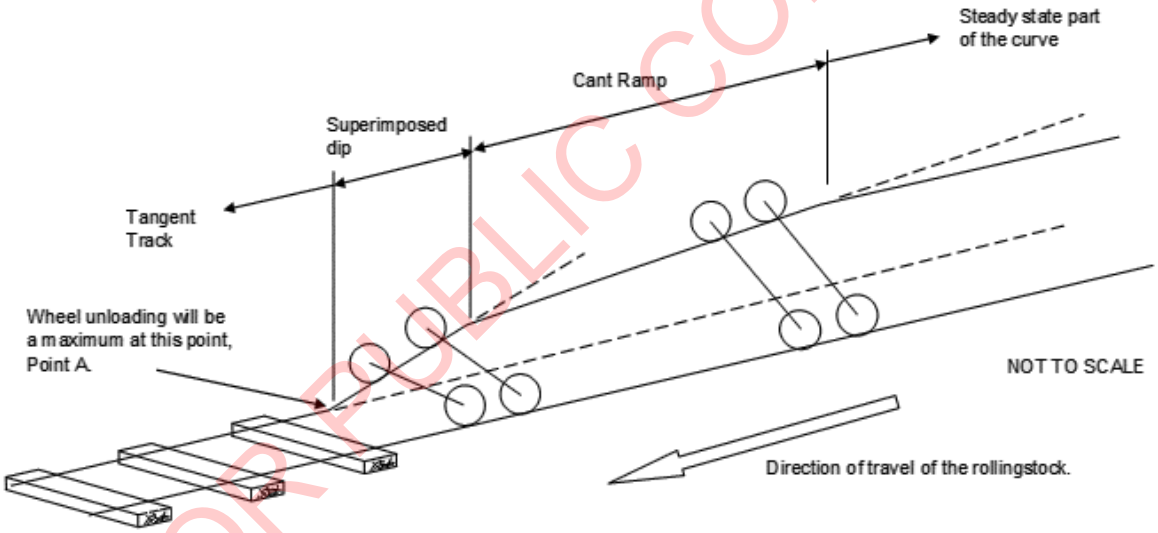


Figure 1 Condition simulated by static twist test

The leading wheels of the leading RGE in any direction of travel shall be assessed.

For RRVs which have more than 2 pair of RGE, the wheels of the leading outermost wheel pair of each intermediate RGE of equal loading shall also be assessed.

Commentary *11.5.1-3*

Articulated RRVs would be included under this description.

11.5.2 Evaluation conditions

11.5.2.1 Vehicle conditions

A vehicle being evaluated for wheel unloading due to track twist shall be in the condition which will provide the worst wheel unloading in service. Type 3 – direct drive RRVs should be tested in both tare and gross conditions.

If any components limiting RGE or wheel pair travel are not fitted during twist testing, then sufficient measurements of suspension deflections shall be taken to verify that the travel limit has not been reached.

The vehicle conditions shall include load condition and maintenance condition.

Worst conditions to be evaluated are:

(a) tare;

(b) shifting load (e.g., bulk liquids); and

(c) uneven loading, including the consideration for work mode with ancillary equipment such as booms in their extended work limits.

All shock absorbers, bump stops, lifting devices and centre pins and cotters, if used, should be in position and correctly adjusted during the tests.

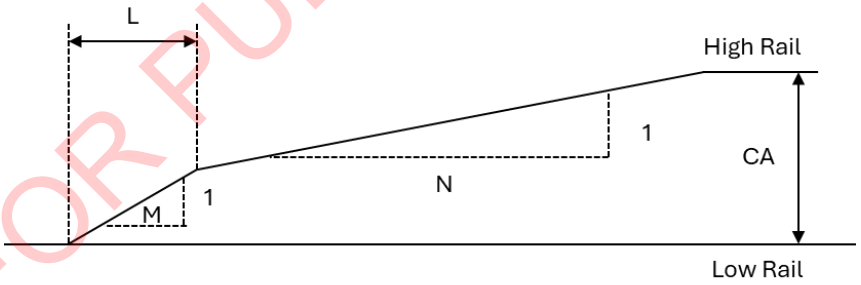
11.5.2.2 Track conditions

The shape of the track to be simulated shall be as defined in Figure 2.

Important parameters describing the shape of the track to be simulated shall be as defined in Figure 3.

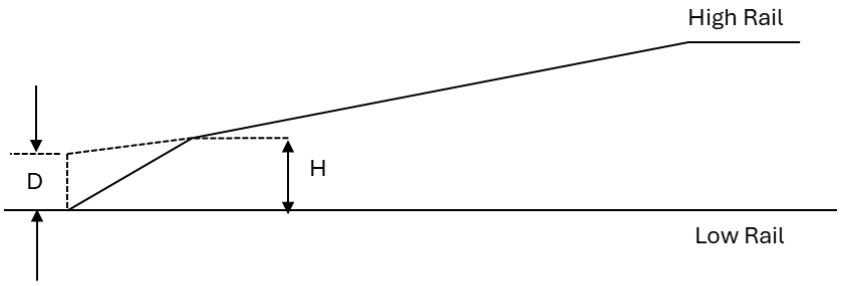
The parameter values that are applicable to various routes shall be in accordance with AS 7509.

Where two separate cases are defined in Table 1 of AS 7509 (i.e. cases 1A & 1B, cases 4A & 4B) RRVs shall be required to meet the parameters of both cases.



CA = Maximum cant to be simulated
N = Gradient of the cant ramp(1/slope)
M = Gradient of superimposed dip (1/slope
L = Length over which the localised dip occurs

Figure 2 Track shape for twist test



D = Magnitude of localised dip
H = Height at end of local dip/start of cant ramp

Figure 3 Important parameters describing the track shape for twist test

The required jacking heights shall be calculated from Equation 2 if the wheel is on the local dip (B < L) and Equation 3 if the wheel is on the uniform slope cant ramp up to a maximum height of CA, if applicable.

Equation 2 Wheel jacking height when on local dip

$$P = \frac{B}{M}$$

Where:

P = Jacking Height of wheel (mm)
B = Horizontal distance to a wheel pair from first wheel pair (mm) M = Parameter defining the gradient of the localised dip (1/slope)

Equation 3 Wheel jacking height when on cant ramp

$$P = H + \frac{(B - L)}{N}$$

Where:

P = Jacking Height of wheel (mm)
H = Height at end of local dip/start of cant ramp (mm)
B = Horizontal distance to a wheel pair from first wheel pair (mm) L = Length over which the localised dip occurs (mm)
N = Parameter defining the gradient of the Cant Ramp (1/slope) CA = Maximum cant to be simulated (mm)

If packing is not available as calculated and only nominal packers are available, the packing selected/used shall be rounded up to the next available size.

11.5.3 Measurements

The tyre pressure for any road tyres in contact with the rail shall have the pressure set to the normal operating specification for the RRV.

The initial rail wheel loads with RRV configured in travel mode shall be measured on the wheel pairs that will remain level during the tests.

Only the wheel of interest shall be measured, not both wheels.

Commentary *C11.5.3-1*

Averaging is not required as per the full twist test procedure. Using the simplified method is acceptable for RRVs.

After all the wheels (including any road wheels) on one side of the RRV, except at the wheel pair being assessed, are raised to the heights calculated using Equation 2 and Equation 3 then the wheel load at the assessed wheel pair on the raised side of the RRV shall be measured.

Road wheels should be lifted from the tread rather than the hub.

The procedure shall be repeated, raising the wheels on the opposite sides of the same axles to the same heights.

Commentary *C11.5.3-2*

Raising the wheels on the opposite sides of the same axles to the same heights would quantify any asymmetry in wheel unloading that would result from any pre-existing twist in the underframe or suspension.

The procedure shall be repeated at the opposite end of the vehicle.

The twist test should be applied to all four corners of the vehicle.

The procedure shall be repeated on the opposite side without releasing any friction in the suspension components.

If the required heights are inadvertently exceeded, all jacks shall be returned to their previous heights before repeating.

Commentary *C11.5.3-3*

Returning jacks to the previous height and repeating the process ensures friction is acting in the same direction.

If the test is conducted by lowering wheels onto packing of the required heights, then care needs to be taken to minimise the heights that the wheels are raised prior to lowering.

To insert packing shims, a wheel pair is typically jacked higher than the required height above rail to allow for the shims to be inserted between wheel and rail. Upon lowering the wheel onto the packing, the wheel load jumps from the unloading portion to the loading portion of the wheel load hysteresis curve. The calculated wheel unloading is then likely to be misreported.

