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Preface

This Standard was prepared by the Rolling Stock Outlines Development Group, overseen by the RISSB Rolling Stock Standing Committee.

Objective

The objective of this Standard is to define the requirements for assessing whether the physical size and predicted kinematic behaviour of candidate rolling stock comply with the rolling stock outlines specified by the Rail Infrastructure Manager (RIM).

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 E.

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 document applies to new rolling stock and existing rolling stock that is undergoing modification where those modifications can affect the outline characteristics. This document also applies to rolling stock proposed to operate on a different network or on a different route on the same network.

This document applies to passenger, locomotive, infrastructure maintenance and freight rolling stock.

The document applies to the design, construction, operation and maintenance of rolling stock under all conditions of loading and wear.

This document sets limits on the maximum two-dimensional outline and three-dimensional envelope of candidate rolling stock to ensure it does not pose an unacceptable collision risk with infrastructure or other vehicles, taking into account track design, geometry, and permitted speeds. However, it is not intended for determining minimum clearances such as between tread plates and platform copes where tighter alignment and lower speeds require a different approach.

Infrastructure related requirements for rail wear, track tolerances, structure outlines, etc. and the magnitude of clearances between vehicles and structures, passing vehicles and electrical clearances, are treated in infrastructure standards.

This document does not cover:

(a) rolling stock used on light rail, cane railway and monorail networks;

(b) infrastructure rolling stock when in work mode.

1.2 Normative references

The following document is referred to in the text in such a way that some or all of their content constitutes requirements of this document:

- AS 7509, *Rolling Stock – Dynamic Behaviour*

NOTE:

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

1.3 Defined terms and abbreviations

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

1.3.1

body roll
angular rotation of the body cross-section relative to the plane of the rails that can be expected to occur in response to cant excess, cant deficiency and/or track irregularities

1.3.2
candidate rolling stock
new or modified vehicle proposed for network operation, currently under evaluation for compliance and not yet approved for regular use

1.3.3
expendable item
feature on rolling stock that exceeds the required rolling stock outline but is considered acceptable by both operator and rail infrastructure manager (RIM) due to the low consequence if struck

1.3.4
horizontal swept outline
swept path

the kinematic outline of the vehicle, including the centre and end curve throw on a specified radius horizontal curve

1.3.5
infrastructure rolling stock
track machines and road-rail vehicles used for infrastructure maintenance or construction

1.3.6
kinematic envelope
envelope generated by the kinematic outline, centre and end throw, and taking into account rolling stock and track tolerances

1.3.7
maximum designed cant deficiency
cant deficiency that the vehicle has been designed to operate with under normal operating conditions

1.3.8
maximum test cant deficiency
cant deficiency that the vehicle would operate under testing conditions

Note 1 to entry: This is greater than the design cant deficiency.

1.3.9
maximum installed cant
maximum track cant that exists on the routes over which the vehicle will operate

1.3.10
maximum lateral translation
maximum lateral movement experienced by the vehicle under the conditions of maximum test cant deficiency and is the maximum lateral displacement between the vehicle wheelset and body

Note 1 to entry: This can include, where applicable, secondary lateral suspension, primary lateral suspension, bogie-axle box lateral clearances, centre plate lateral clearances, etc. but not including wheel-to-rail lateral clearances, wheel flange wear or rail side wear and not including body roll or bogie roll.

1.3.11
maximum static height
case of a stationary vehicle in minimum tare condition (i.e. no fuel, sand, water, etc.) that is in a service ready condition with new wheels, new wear surfaces and rolling stock packed to compensate for future wear and gives the maximum height above rail

1.3.12
reference kinematic outline
kinematic outline of a reference vehicle

1.3.13
reference rolling stock outline
three-dimensional size of a reference vehicle consisting of three specific parts: the reference static outline; reference kinematic outline; and reference swept outline

1.3.14
reference static outline
static outline of a reference vehicle

1.3.15
reference swept outline
swept outline of a reference vehicle

1.3.16
reference vehicle
three-dimensional depiction of a nominated theoretical vehicle, whose nominated dimensions and movements are accepted by the RIM as being applicable to a defined route

Note 1 to entry: See Appendix A for the list of current reference vehicles.