Ideally, the packers are to be used like a feeler gauge to indicate that the desired height has been reached such that no reversal in direction of jacking is made.

11.5.4 Acceptance criteria

Maximum wheel unloading when calculated in accordance with Equation 4 shall not exceed 60 %.

Equation 4 Wheel unloading

$$Wheel\ unloading = 1 - \frac{Minimum\ wheel\ load}{Static\ wheel\ load}$$

Where:

Minimum wheel load is the remaining wheel load (t) on the wheel of interest when the balance of the wheels on one side of the road rail vehicle are raised to their required heights.

Commentary *C11.5.4*

The wheel load on the wheel of interest prior to raising any wheels to their required heights

Calculating the wheel unloading from the starting load on an individual wheel does not properly show the flange climb potential of wheels that are already unloaded from the average on level track.

Section 12 Suspension

12.1 General

Commentary *C12.1*

This section covers the requirements for the systems that transfer vertical loads from the base vehicle to the rail wheels, these systems do not require the use of springs and dampers to be applicable. The systems may include ridged frames that are hydraulically controlled, free acting pivoting axles or hybrid systems involving multiple system types working together.

Suspension components shall be selected, installed, inspected, and maintained in accordance with the component manufacturer's specifications and instructions. Any departures shall be explicitly noted in detail on the compliance certificate as a non-compliance. This includes use of a sub-component from within a component manufacturer's assembly as a stand-alone component, such as use of a single spring from a spring nest or pair.

Suspension components shall not exceed the component manufacturer's rated capacity during operation for all vehicle operating modes and load conditions, including asymmetric loads.

The proper settings for all configurable settings shall be stored with the vehicle documentation in the operator's cab. All settings that potentially impact compliance with this Standard shall also be recorded on the nearest surface to the place where the setting is adjusted (e.g., all Type 3 RRVs shall have a controlled tyre pressure). Each tyre shall have its operational window marked on the vehicle body above the axle.

12.2 Design

The RRV designer shall specify the suspension system requirements to comply with the following sections of this Standard:

(a) Section 7 – Vehicle design;
(b) Section 8 – Rail guidance system load cases;
(c) Section 9 – Road rail vehicle outlines;
(d) Section 10 – Track forces and stresses; and
(e) Section 11 – Dynamic vehicle behaviour.

A fatigue assessment of new suspension designs shall be performed as defined in section 7.3 of this Standard.

The design shall ensure that the suspension systems employed shall be adequately adjustable to enable incremental wheel load and direction adjustments to be made over the service life of the vehicle in order to meet the requirements of section 11 of this Standard.

A suspension design shall incorporate suspension movements that do not adversely affect the performance of the braking system. In addition, the braking system should not affect the suspension system operation (i.e., locking out or short-circuiting suspension system when braking is applied).

12.3 Pivoting axle systems

Commentary *C12.3-1*

Pivoting axle systems manage the rail wheel load by distributing it to each rail via a centre bearing that allows it to freely pivot around a longitudinal axis.

The RRV shall not have more than 50% of the mass supported by these systems.

Commentary *C12.3-2*

Some RRVs may appear to have 100 % of their mass supported by pivoting axle system, however one end will need suspension elements incorporated into the design to ensure its proper function.

Pivoting axle systems typically include locking mechanisms to allow for eccentric loading during work-mode operations.

If the RRV is unable to pass the compliance testing with the locking mechanism engaged, the design shall alert the operator to the incorrect position of the locking mechanism. Travel shall not be permitted with a locked pivoting axle that does not comply with the requirements (i.e., twist test).

The pivoting axle system shall be designed to maintain load share on all rail wheels when subjected to transit load effects of objects on the rail head or increases and decreases in the footprint of pneumatic tyres.

Commentary *C12.3-3*

The footprint of pneumatic tyres is commonly altered when the vehicle is traversing points, checkrails, level crossings and track that is flooded with ballast.

12.4 Bogies

RRV units that utilise bogies as a part of the RGE shall comply with AS 7519 as applicable to the bogie design.

12.5 Spring and damper elements

Suspension components may include:

(a) coil/leaf/elastomeric springs;

(b) steel/elastomeric torsion springs; and/or

(c) friction/hydraulic/pneumatic/elastomeric dampers.

The suspension components manufacturer should provide detailed specifications and instructions covering the requirements of AS 7518 and additional requirements as described in section 12.7 of this Standard. Where suspension components do not comply with AS 7518 or Section 12.7 of this Standard they shall be able to be replaced prior to returning to service after a derailment or the 10 year maintenance interval.

Non-elastomer based suspension designs or suspensions without adequate damping shall be fitted with dampers to control axle movement.

12.6 Preload and suspension travel

Suspension elements shall be appropriately loaded and have reserve travel such that sufficient load can be maintained on the rail wheels to ensure adequate guidance at all times and under vehicle twist and ride performance test conditions on the worst-case curves and superelevation (i.e., typically 150 mm for standard gauge track). If during the conduct of any static or dynamic testing the rail wheel loses contact with the rail head, the vehicle does not comply with this requirement.

RGE suspension shall be designed to have sufficient travel and preload when fully deployed to prevent rail wheels unloading by 60 % or more of the static wheel load during a track twist test with the vehicle in the operating configuration and load condition that minimises the load on the test rail wheel.

Commentary *C12.6*

Type 3(b) RRVs that are tray back utilities and trucks may unload the front RGE when loaded to maximum GVM, in these cases the vehicle may be required to be retested at maximum GVM. The vehicle may be retested at tare for condition-based testing that may be included in the Technical Maintenance Plan for the vehicle.

In addition, Type 3 RRVs shall maintain a minimum rail wheel load of 5 % of the rail wheel load at GVM in the twisted condition. This may be a greater wheel load than 40 % of the static wheel load.

Suspension shall be capable of reacting to the accelerations defined in section 8 of this Standard at both tare and WLL without the rail wheels losing contact with the rail or suspension reaching the limits of its travel (e.g., bottoming out). For Type 3 RRV's the suspension should not be overloaded if a road tyre deflates.

RRVs with suspension, including the securing structure, that are unable to support the vehicle mass at WLL in the event of a derailment or road tyre failure, shall have procedures detailing the recertification and requalification processes required prior to returning a vehicle to service after a derailment.

12.7 Elastomeric torsion springs

Elastomeric torsion springs (ETS) may be used in RRV designs and are commonly known as flexitors. All ETS shall be accordance with AS 7518 and the additional requirements in section 12.7 of this Standard.

12.7.1 Design and manufacture

ETSs should be manufactured in accordance with applicable Standards, such as ISO 6721 and DIN 7716. The OEM qualification of an ETS shall be invalidated if it is modified or hot work is performed on any part of the spring or it's housing. The RSO shall provide detailed instruction or requalification of any modified spring elements.

ETSs shall be marked with the date of manufacture.

ETSs should be marked with:

(a) product/batch number;

(b) part number; and

(c) alignment angle markings of the spring under the maximum torsional load.

The original design assessment shall limit the maximum allowable stiffness range.

The design shall detail the impact of physical property changes and creep over the life cycle.

Where the axle is retained solely by elastomer or is bonded to elastomer components, a secondary restraint shall be provided that will retain the axle in the event of a derailment and permits safe lifting of the assembled RGE.

For composite springs incorporating elastomers, where the elastomer is not the primary means of supporting the sprung mass, the elastomer shall be maintained as a resilient component in accordance with AS 7518. The spring element supporting the sprung mass shall be maintained in accordance with AS 7518.

12.7.2 Inspection, testing and maintenance

Inspection and maintenance procedures for elastomeric springs shall comply with the requirements in AS 7518.

Inspection and maintenance activities should include:

(a) scheduled replacements;

(b) monitoring of settling;

(c) physical appearance; and

(d) periodic in-service/sample testing for deterioration (in accordance with EN 13913 or ISO 6721) for 'in-service items and/or AS 7518 for items that have been in storage.

Commentary *C12.7.2*

The results of periodic in-service/sample testing for deterioration these tests can be used to assess possible increase in derailment risk (refer AS 7518 and section 11 of this Standard) and to review maintenance schedules as necessary.

12.8 Load share management

Vehicle designers shall incorporate all necessary design and maintenance activities and instructions to ensure that the load share is controlled such that adequate vertical load is on the rail wheels to resist lateral loading, ensuring the rail wheel and where applicable road wheels are continuously aligned with the railhead.

Commentary *C12.8*

All Type 1 and Type 2 RRVs have 100 % rail load share on both ends of the vehicle. Type 3 (a) vehicles have 100 % of the load on the front RGE. Where load share needs to be managed, the typically expected load share percentage requirements for Type 3 RRVs at static tare loading are (see section 10.3 of this Standard):

(a) an RRV end with a single road axle sharing the load with a rail load should have a minimum 35 % load on rail axle(s).

(b) an RRV end with dual road axles sharing the load with a rail load should have a minimum 50 % load on the rail axle(s).

RIMs/RSOs may require the design's load share to be validated by way of an engineering assessment of L/V to be included in the engineering certification documents.

RRVs shall maintain sufficient load share on the appropriate braked axles to meet the braking requirements in section 14 of this Standard. This typically means that a minimum of 50% of the vehicle mass should be on axles that provide service, automatic and/or park brake.

For unattended securing of an RRV on track, the park brake shall not rely on pneumatic tyres to achieve the 50 % load share.

In addition, 50 % of the RRVs load share should be on drive axles to enable the vehicle to reliably drive up a 1 in 30 incline without excessive wheel spin.

RRVs shall be balanced side to side so far as is reasonably practicable.

12.9 Guide roller RGE designs

Commentary *C12.9-1*

Guide roller rail guidance systems utilise a semi-rigid design without suspension, or compressible tyres to guide the RRV on rail at speeds not exceeding 6 km/h (walking pace).

The guide roller system shall be designed, tested and maintained such that it is incapable of unloading the driven or braked wheels/tracks under all operating conditions.

Where a guide roller design can automatically relieve pressure when loaded beyond its rated capacity, clear instructions shall be provided to the operator to allow them to identify when rail wheel loading is insufficient and/or when the guidance frame should be re-deployed.

The technical maintenance plan shall include detailed instructions to allow the operator and/or maintainer to ensure the load limiting system is functioning correctly.

Further requirements relating to the design, operation and maintenance of semi-rigid systems may be specified by the RIM.

Commentary *C12.9-2*

Guide roller rail guidance systems are often fitted to small excavators where rubberised crawler tracks provide traction, braking and stability directly on the rail head. These are commonly known as “guide roller excavators”. Their use is limited to small machines where the base vehicle track width is similar to the rail gauge on which it will operate.

12.10 Base vehicles with active suspension systems

Where the base vehicle utilises an active suspension system, such as air suspension with ride height control, the RGE suspension shall maintain the required rail wheel loads as per section 12.8 of this Standard under all operating conditions, including situations where the base vehicle suspension system can adjust the chassis height either automatically or through driver input.

The RRV designer shall assume that the load on the road axle(s) is independent of the chassis ride height.

Commentary *C12.10*
Some vehicles can achieve maximum road wheel loads while the road suspension is fully extended and/or controlling the load of the road wheels completely independently to maintain a level tray with a significantly eccentric load.

Consideration shall be given to the effect of variable vehicle loading and supporting surfaces such as level crossings and check rails which, may cause the base vehicle suspension system to automatically adjust, resulting in an unfavourable change in rail wheel loading.

Base vehicle active suspension systems are typically able to adjust the chassis height either automatically or through driver input.

Commonly, the difference between minimum and maximum chassis height on vehicles with active suspension greatly exceeds what is achievable with spring suspension. Therefore, it is unlikely that utilising a spring suspension or pivoting centre RGE on a vehicle with active suspension will achieve a satisfactory outcome.

Section 13 Rail axles

13.1 Rail wheel axle design loads

Axles and stub axles shall be designed with for the operational life of the RRV.

Axle design analysis should allow for the following:

(a) dynamic vertical and lateral loads for travel mode and (where applicable) work modes;

(b) stress concentration due to axle geometry;

(c) stress concentration due to interference fitted component;

(d) material properties;

(e) size effects on material properties; and

(f) surface finish, including in-service damage and corrosion effects.

13.2 Material

RRV axles shall be produced from material in accordance with AS 7515.

13.3 Inspection maintenance and repair

Designers shall develop and include in the maintenance manual inspection and maintenance criteria that define when an axle should be condemned.

Maintainers shall comply with regimes for inspection and maintenance and criteria that define when an axle should be condemned.

No part of any axle shall be welded for repair.

13.4 Axle bearings

Axle bearings shall be designed to accommodate the loads of the vehicle in accordance with the static load cases specified in section 8 of this Standard and intended operating conditions.

Axle bearing life expectancy shall be determined by calculation following the bearing manufacturer's method or AS 2729. The expected bearing life shall be included in the maintenance manual with inspection and repack intervals.

Seals shall be provided to exclude contaminants and retain lubricant under the full range of service and workshop conditions by either:

(a) The axle bearing manufacturer, or

(b) AS 2729/ISO 281.

Section 14 Rail axles

14.1 Rail wheel axle design loads

Axles and stub axles shall be designed with for the operational life of the RRV.

Axle design analysis should allow for the following:

(a) dynamic vertical and lateral loads for travel mode and (where applicable) work modes;

(b) stress concentration due to axle geometry;

(c) stress concentration due to interference fitted component;

(d) material properties;

(e) size effects on material properties; and

(f) surface finish, including in-service damage and corrosion effects.

14.2 Material

RRV axles shall be produced from material in accordance with AS 7515.

14.3 Inspection maintenance and repair

Designers shall develop and include in the maintenance manual inspection and maintenance criteria that define when an axle should be condemned.

Maintainers shall comply with regimes for inspection and maintenance and criteria that define when an axle should be condemned.

No part of any axle shall be welded for repair.

14.4 Axle bearings

Axle bearings shall be designed to accommodate the loads of the vehicle in accordance with the static load cases specified in section 8 of this Standard and intended operating conditions.

Axle bearing life expectancy shall be determined by calculation following the bearing manufacturer's method or AS 2729. The expected bearing life shall be included in the maintenance manual with inspection and repack intervals.

Seals shall be provided to exclude contaminants and retain lubricant under the full range of service and workshop conditions by either:

(a) The axle bearing manufacturer, or

(b) AS 2729/ISO 281.

Section 15 Rail and road wheels

15.1 General

The design process of a new rail wheel shall include the following three aspects:

(a) Geometrical aspect – to assure compatibility with track and interchangeability of different solutions;

(b) Mechanical aspect – to ensure that no fatigue cracks will occur in the wheel; and

(c) On tread-braked wheels, thermo-mechanical aspect / to manage wheel deformations and to ensure that braking will not cause wheel fracture.

New rail wheels should be fully machined or shot peened.

Wheels shall not be welded in anyway, including for manufacture, for repair of defects, or for build-up of worn wheels.

Rail wheels secured by bolts or nuts shall be fitted with wheel nut indicators.

15.2 Rim width

The RIM may specify a range of acceptable wheel rim widths for RRVs dependent on wheel pair load.

For RRVs with wheel pair loads ≤ 10 tonnes, smaller wheel rim widths than those specified by RIMs for heavier road rail vehicles (> 10t wheel pair load) may be allowed, provided they are a proven design for the application.

Commentary *C15.2*

In general, the minimum nominal wheel width is 130 mm. Track design assumes a minimum width to be able to traverse special types of tracks.

15.3 Wheel diameter

The P/D limits for wheel diameter are given in Section 10.4.1 of this Standard. The minimum wheel diameter shall not be less than 250 mm.

15.4 Wheel profile

Wheel profiles shall be as agreed with the RIM.

15.5 Material

All RRV wheels shall be made from material in accordance with AS 7514.

Commentary *C15.5*

Other alternative materials may also be acceptable e.g. 4140 grade steel is commonly used on RRVs.

15.6 Inspection and maintenance of wheels

Rail wheels should be selected, installed, inspected and maintained in accordance with the manufacturer's specifications.

The manufacturer’s rail wheel dimensional limit criteria shall be approved by the relevant RIM where non-conformant with AS 7514.

Commentary *C15.6*

Further guidance on wheel inspection and maintenance is contained in RISSB Wheel Defects Code of Practice.

15.7 Back-to-back measurement

The wheel flange back-to-back dimension shall be measured between the inner faces of wheel pairs at a point 35 mm above the lowest point on the outer circumference of the wheel flange (6 o’clock position), whilst the vehicle is on track in the fully loaded condition.