1.3.17
RIM
rail infrastructure manager as defined by Rail Safety National Law

1.3.18
RSO
rolling stock operator as defined by Rail Safety National Law

1.3.19
static outline
outline drawing of a nominal vehicle cross section, which describes the permissible rolling stock dimensions under all loading, wear, and suspension translations in the vertical direction

1.3.20
RTO
rail transport operator as defined by Rail Safety National Law

1.3.21
vertical swept outline
swept path

two-dimensional cross-section for the vehicle that consists of the static outline, plus the upper and lower curve throw on a specified radius vertical curve produced by the vehicle on a humped or dipped

1.3.22
wheel guard
lifeguards
guard-irons

deflector mounted in front of the leading wheels of a vehicle to deflect small objects from the rails

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

Section 2 Principles of rolling stock outlines

2.1 General

The maximum permitted size of rolling stock varies for different routes in Australia.

For a vehicle to be permitted to operate over a defined route, it will need to be demonstrated that its rolling stock outline does not exceed that of a reference vehicle, or reference vehicles, as nominated by the RIM/s.

Rolling stock shall always be assessed against the reference vehicles that are described within this document.

Rolling stock shall not be assessed against other rolling stock.

The RIM is responsible for specifying the appropriate reference rolling stock outline for each route.

The RSO is responsible for ensuring that their rolling stock complies with the appropriate reference rolling stock outline.

2.2 Modification of rolling stock

Rolling stock that has been accepted onto rail networks are expected to maintain the rolling stock outline in the original network accepted configuration. Modifications to the outline, or modification to any part of the rolling stock that can affect the rolling stock outline, or modifications to operating conditions, will require assessment and resubmission to the applicable network RIM for network acceptance.

Examples of modification directly affecting the rolling stock can include, but are not limited to;

(a) changes to the rolling stock body or chassis that affect the candidate vehicle static outline,

(b) modification to the suspension springs affecting the static and kinematic outline; or

(c) modifications to operating conditions including, increase gross mass or increase operating speeds affecting static and kinematic outline.

Assessment of the modification shall include all aspects detailed in this document. However, with the agreement of the applicable network RIM, modification that are limited and/or to specific areas of the rolling stock, may have the assessment scope narrowed to the specific outline criteria that can be affected.

The new modified rolling stock outline configuration shall be network accepted by the applicable network RIM prior to operation on the network and can be subject to updated operating conditions.

2.3 Rolling stock outlines

2.3.1 General

A rolling stock outline consists of four parts:

(a) Static outline

(b) Horizontal swept outline

(c) Vertical swept outline

(d) Kinematic outline

Both the vehicle rolling stock outline and the reference rolling stock outline comprise of these outline parts. The reference vehicle outline parts define the maximum allowable outline characteristic whilst

the vehicle outline parts describe the outline characteristics of the vehicle. The outline characteristics of the vehicle shall be within the reference vehicle outline.

2.3.2 Static outline

A stationary vehicle shall always satisfy the static outline, shown in Figure 1, which is the maximum permitted two-dimensional envelope. Figure 1 shows the reference static outline with the vehicle outline in the vehicle's maximum and minimum heights (for example, when empty and fully loaded). See Section 3.2.2 for additional details.

The static outline is defined by a dimensioned drawing nominated by the RIM.