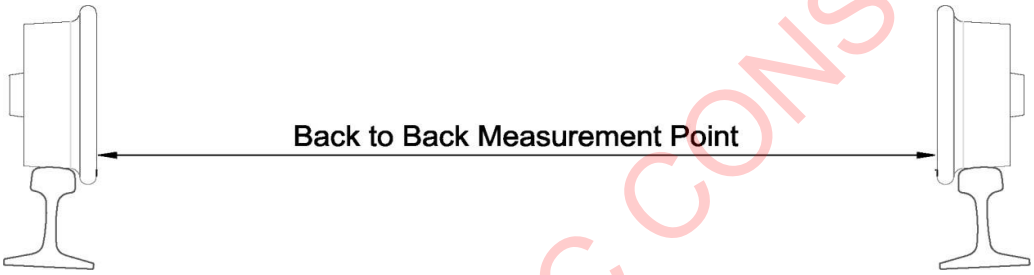


Figure 4 Measurement point for wheel back to back

Wheel flange back-to-back dimensions shall comply with the applicable range given in Table 1.

Table 1 Back-to-back Dimensions

Network Gauge	A1 (mm)
Standard gauge track (except standalone heavy haul systems)	1,357 to 1,359
Broad gauge track	1,522 to 1,525
Queensland and Tasmanian narrow-gauge track	990 to 992
West Australian narrow-gauge track	992 to 993
South Australian narrow-gauge track	988 to 991

15.8 Road wheels and tyres – general

For RRVs that have road tyres and wheels which provide traction, braking and drive there are specific factors to be managed shall include:

(a) the tyres on the vehicles must be of the correct type, pressures and tread pattern specified by the OEM or rail equipment designer;

(b) the tread patterns on both wheels of the same axle in contact with the rail head must be the same, otherwise there is a risk of unbalanced braking and

acceleration as the tyre on one side can outperform the other (as this may lead to derailment); and

(c) security of the wheels and torque of the wheel nuts, including the use of wheel nut indicators.

The OEM tyres and wheels shall not be changed for/to different types and/or sizes without appropriate authority and following application of the change management process.

The use of recap type tyres shall not be permitted on RRV's.

Rim modifications shall comply with the Tyre and Rim Association of Australia Standards manual.

15.9 Tyres and loading

Specific requirements in relation to tyred vehicles and loading aspects shall be adhered to. The tyres recommended for the RRV, or as otherwise prescribed by the equipment designer/owner, and their "on rail" pressures shall be defined in the RGE OEM manual or other suitable instructions when modified from the vehicle OEM recommendations.

Loads on rubber tyres in contact with the rail shall not exceed the manufacturer's load rating under any condition of loading. It is recommended that at maximum vehicle load, the maximum load on the tyre should be limited to 90% of its load rating.

There shall be sufficient load carried on the tyres to provide adequate grip for traction and braking due to the significantly reduced contact pattern available from the rail head as compared to on road operation.

The tyre treads/crawler tracks on Type 3 RRVs shall completely cover the rail head at all times.

Commentary *C15.9*

Gauge widening in tight curves for the networks the vehicle will operate on may be required.

Those vehicles that have dual rear wheels and therefore have a pair of tyres not in contact with the rail head, that would normally be sharing the load and braking performance, shall also be evaluated in terms of loading, braking performance and uneven wear which may impact on safe operations on road.

15.10 Wheelset alignment

RRV's shall be designed to provide sufficient lateral adjustment to control and maintain alignment of the centrelines of the rail wheel track and road wheel track to within a maximum tolerance of +/- 5 mm.

Section 16 Electrical considerations

16.1 General

RRVs which are fitted with movable elements such as load shifting equipment and elevating work platforms, which work or travel under live overhead power lines shall:

(a) be fitted with a failsafe height limiting system(s) approved by the relevant RIM;

(b) be fitted with an earth path to rail to any part of the equipment which is high enough to connect with overhead power lines; and

(c) the earth path shall not rely on conduction through bearings.

RRVs fitted with pantographs or moveable elements designed to manipulate the overhead line equipment shall refer to RIM requirements for interfacing with OLE.

In all cases where RRVs are required to operate in live overhead power territory, the RRV shall meet the requirements of the RIM's safeworking rules and procedures for rolling stock operating in such areas.

Where any RRV has identified limitations which prohibit its operation or which require restrictions to be applied for operations in live overhead power territory, those limitations shall be clearly identified in the rail compliance certification documentation and permanent warning signs shall also be clearly displayed at the operator station.

Any RRV that cannot safely operate under live OLE shall have signage stating "Not to be Used Under Live Overhead" affixed to both sides of the RRV in text at least 50mm high.

RRVs that operate on live overhead power networks shall be inspected/assessed for any climbing potential or areas where persons can infringe the safe approach distance to overhead line equipment or have moveable elements which can infringe the safe approach distance to overhead line equipment.

Where such risk exists, the RRV shall have suitable signage providing warning of the restriction/prohibition and any 'climbing risk' and/or 'safe approach distance' warnings clearly displayed on the RRV at prominent locations including as a minimum at the operators position and on both sides of the vehicle in a form approved by the RIM and complying with AS 1319.

16.2 Signalling detection

Unless otherwise specified by the RIM, the RGE in contact with rails shall be electrically insulated against being detectable to signals.

The RIM shall specify any special requirements with respect to wheel diameter for RRVs vehicles which may be required to be detectable by signalling systems such as axle counters etc.

Commentary *C16.2*

For further information refer to AS 7505 Signalling Detection Interface.

Due to RRVs having a low number of axles, low axle loads, rubber tyres, insulated rail wheels, and small wheel diameters, these vehicles are unreliable for signal detection and if operated outside of possessions or worksites, would require manual forms of operation (such as block working). Refer to RIM requirements for operation of RRVs.

16.3 Electromagnetic compatibility

RRVs with electrical or electronic equipment, which could cause a failure or abnormal operation of rail systems susceptible to electromagnetic interference (e.g., traction power supply, signalling, ATP, communications and other ancillary electrical/electronic equipment, necessary for the safe operation of RRV on the network) shall comply with AS 7722.

Section 17 Rail guidance equipment status indication

The RRV shall be fitted with indicators which independently show when both front and rear RGE is fully stowed, fully deployed, or in transition.

There shall be a clear indication (e.g., a light or similar) showing the RGE status (fully stowed, fully deployed or in transition) of both the front and rear RGE.

The indication shall be clearly visible to the operator at every driving/operating position where practicable.

An indication audible to the operator shall sound when the RGE is out of fully stowed or fully deployed positions, or in transition, where practicable.

Section 18 Audible warning devices

18.1 Warning horns

Audible warning devices for use on road registered RRV units shall comply with the requirements of the ADR.

For non-road registerable RRV units, an audible warning device capable of achieving a level, as a minimum, equal to that of the ADR requirements shall be fitted to RRVs.

18.2 Reversing and movement awareness alarms

RRVs shall be fitted with reversing alarms.

RRVs which frequently operate in bi-directional mode shall be fitted with a movement awareness alarm.

A movement alarm may also perform the function of the reversing alarm.

Reversing and/or movement awareness alarms shall be automatically activated when travel is in the reverse direction.

Commentary *C18.2:*

There is no legally prescribed sound power level for such alarms, however a basic guide would be an intermittent audible signal of a minimum level of 90 db at 1 m. Alternatively, there are also units available that automatically adjust their level based on the background noise. These should be considered as a preferred option where the RRV is likely to operate frequently in built up areas at night.

Although monotonal ‘beeper units’ are the most common type of alarm, ‘white noise’ or ‘squawker’ style alarms are acceptable and are also preferred for work in built up areas to minimise noise nuisance.

Section 19 Lighting and visibility

19.1 General

All lighting on road registered/registerable RRVs shall comply with the applicable ADRs and NHVRs.

Additional lighting shall comply with the requirements of AS 7531.

For those RRV units which are not ‘road registerable’ or are not based on an approved design which meets ADR requirements, the requirements of AS 7531 as applicable to infrastructure maintenance rolling stock shall be applied.

For those RRV units that are required to regularly travel in reverse direction at more than 5 km/h, or work with other on track vehicles, all necessary lights shall be replicated at each end of the vehicle.

Where such lighting is fitted, the lights shall be interlocked with the direction controller of the RRV to prevent contravention of the ADR requirements when operating on road.

19.2 Flashing beacons

Vehicles shall be fitted with amber or orange flashing beacons.

All beacons shall meet the requirements of AS 7531 and SAE J845.

It shall be possible to manually activate the flashing.

19.3 General Livery

All RRV units shall have livery meeting the requirements of AS 7531.

19.4 Reflective conspicuity markings

For those RRVs that are governed by the ADR and/or the NHVR the following shall be required for compliance:

(a) only yellow reflectors shall be fitted to the side of a vehicle;

(b) only red reflectors shall be fitted to the rear of a vehicle; and

(c) no additional reflectors shall be fitted to the front of a vehicle.