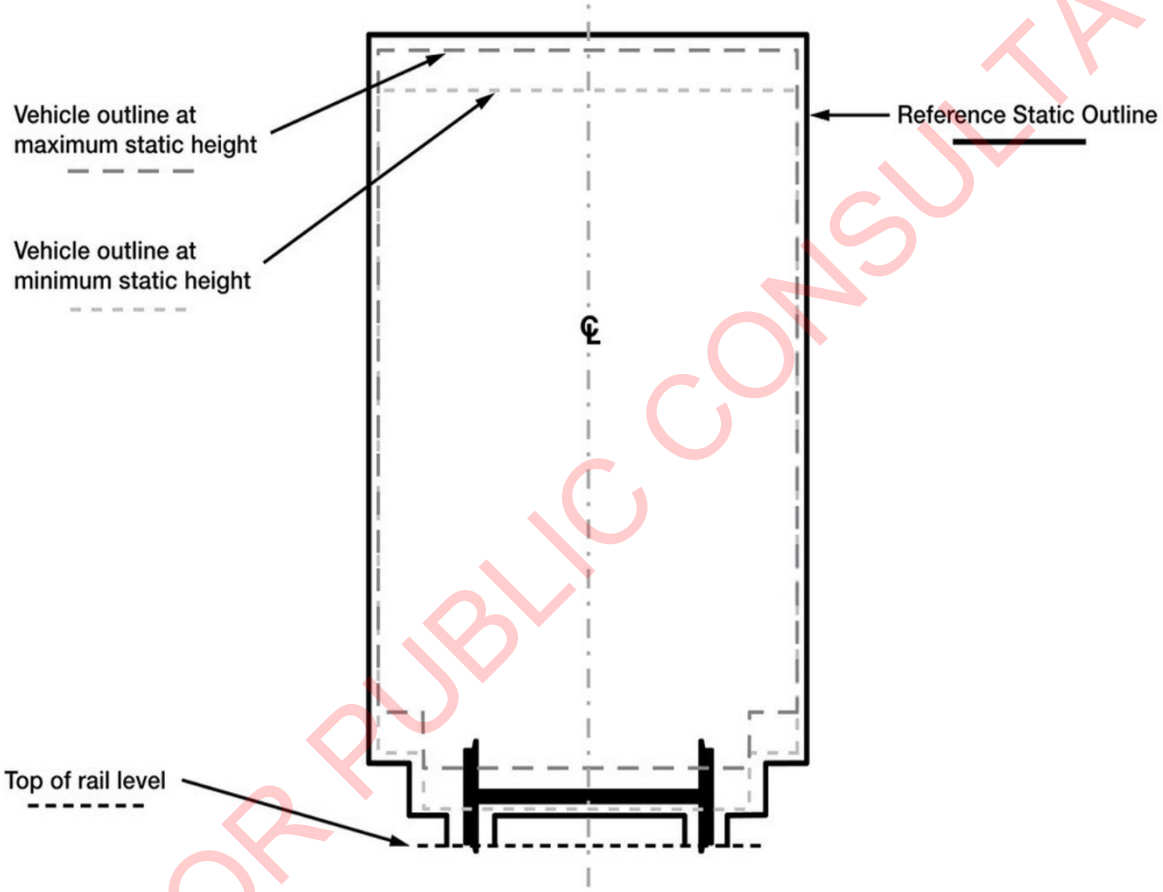


Figure 1 Static outline

NOTE:

Figure 1 is provided for illustrative purposes only.

2.3.3 Swept outline

2.3.3.1 General

The swept outline represents the dynamic space requirements of a vehicle as it moves along the track, accounting for both static and kinematic influences. It is defined as the rolling stock kinematic outline of the vehicle, including the additional clearances generated by the inner and outer curve throw on a specified radius horizontal curve. In practical terms, the swept outline is a two-dimensional cross-section that comprises the kinematic outline together with the curve-induced displacements produced as the vehicle negotiates curves. This provides a realistic assessment of the maximum space envelope a vehicle can require, forming the basis for infrastructure and clearance compatibility assessments. Figure 5 in Section 3.2.4, provides the method for calculation of centre and end throws.

2.3.3.2 Horizontal swept outline

The horizontal swept outline consists of the kinematic outline plus the inner and outer curve throw produced by the vehicle on a specified radius horizontal curve, as shown in Figure 2.

The body length and bogie spacing (as detailed in the reference vehicles in Appendix A) will define the curve throws produced. See Equation 1 and Equation 2 in Section 3.2.4.

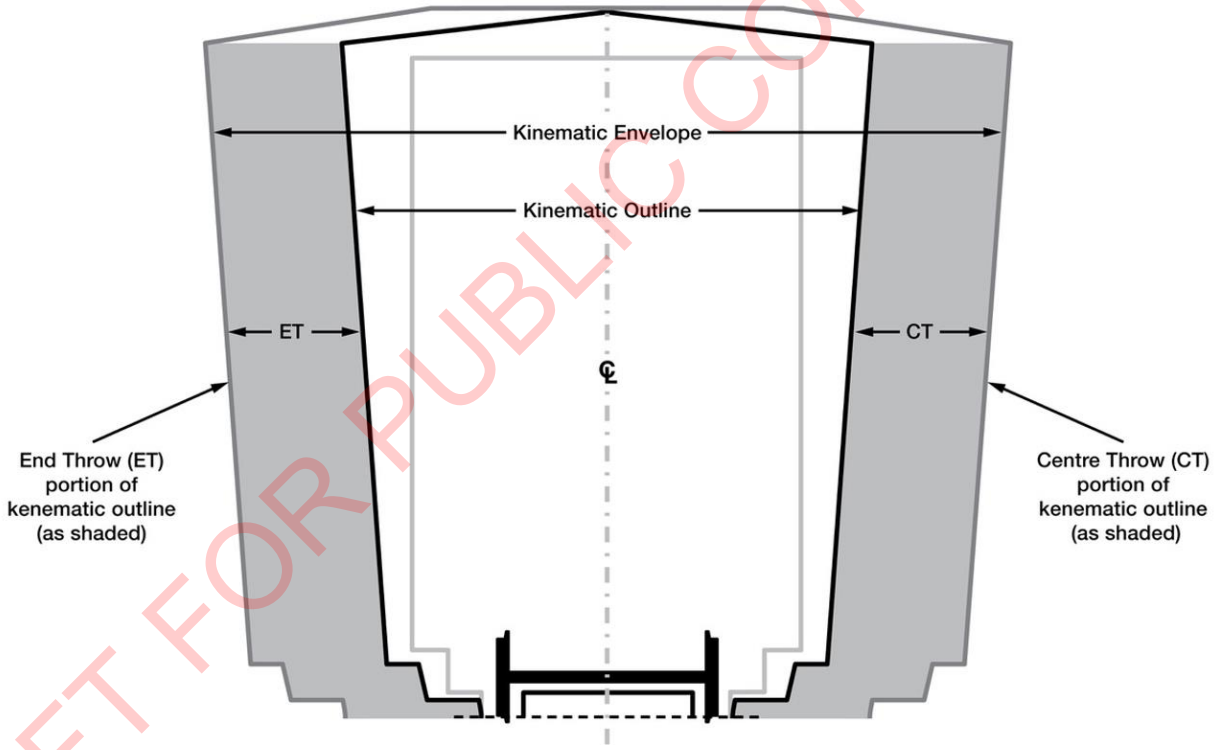


Figure 2 Horizontal swept outline

2.3.4 Vertical swept outline

The vertical swept outline is a two-dimensional cross-section for the vehicle that consists of the static outline, plus the upper and lower vertical curve throw produced by the vehicle on a humped or dipped vertical curve, as shown in Figure 3.

Both convex and concave (hump and dip) vertical curves shall be assessed.

The upper section of the static outline shall utilize the maximum vehicle height, whilst the lower section of the static outline shall utilize the minimum vehicle height (See Section 3.2.2).

Both limits are to be calculated using a specified vertical curve radius, unless another radius is agreed with the RIM. The equation for the vertical swept outline is shown in Figure 5.

If the vehicle bogie centre and overhang dimensions are within the reference vehicle dimensions, then the swept outline will be compliant.

Underframe fittings such as cowcatchers and underslung equipment shall not exceed the vertical swept outline of the reference vehicle at any position around the vehicle on straight track for vertical curves (humped or dipped) down to a specified radius.