For all other RRVs not meeting ADR and/or NHVR requirements the following shall apply:

(d) reflective conspicuity markings shall be fitted to vertical surfaces on each side of the vehicle;

(e) reflective conspicuity markings shall not be fitted to the front of the vehicle;

(f) reflective conspicuity markings shall be mounted between 800 mm and 2,000 mm above rail;

(g) each reflective conspicuity marker (marker) shall have a minimum area of 0.025 square metres and minimum length of 250 mm;

(h) where the vehicle design precludes the placement of a marker of this size, a marker as large as possible shall be affixed with additional markers placed as close as practicable to make up the total size of 0.025 square metres;

(i) at least two markers per side shall be fitted, with one mounted near each end of the vehicle to highlight the extremities of the vehicle;

(j) additional markers should be fitted every 1.0 to 2.5 metres between the end-mounted markers as vehicle size permits; and

(k) vehicles with body lengths less than 2,500 mm should have continuous reflective material all the way to the corners of the vehicle.

Retroreflective material compliant with AS/NZS 1906.1 shall be used.

Other than as provided for by the ADR or NHVR, the colour of markers should be white or yellow, or as designated by the RIM. Green and red shall not be used on the sides.

The width of the continuous marker material shall be 100 mm unless as is otherwise practicable based on the vehicle design and available space.

Continuous stripe material may be solid colour or a diagonal (zebra/tiger stripe) design. If a diagonal stripe design is used, then the diagonal stripes should be at 45 degrees to the horizontal and a minimum width of 50 mm as shown in Figure 5 below.

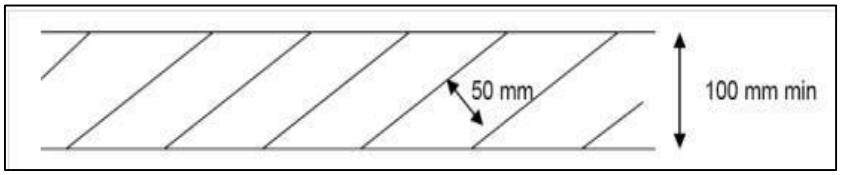


Figure 5 Dimensions of continuous reflective striping

Section 20 Driving cabs

20.1 General

If driving cabs are being designed from first principles, the cab design shall comply with the requirements described in AS 7533.

For existing base vehicles, the OEM standard cab complying with the relevant ADR requirements and/or other applicable standards shall be acceptable.

20.2 Roll over protection/falling object protection

Where required, roll over protection (ROP) and/or falling object protection (FOP) for RRVs shall be designed in accordance with requirements of:

(a) ROP: ISO 3471 and ISO 12117 (for excavators); and

(b) FOP: ISO 3449 and ISO 10262 (for excavators).

Weight and height effects of the RGE shall be evaluated when designing ROP/FOP for RRVs.

Section 21 Driver safety systems

21.1 Vigilance systems

RRVs that have a kinetic energy of 600 kJ or more and which will operate outside of track closures shall have a braked vigilance system meeting the requirements of AS 7511, or as per the RIM's requirements.

21.2 Anti-collision systems

Those RRVs that are required to be fitted with on-board anti-collision and/or proximity warning systems shall meet the requirements of AS 7479.

Section 22 Driver safety systems

22.1 Vigilance systems

RRVs that have a kinetic energy of 600 kJ or more and which will operate outside of track closures shall have a braked vigilance system meeting the requirements of AS 7511, or as per the RIM's requirements.

22.2 Anti-collision systems

Those RRVs that are required to be fitted with on-board anti-collision and/or proximity warning systems shall meet the requirements of AS 7479.

Section 23 Fire safety

23.1 Ignition risk mitigation

A risk assessment shall be conducted to ensure the design of the RRV mitigates the risk of ignition.

Commentary *C23.1*

For example, the consequences of the release of flammable liquids that have been routed through hot areas of the vehicle, installation of a battery isolation switch, electrical short circuit from poorly installed wiring, inadequate cooling system, flammable materials near hot surfaces etc.

23.2 Firefighting equipment

RRVs shall be provided with an adequate supply of firefighting equipment such as fire blankets and a number of suitably sized portable fire extinguishers compliant with AS/NZS 1841.

The number, size, type and installation location of firefighting equipment shall take into consideration:

(a) the nature of the fire hazards within the RRV;

(b) the potential size of any fires which may occur on the RRV; and

(c) the potential environmental risks (e.g., bush and/or grass fire).

Section 24 Emergency equipment

24.1 General

Emergency equipment carried shall meet the requirements described in AS 7523.4, or as per the RIM's requirements as appropriate to the RRV type and operations.

Emergency 'off-tracking' equipment shall be available as described in Section 6 of this Standard.

Provision for emergency equipment storage shall be provided on RRVs.

Additional emergency equipment shall be carried in accordance with RIM requirements.

Emergency equipment lockers should be installed in areas only accessible to operating crew or other authorised personnel and secured with a lock and have a tamper-evident seal.

Commentary *C24.1*

The tamper-evident seal is used to demonstrate whether the emergency equipment compartments or lockers have been opened since it was last serviced/re-stocked. The intent is to protect from theft without limiting accessibility in an emergency.

24.2 First aid equipment

First aid equipment shall be carried on RRVs.

Commentary *C24.2*

The obligation for deciding and selecting the nature and type of first aid equipment required is governed under the WHS national law and relevant state codes of practice (CoP) and is decided by the employer using a risk-based approach as described in the relevant states CoPs.

Section 25 Derailment catch system

RRVs shall be fitted with derailment catch systems in accordance with AS 7520.4.

Commentary *C25*

Notwithstanding the requirements contained in as 7520.4, for those vehicles which have dual rear wheel arrangements, the gap between the rear tyres is considered suitable as part of a derail catch system.

Section 26 Trailers

Commentary *C26*

Trailers are vehicles which are towed or propelled by a RRV whilst the RRV is in rail mode.

Trailers do not conform to the definition of RRV as defined in this Standard.

The scope of this Standard does not address trailers however, it is acknowledged that some operators may wish to use trailers in combination with RRVs.

If the RIM permits trailers to be used with road rail vehicles, the designer/user of the RRV shall include:

(a) the maximum expected trailing/pushing load;
(b) breakaway systems;
(c) suitability of the RRV structure to safely haul the total load;
(d) compatibility of coupling systems;
(e) method and design to enable re-railing a derailed trailer;
(f) effect of trailer on:
(g) RRV braking;
(h) field of view; and
(i) ability of persons to hear audible warning devices, including reversing alarms.

Where RIMs allow use of trailers in combination with RRVs, RIMs shall develop their own safety and technical requirements with regard to these consists.

Section 27 Documentation

27.1 Operations and maintenance manuals

Operations manuals shall be supplied for each RRV which outline the:

(a) design;
(b) intended purpose and use;
(c) operation of the RGE;
(d) operation of RRV on rail;
(e) limitations of equipment; and
(f) any ancillary equipment and its interface with the vehicle.

Commentary *C27.1*

For the purposes of this section, ancillary equipment relates to equipment relevant to the use of the RRV on-rail such as towing and emergency response equipment. It also applies to such items as buckets or other digging/lifting attachments which may affect the safe on-rail operation of the RRV e.g. out of gauge, unstable loading etc. It does not apply to the functional use of such items which are covered by specific WHS requirements and subject to those legislative provisions.

Maintenance manuals shall be supplied for each RRV detailing the correct maintenance intervals, inspection criteria, wear limits, sound levels and maintenance procedures for RRV critical components including:

(g) wheels;
(h) axles;
(i) bearings;
(j) brakes;
(k) suspension;
(l) lighting and visibility;
(m) warning horn/s, movement and reversing alarms; and

(n) exhaust system and emissions.

Maintenance documentation shall also include instructions for:

(o) checking, adjusting, and setting the rail equipment alignment;

(p) checking, adjusting, and setting load sharing between road wheels and rail wheels on Type 3 RRVs; and

(q) checking, adjusting, and setting friction contact for Type 2 RRVs.

27.2 Maintenance plans

The RSO shall develop and follow a maintenance plan for each RRV and its ancillary equipment.

Maintenance plans shall include maintenance requirements and the maintenance schedule(s) for different duty cycles as specified by the OEM.

The maintenance plan shall be a controlled document within the vehicle owner's management system.

Commentary *C27.2*

For more detail on maintenance plans, refer to section 29.3 of this Standard.

Section 28 Construction

28.1 General

Construction of RRVs and modifications to base vehicles to enable travel on rail shall be in accordance with AS 7501.