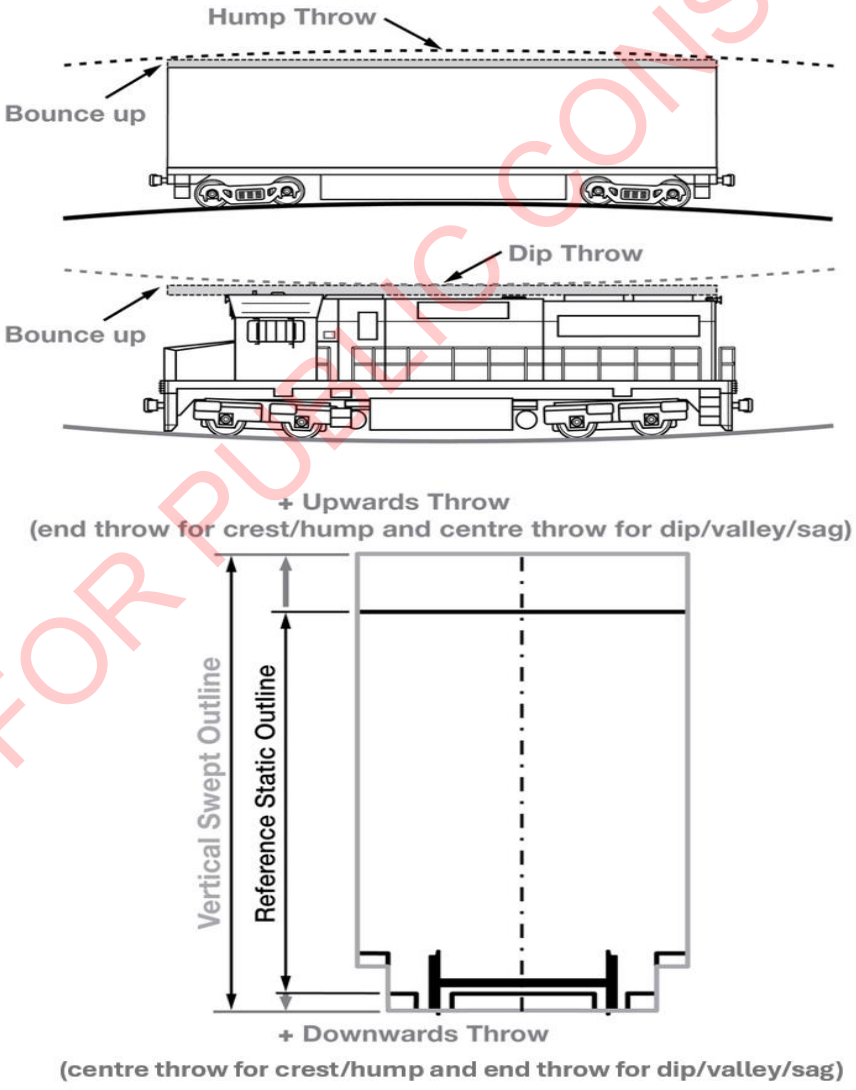


Figure 3 Vertical swept outline

2.3.5 Kinematic outline

The kinematic outline, as shown in Figure 4, consists of:

(a) the static outline;

(b) the maximum permitted allowance for vertical bounce upwards;

(c) the maximum lateral translation of the body relative to the wheelset;

(d) body roll in response to a steady-state cant deficiency force at maximum permitted cant deficiency (or the maximum installed cant); and

(e) dynamic movements in response to track irregularity.

The kinematic outline is usually defined by movements that are applied to the static outline in vertical, lateral and roll translation, but may be defined by another dimensioned drawing.

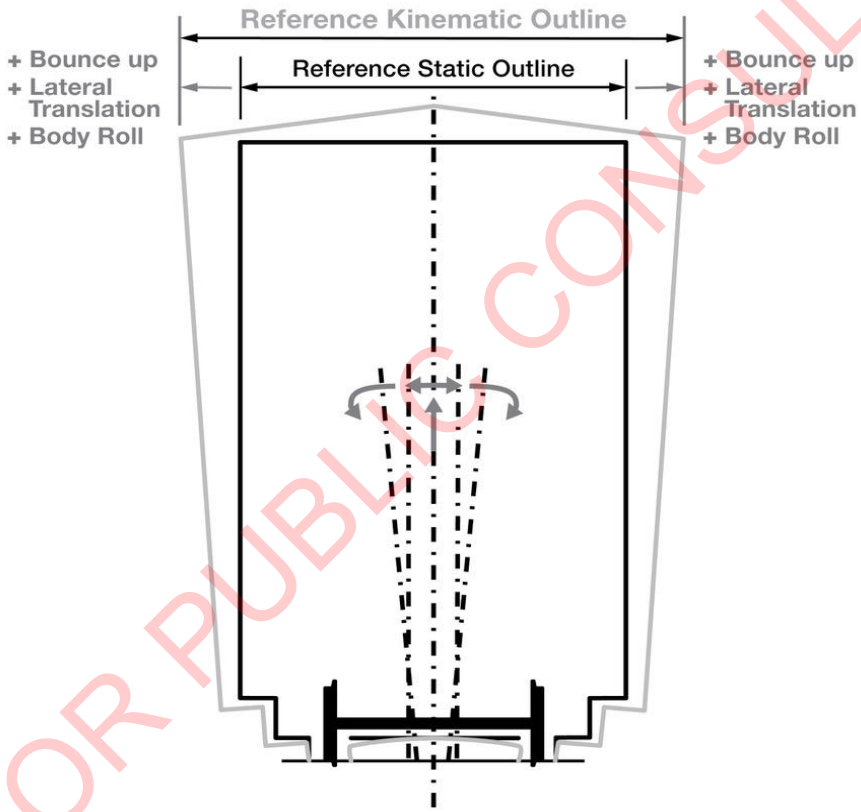


Figure 4 Kinematic outline

The reference kinematic outlines are each produced as a result of moving the corresponding reference static outline through the lateral translation, body roll and bounce upwards movements detailed in Appendix A.

The inner, black outline represents the reference static outline; the outer, grey outline represents the reference kinematic outline that is obtained by applying the defined lateral, roll and bounce upwards movements to the reference static outline. The dotted black lines show lateral translation and body roll against the vehicle centre line.

Note that bounce is applied upwards but not downwards. Downwards bounce is accounted for in the static outline in based on the suspension 'solid' in the minimum static height condition.

2.4 Reference vehicles

This document has defined 38 reference vehicles with their associated rolling stock outlines, based on those used by RIMs at the time of this document's development. Organisations wishing to add new reference vehicles to this document should contact RISSB.

A reference vehicle defines:

(a) the static outline, via a dimensioned drawing;

(b) the maximum permissible vertical, lateral and roll translations, plus the position of the roll centre, to calculate the permissible kinematic outline; and

(c) the bogie spacing and maximum body length to calculate the permissible horizontal and vertical swept outline swept outline.

NOTE:

Where applicable, Reference Vehicle 38 does not have a defined kinematic outline.

Advice shall be obtained from the RIM as to the appropriate reference rolling stock outline, or outlines, applicable for the routes on which a new or modified vehicle is proposed to operate. Advice sought from the RIM at the earliest possible stage in the vehicle design should avoid abortive work and delays.

Rolling stock shall conform to the applicable reference rolling stock outlines as advised by the RIM.

Non-conformances may be permitted with approval from the RIM but operating restrictions may be applied.

NOTE:

Not all reference rolling stock outlines are authorized for new vehicles; some reference outlines are only applicable to existing or legacy/heritage rolling stock.

A design for a new or modified vehicle may have actual dimensions and characteristics that differ from but remain within the reference vehicle static, kinematic, and horizontal and vertical swept outlines, and vertical swept outline.

For example, (subject to agreement by the RIM):

(d) the new vehicle may be longer and thinner than the reference rolling stock outline such that its smaller static cross-section offsets the larger curve throws due to its length whilst still remaining within the reference swept outline;

(e) a vehicle, such as an active tilting train, may have greater lateral and roll movements than allowed for by the reference kinematic outline, but would require to be designed with a smaller static cross-section so it may be designed with a smaller static cross-section to offset the greater kinematic movements such that the reference kinematic outline can be met; and

(f) a vehicle could be designed with non-uniform cross-section (tapered ends, for instance) in order to be able to maximize its cross-section and length within the limits permitted by the reference static outline and reference swept outline, as long as the reference kinematic outline is still met. Note that the width of the vehicle shall not exceed the width of the reference static outline.

A design for a new or modified vehicle is permitted to have dimensions that use the features of more than one reference rolling stock outline, providing the overall combined rolling stock outline is not exceeded with RIM agreement. For example, if a route is clear for two reference vehicles, where one has a wider body and the other is taller, it is permissible for a new vehicle to make use of both features.

Section 3 Assessment of rolling stock outlines

3.1 Assessment

When a new or modified vehicle is designed, its dimensions and kinematic characteristics shall be assessed against the appropriate reference vehicle and its outlines. The RIM can confirm the appropriate reference vehicle.

A new or modified vehicle may comply with a reference vehicle either:

(a) completely, including lengths and tolerances; or

(b) fit within the swept path of the reference outline, and tolerances on tangent and specified horizontal and vertical curve radius.

An outline assessment process flow chart can be found in Appendix D.

3.2 Conformance to a reference vehicle

3.2.1 Assessment of conformance

The first stage of assessment of conformance of a new or modified vehicle to a reference vehicle is made at design stage by calculation, and includes:

(a) identifying the appropriate reference rolling stock outline/s;

(b) calculating the static, kinematic, horizontal and vertical swept outlines of the rolling stock; and

(c) ensuring the rolling stock outlines are within the reference vehicle/s outlines.

Commentary C3.2.1

The RIM can confirm the appropriate reference vehicle and reference rolling stock outline. The reference rolling stock outline should consist of the vehicle dimensions and all relevant allowances for suspension movements, wheel wear, curve throw, etc. as defined in this document.

The second stage is undertaken on completion of the vehicle build or modification and is made by physical test to confirm that the outlines have been achieved. See Section 5 for more information.

3.2.2 Conformance to static outlines

3.2.2.1 Conformance

For rolling stock to comply with a reference static outline, its dimensions shall not exceed the reference static outline at any position around the perimeter of the cross section under the defined conditions of:

(a) maximum static height (includes; tare mass, new wheels, maximum packing for future wear, near wear surfaces and inflated air springs); and

(b) minimum static height (includes, solid suspension, worn wheels, max worn wear surfaces).

In assessing conformance of a vehicle to a reference static outline, the vehicle wheelset is assumed to remain fixed at the centreline of the track and no account needs to be taken of wheelset lateral translation relative to the track.

The assessment shall include rolling stock build and maintenance tolerances.

3.2.3 Conformance to kinematic outline

For rolling stock to comply with a reference kinematic outline, its kinematic outline shall not exceed the reference kinematic outline at any position around the perimeter of the cross section under the combined conditions of:

(a) maximum lateral translation;

(b) maximum vehicle body roll relative to the wheelset in response to a steady-state cant deficiency force at the maximum design test cant deficiency for the vehicle, or the maximum installed cant, plus an allowance for dynamic movements in response to track irregularity, whichever is the greater value;

(c) vehicle body bounce upwards; and

(d) dynamic movement to track irregularity and geometry.