Construction of RGE and RRV equipment shall meet the requirements of standards and codes of practice appropriate to the material of construction.

The quality of the workmanship in construction shall be sufficient to ensure that the actual structure meets the structural requirements of this Standard.

The RRV manufacturer shall be able to demonstrate that welding of steel has been performed in accordance with AS/NZS 1554 and welding of aluminium has been performed in accordance with AS/NZS 1665, or equivalent international standards.

RGE and RRV equipment shall be fabricated, assembled and constructed in accordance with AS/NZS 3990.

RGE and RRV equipment connected using fasteners shall be in accordance with AS/NZS 4100 Section 9.

Any fasteners that are susceptible to come loose from vibration shall be vibration resistant.

Thread locking substances shall not be the sole means of vibration resistance for fasteners.

Where RGE or RRV structures are exposed to a corrosive environment, the steelwork shall be given adequate protection against corrosion.

The degree of protection to be employed shall be determined after consideration has been given to use of the structure, climatic or other local conditions, and maintenance provisions.

Recommendations for corrosion protection may be found in AS/NZS 2312.

The tread of the rail wheel shall not be painted.

Cast components used in RGE and RRV equipment shall be manufactured according to AS/NZS 2074.

Any new or existing electrical systems on RRVs shall be in accordance with the ADR requirements. For those RRV units which have electrical systems >50 V AC RMS or 120 V ripple free DC and <1000 V AC

RMS or 1500 V DC shall comply with AS/NZS 3820 – Essential safety requirements for low voltage electrical equipment.

Any new or existing hydraulic installations to RRVs including brake equipment shall be in accordance with AS 2671.

Burst protection sleeves shall be fitted to all hoses that have the potential to cause injury to operators.

Changes to the original vehicle brake system on road registered vehicles shall comply with vehicle modification codes and have modification plates fitted.

Any new or existing pneumatic systems shall conform to AS/NZS 1200 Pressure equipment, AS 1210 Pressure vessels and AS/NZS 3788 Pressure equipment in-service inspection or equivalent internationally recognised standard.

As defined in section 6 of this Standard, RRVs shall be fitted with emergency off-tracking equipment such that RGE can be retracted (raised) using manual or secondary power in the event of failure of the main power supply.

As defined in section 3 of this Standard, installation of RGE to a road vehicle is a modification and requires approval under Federal, National, State and Territory transport law.

28.2 Operational parameters

Once the decision has been made for the fitment of an RGE onto a base vehicle, an assessment of the impact of the fitment of the RGE on the base vehicles functional operations and operating parameters shall be carried out.

This shall include any effect on the following:

(a) load shifting capacity e.g. cranes;

(b) reach (e.g., EWPs); and

(c) any other functional/operational features.

Any such identified effects shall require the application of limitations and/or other controls to be applied to the machine and it shall be for the designer/installer of the RGE to establish and communicate the relevant limitations to the operation(s) of the base vehicle when being used in an ‘on-rail’ configuration.

Base vehicles that are a ‘registered’ plant design as prescribed under WHS national law, have specific legal implications which require that modifications to the base design shall require re-registration with the relevant authorities.

In addition to the above suitable indelible permanent signage shall be fitted to the outside of the RRV in a prominent position. It shall contain at least the following information:

(d) Road Rail Vehicle - (Class and number to be issued by RIM)

(e) Detection Rating - R3

(f) Overall length _____metres

(g) Overall height on rail _____ metres

(h) Max allowable speed on rail __km/h

(i) Road Rail Manufacturer _____

(j) Front rail assembly serial no. _____ Max axle load _____kg

(k) Rear rail assembly serial no. _____ Max axle load _____kg

28.3 Compliance identification

28.3.1 Vehicle identification

All new RRV identification requirements shall be in accordance with AS 7503 and the requirements of the RIM.

28.3.2 Existing rail guidance equipment identification

For older existing RRV units that are operating but have not been fitted with an identification plate, identification plates shall be fitted on all RGE displaying the following information:

(a) manufacturer (if known);

(b) model number (if applicable);

(c) serial number (generate a number if necessary);

(d) date manufactured (if known);

(e) approved configurations:

  (i) track gauge(s) narrow, standard and /or broad;

  (ii) drive mode(s) Type 1, 2 and/ or 3.

(f) vehicle VIN;

(g) date fitted to vehicle (if known);

(h) working load limit applicable to rail guidance equipment; and

(i) the ‘on-rail’ GVM.

Where the operating history is unknown, then compliance plates shall be fitted, and the vehicle shall then be treated as a ten-year-old vehicle.

All axles, rail wheels and RGE structural elements, including mounting on vehicle chassis shall be subject to appropriate non-destructive testing in accordance with Australian standards to ascertain if any external and/or internal defects exist. A visual inspection alone is not a sufficient evaluation.

Section 29 Maintenance

29.1 General

The vehicle owner shall ensure that the vehicle maintainer is competent to work on RGE and is aware of the impact of parent vehicle maintenance or modification on RGE.

RRVs shall be maintained appropriately to ensure that the performance requirements of this Standard are maintained, or exceeded, for the life of the vehicle.

29.2 Isolation and ‘lock-out/tag out’

RRVs shall be designed to have suitable and sufficient means to ensure the isolation of hazardous energy sources, also often referred to as ‘lock-out/tag out’, during the conduct of maintenance or other operations on the RRV.

29.3 Maintenance plans

The maintenance plan shall be implemented so that the RRV and any associated equipment are kept in compliance with this Standard throughout the life of the vehicle.

The maintenance plan shall be designed to enable users to understand quickly and easily what they have to do and when, what acceptance criteria apply, and on safety-critical systems the remedial action to be taken when defects are found.

Maintenance plans shall be based on:

(a) OEM instructions, guidelines and/or recommendations;

(b) best practice; and

(c) minimum standards.

Where the owner or supplier do not include items as recommended, they shall perform and record a full risk assessment demonstrating how the risks associated with not performing those tasks are mitigated. This also applies to the recommendation of the OEM's maintenance frequency.

The RRV owner, RSO or RIM may add additional tasks or checks to satisfy themselves of the safe condition of the RRV.

The maintenance plan shall include the requirement to retain auditable records of maintenance attention to safety critical systems and components.

The auditable records shall provide traceability to the vehicle concerned, date, location and personnel who carried out the maintenance.

The maintenance plan shall include the requirement to update the RRV maintenance record with the date and examination type of the last maintenance carried out.

The maintenance plan shall include the requirement to record the results of any measurements taken, such as results of brake tests, rail wheel dimensional checks, tyre pressure/condition.

29.3.1 Maintenance plan content

29.3.1.1 Competence

Personnel undertaking maintenance of RRVs shall have the appropriate competencies to perform the maintenance tasks required in accordance with the competence requirements of the safety management system of the RSO.

29.3.1.2 Base vehicle

If the maintenance requirements of the base vehicle are not included in the maintenance plan, the relevant document(s) shall be referenced.

In the case of a vehicle that is a conversion or derived from a non-rail vehicle, then the manufacturer’s instruction handbook for the base vehicle should form part of the maintenance plan. If it is not practical to include the content of the document, then it should be referenced in the maintenance plan.

Wherever possible the location of the relevant sections of the base vehicle instruction handbook should be given in the appropriate parts of the maintenance plan.

29.3.1.3 Maintenance frequency

The maintenance plan shall include a statement of the intervals at which each scheduled maintenance activity is to be carried out, and the allowable latitude for compliance (e.g., 6 months +/- 10 %).

Each examination should be identified by means of a code (letter, number or colour) and clearly specify the limits which apply.

Maintenance periodicity may be based on different parameters, for example calendar dates, engine hours, days used, shifts used, distance travelled etc.

Maintenance plan shall include a daily or pre-use check sheet to be carried out by the operator.

Maintenance regimes for the base vehicle should be assessed and modified as required after considering the increased wear and tear on various components as a result of fitting the RGE.

29.3.1.4 Task descriptions

The maintenance plan shall include a statement or task description for each component, group of components or system which requires attention. Where appropriate this shall include:

(a) acceptance criteria and wear limits;

(b) method statements, especially for brake testing and wheel examination and gauging; and

(c) illustrations to clarify the above and show locations of components and safety labels.

The maintenance plan should cover the component, group of components and systems of the vehicle concerned. An example of such a maintenance plan including common types of components and systems to be included is listed in Table 2. These should be tailored to each particular type of RRV. Each task or job should be identified by means of a number and title, which clearly defines the components or system covered, and the intent of the task or job. The intent is usually one of the defined maintenance terms.