Commentary *C3.2.3*

These requirements control the maximum basic kinematic outline under conditions of maximum cant deficiency or maximum cant excess only. They do not control the size of the basic kinematic outline under other conditions such as lesser cant deficiency or cant excess, or straight track.

For vehicles with air springs, the vehicle shall fit within the reference kinematic outline with air springs inflated and deflated.

Conditions a) and b) are assessed during the vehicles response to the vehicle traversing defined test tracks.

For vehicles with active suspension, for example tilting trains:

(a) the additional movements due to the active system are to be taken into account and are not to exceed the reference kinematic outline; and

(b) there should be suitable controls such that the effect of failure of the active system does not cause exceedance of the reference kinematic outline.

In order to retain safe clearances, it can be necessary to assess the effects of crosswinds, or pressure pulses from passing trains, on the vehicle's kinematic outline, particularly on high-sided and/or lightweight vehicles on exposed routes. The assessment shall include rolling stock build and maintenance tolerances.

Commentary *C3.2.3*

The RIM accounts for wheel-rail movement, track tolerances and clearances.

Kinematic calculations for the vehicle shall use the actual roll centre height and kinematic tolerances applicable to the vehicle design. For example, the reference kinematic outlines specify heights at which the body roll allowance is applied, typically 440 mm, 610 mm or 1,100 mm above rail level. These roll centre heights are for the reference kinematic outline and are not to be assumed for the vehicle. This is usually determined by actual measured spring deflections in the suspension system.

Reducing the kinematic outline cannot be used to compensate for exceeding the static rolling stock outline and/or swept rolling stock outline.

For the assessment of kinematic outline conformance, the worst condition of lateral displacement, whether from static or dynamic kinematic testing or both, shall be assessed for compliance with the reference kinematic rolling stock outline.

Commentary *C3.2.3*

Rolling stock must not develop excessive longitudinal tractive and braking forces that could damage the structural integrity of the rails, track, or infrastructure.

3.2.4 Conformance to swept outlines

For a vehicle to comply with a reference horizontal and vertical swept outline, the vehicle shall not:

(a) exceed the reference swept outline at any position around the vehicle on level track for specified horizontal curve radius;

(b) exceed the vertical swept outline of the reference vehicle at any position around the vehicle on straight track for specified vertical curve (humped or dipped) radius; and

(c) drop below rail level at any position around the vehicle on straight track for specified vertical curve (humped or dipped) radius.

Below is the method for calculation of centre and end throws. Assess the vehicle on a horizontal curve of constant radius, where –

(d) CT = Centre Throw

(e) ET = End Throw

(f) B = Bogie centres

(g) L = Body length

(h) R = Curve radius

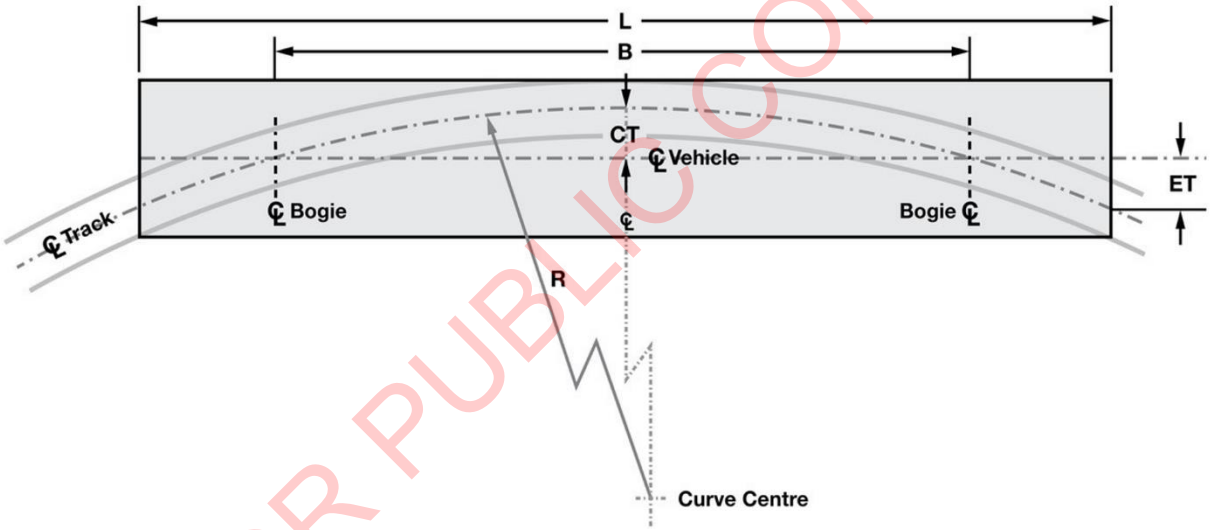


Figure 5 Centre and end throw

The end throw (ET) is given by Equation 1. This equation omits the effect of throw due to bogie wheelbase.