Table 2 Example RRV Maintenance Chart

Example Task Code	Task	Example Exam Code		
		A	B	C
Vehicle Body				
BO-1	Wipers and Washers - Inspect and fill	X		
BO-2	Doors and Panels Locks/Security - Inspact	X		
BO-3	Safety Labels - Inspect	X		
BO-4	Cleanliness - Inspect	X		
BO-5	General Condition - Inspect	X		
Vehicle Electrical System				
EL-1	Battery and Power Cables - Inspect		X	
EL-2	Lights and Flashers - Clean and Test	X		
EL-3	Test Audible Warning Devices	X		
EL-4	General cabling and connectors - Inspect			X
EL-5	Test Emergency Stop System	X		
EL-6	Starting System - Inspect		X	
EL-7	Generating System - Inspect		X	
Brake System				
BR-1	Brake System Examination		X	
BR-2	Brake Fluid Levels - Inspect		X	
BR-3	Brake System Hoses and Pipework - Inspect		X	
BR-4	Drain Air Tanks	X		
BR-5	Test Park Brake	X		
BR-6	Test Service Brake	X		
BR-7	Brake Friction Elements - Inspect			X
Wheelsets and Bogies				
WB-1	Tyre Condition - Inspect	X		
WB-2	Rail Wheels - Inspect		X	
WB-3	Tyre Pressures and Wheel Nuts - Inspect	X		

WB-4	Bogie Components - Inspect		X	
WB-5	Wheel Bearing - Inspect			X
WB-6	Suspension Components - Inspect		X	
Vehicle Underframe				
U-1	Fasteners - Inspect		X	
U-2	Underframe - Inspect			X
U-3	Wheelset/Bogie Interface - Inspect		X	
U-4	Tow Points and Couplings - Inspect			X

29.4 Particular requirements

In addition to maintenance requirements specified by the designer, the RIM may specify further requirements which shall be followed.

Section 30 Modification

All RRVs authorised or accepted to operate on a network are only authorised/accepted in their original configuration. Any modification to the vehicle configuration or its operating conditions will require reassessment of the vehicle and acceptance by the relevant RIM prior to operation in the modified configuration. Refer to section 4 of this Standard.

The scope of assessment and testing shall include all aspects of the vehicle design and performance which may be affected by the modification(s).

Section 31 Decommissioning and disposal

When RGE equipment has:

(a) reached the end of its serviceable life;

(b) deteriorated beyond economical repair; or

(c) sustained irreparable damage,

the RGE shall be removed from the vehicle, the equipment shall be disposed of in accordance with OEM requirements, RIM and/or RSO procedures and any relevant legislation.

The decommissioning process shall have a process for ensuring the prevention of ‘end of serviceable life’ re-use either internally or by third parties. This may require the partial or complete destruction of the RGE.

Where the RGE is removed from a vehicle for decommissioning and intends to transfer the RGE to a new base vehicle, it shall be subject to the full recertification process as described in this Standard prior to being returned to operational service. In these circumstances, the RSO shall ensure that complete the documented history including service, maintenance, fault and incidents, and all documentation as per section 27 of this Standard for the RGE is transferred with the RGE to the new RRV.

Where the RSO intends to retain the decommissioned RGE for spares, the RGE components shall be subject to requalification in accordance with the OEM recommendations. Any RGE components that fail to pass the qualification inspections and tests shall be destroyed or rendered unusable.

For those RRVs that remain serviceable but which the RSO no longer requires, and which the RSO intends to dispose of as a whole unit i.e. the base vehicle complete with RGE, the RRV shall be subject to a compliance review process as described in section 4 of this Standard prior to being returned to operational service. Where such disposal is chosen, the RSO shall ensure that the complete documented history of the RRV, and all documentation as per sections 4 and 27 of this Standard for the RRV is transferred with the RRV to the recipient owner.

Where disposal of the RRV also includes the disposal of the base vehicle with the RGE removed, the base vehicle shall be returned to road legal operational condition, meeting all ADR applicable requirements. Where this is not practicable the base vehicle shall be disposed of as a non-repairable write off in accordance with the RSOs' procedures and any other relevant legislation.

Appendix A Types of road rail vehicles (informative)

A.1.0 Types of road rail vehicles

Road rail vehicles can be classified into 3 main types, depending on their braking and traction arrangement, as follows:

(a) Type 1 – Self Powered Rail Wheels

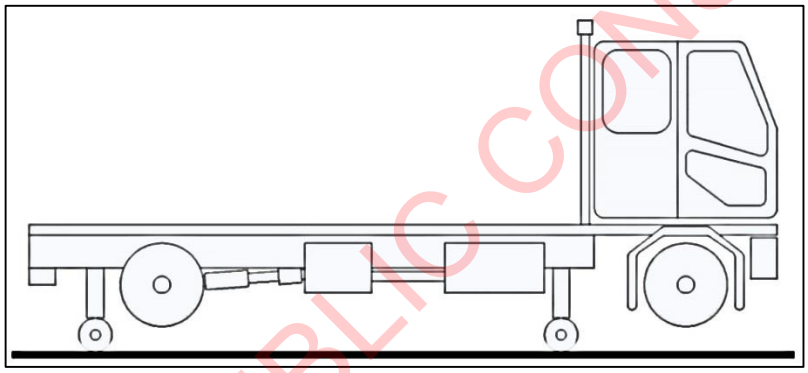
(b) Type 2 – Friction Drive

(c) Type 3 – Direct Drive

It is possible that some road rail vehicles may fall into two or more classification types. Typically, the difference in classification type may be between travel and work modes.

A.1.1 Type 1 – Self powered rail wheels

Also referred to as 'fully elevated – direct drive', braking and traction is applied directly through the rail wheels. All road wheels (or crawler tracks, etc.) are lifted fully clear of the rails when in rail mode, and there is no contact between road wheels (or crawler tracks, etc.) and rail wheels.

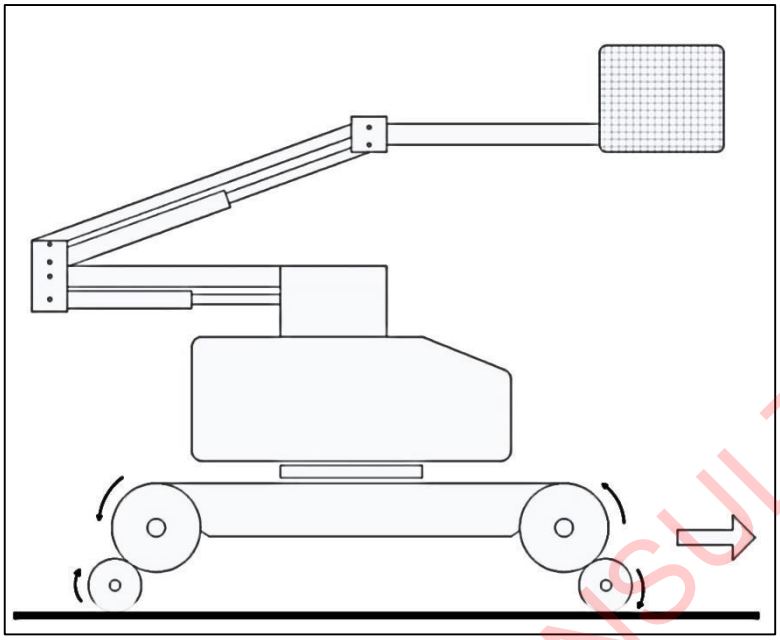


Appendix Figure A.1.1 Type 1 vehicle

A.1.2 Type 2 – Friction drive

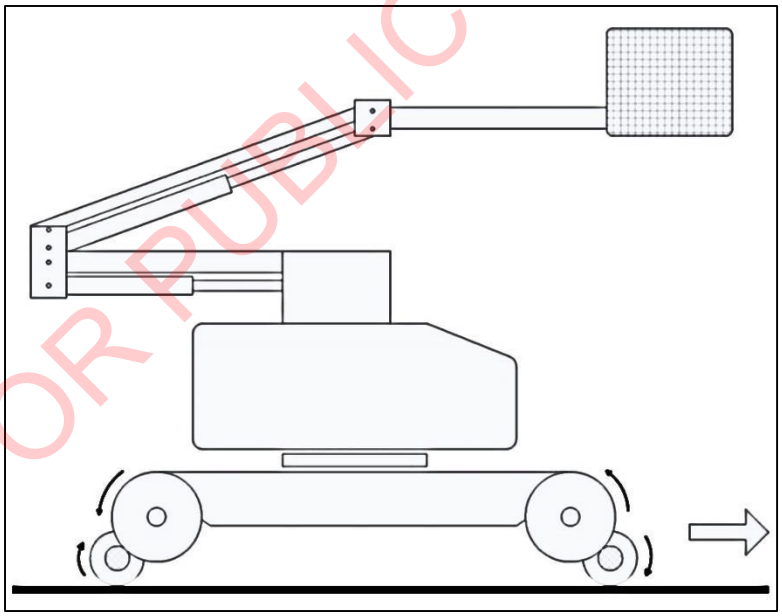
Also called 'high ride machines', braking and traction is provided indirectly through various arrangements from the road wheels to the rail wheels. This is most commonly achieved through one of three methods as follows:

Type 2(a) – Contact from the road wheel onto the rail wheel tread and/or rail wheel flange.



Appendix Figure A.1.2-1 Type 2(a) vehicle

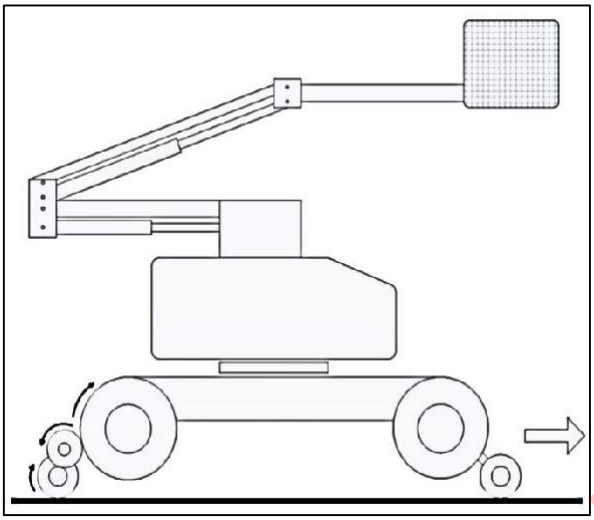
Type 2(b) – Contact from the road wheel onto a rail wheel axle extension hub.



Appendix Figure A.1.2-2 Type 2(b) vehicle

NOTE: Some type 2(b) vehicles incorporate epicyclic, or planetary gearing systems, such that forward gearing of the base vehicle results in forward rotation of the rail wheels, without use of an intermediate idler wheel. In this manner the full forward gearbox speed range of the base vehicle can be translated as forward motion at the rail wheels.

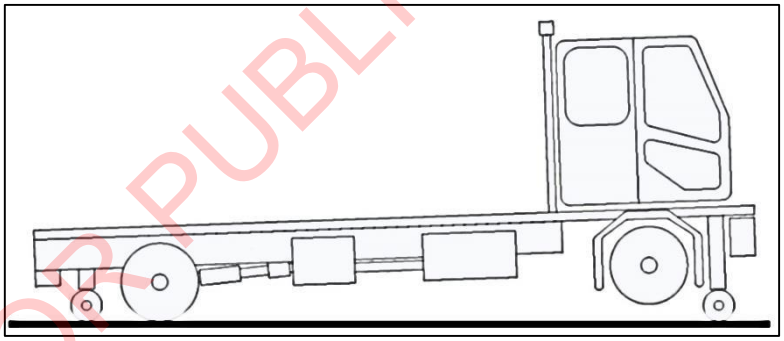
Type 2(c) – Contact from the road wheel onto the rail wheel via an intermediate “idler” wheel.



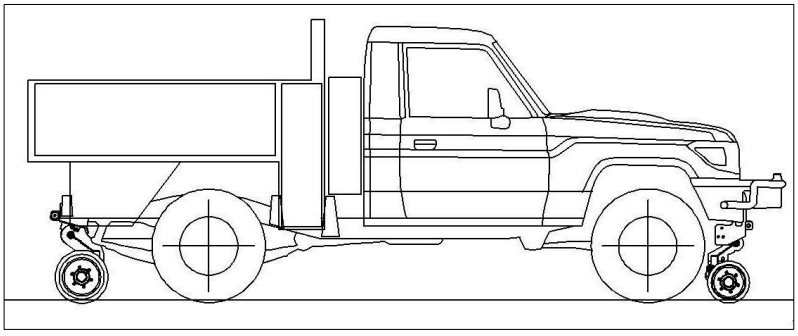
Appendix Figure A.1.2-3 Type 2(c) vehicle

A.1.3 Type 3 – direct drive

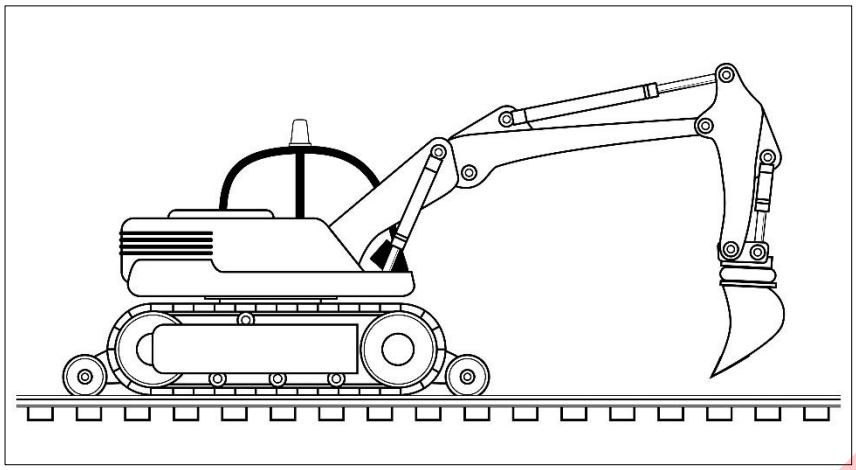
Also called ‘low-ride machines’, braking and traction is provided directly by at least one pair of road wheels, or crawler tracks in the case of tracked vehicles/plant, in direct contact with the rail when in rail mode. Some road wheels may be lifted clear of the rail by rail wheels (front elevated), or all road wheels may remain in contact with the rail.



Appendix Figure A.1.2-4 Type 3(a) vehicle (front elevated)



Appendix Figure A.1.2-5 Type 3(b) vehicle



Appendix Figure A.1.2-6 Type 3(b) vehicle

Appendix B Hazard register (Informative)

Hazard Number	Hazard
5.3.1.3	Harm to persons - Derailment or Collision, Human Error, Track Failure, Design Failure, Health, Organisational SMS Failure, Security Breaches, Loads not Secure and or Vandalism - Bodily impact
5.3.1.4	Harm to persons - Derailment or Collision, Human Error, Track Failure, Design Failure, Health, Organisational SMS Failure, Security Breaches, Loads not Secure and or Vandalism - Trips and falls
5.3.1.15	Harm to persons - Derailment or Collision, Human Error, Track Failure, Design Failure, Health, Organisational SMS Failure, Security Breaches, Loads not Secure and or Vandalism - Sharp edges, burrs or cuts
5.3.1.16	Harm to persons - Derailment or Collision, Human Error, Track Failure, Design Failure, Health, Organisational SMS Failure, Security Breaches, Loads not Secure and or Vandalism - Rotating or moving parts or cuts
5.3.1.44	Harm to persons - Derailment or Collision, Human Error, Track Failure, Design Failure, Health, Organisational SMS Failure, Security Breaches, Loads not Secure and or Vandalism - Back pain/musculoskeletal injury due to inadequate seating
5.44.1.1	Impact with interior surfaces (Impact caused by excessive accelerations)
5.44.1.28	Body parts being hit on protruding interior features (Person inside train - Impact with part of train)
7.2.1.10	Harm to Persons - Human Factors - Vandalism
7.2.1.13	Harm to Persons - Human Factors - Poor ergonomic design

Appendix C Bibliography (informative)

The following referenced documents are cited in this Standard for information only:

- AS 7505, *Signalling Detection and Interface*
- AS 7507, *Rolling Stock Outlines*
- EN 15746-1, *Railway Applications – Track – Road-rail machines and associated equipment – Part 1: Technical requirements for travelling and working*
- EN 15746-2, *Railway Applications – Track – Road-rail machines and associated equipment – Part 2: General safety requirements*
- EN 15746-3, *Railway Applications – Track – Road-rail machines and associated equipment – Part 3: Technical requirements for running*
- EN 15746-4, *Railway Applications – Track – Road-rail machines and associated equipment – Part 4: Technical requirements for running and working on urban rail*
- *RISSB Wheel defects Code of Practice*
- *UNIFE, Railway industry substance list*