Equation 1 End throw for a longitudinally symmetrical vehicle

$$ET = \frac{[L^2 - \mathrm{B}^2]}{8R}$$

The centre throw (CT) is given by Equation 2. This equation omits the effect of throw due to bogie wheelbase.

Equation 2 Centre throw for a symmetrical vehicle

$$CT = \frac{B^2}{8R}$$

Section 4 Specific items

4.1 Wheels

The area of the static outline marked for wheels only also represents the kinematic outline and swept outline for wheel-related equipment such as wheel guards; derail catch bars and sanding equipment.

The static outline of wheel-related equipment at minimum static height shall be above rail level.

Trackside equipment nominated by the RIM shall not be affected by any wheel-related equipment installed in the for wheels only area.

4.2 Bogie-only components

Some outlines contain sections identified as bogie only components located at the bottom extremities of the outlines. These areas have minimal clearances to infrastructure and thus have minimal capacity for sweeping in curves. Therefore these areas are limited to items associated with the bogie and shall not include any body related components or items.

4.3 Axle spacing (signalling)

Axle spacing of vehicles based on the bogies utilized and their respective wheelbases shall comply with the rail networks maximum overhang distance and maximum spacing between axles for signalling purposes.

4.4 Expendable items

A part of a vehicle that is outside of the reference rolling stock outline but has low consequences in the event of an infringement can be treated as an expendable item.

Some rolling stock outlines, in combination with infrastructure transit spaces, especially where reduced clearances exist, are designed to not allow expendable items.

Expendable items shall be minimized by design and shall not be incorporated as a design feature of new rolling stock. New rolling stock designs shall incorporate alternative means of achieving the requirement without resorting to outline infringements resulting in expendable items.

Where no alternative is possible for existing vehicles, some parts (generally items of equipment attached to the exterior) of vehicles may project beyond the rolling stock outline. These items can only be taken into account and treated as expendable items. By their nature, they shall have low consequences if contact at speed occurs with infrastructure or other vehicles.

Examples of items that could be expendable items include the following:

(a) mirrors
(b) warning lights
(c) speakers
(d) periscopes
(e) antennae
(f) roof gutters

Any expendable items, including new and existing items modified, shall not be introduced without the formal agreement of the RIM and the subsequent derogation process of the RIM.

Vehicle owners/operators are to ensure that expendable items are designed, constructed and maintained, such that in the event of contact with infrastructure or other vehicles, they will not cause damage to the infrastructure or other vehicles, injury to rail employees or public, or result in unsafe operating conditions.

Examples of outcomes to ensure for expendable items contacting infrastructure or other vehicles includes the following:

(g) Items cannot disrupt the functionality of rail utilities located in close proximity to the rolling stock outline, for example cable or signal troughing.

(h) Items cannot become a dangerous projectile

(i) Items cannot become partially dislodges, resulting in flapping or whipping.

(j) Items cannot result in an unsafe operating condition due to loss of lights, communication, beacons, strobe lights, and so on.

Expendable items shall be assessed and reviewed in a risk assessment to ensure the above factors are taken into account.

For vehicles conforming to RISSB Reference Vehicle 27, new expendable items or existing expendable items that are modified, shall occupy an area already used by similar expendable items as shown in Appendix B, Appendix Figure B1.

4.5 Cowcatchers

Cowcatchers shall be height adjustable so height above rail can account for manufacturing tolerances, and account for wheel wear and other wearing or packing factors.

The installed height of the cowcatcher should:

(a) satisfy the applicable rolling stock outlines;

(b) not contact the rail when the rolling stock in its Minimum Static Height condition; and

(c) have a longitudinal position such that the rolling stock can negotiate the minimum radius vertical curves (sag, dipped, concave) permitted by the RIM without contacting the rail.

Cowcatchers should be designed to be removable to permit the movement of a vehicle when required.

4.6 AWS & APC receiver heads

The RIM can have specific guidance regarding the installation height above rail level (ARL) of AWS and APC receiver heads.

4.7 Pantographs

For pantographs in their lowered position, all parts of the pantograph and associated equipment shall not exceed the appropriate static outline as described in Appendix A.

The RISSB pantograph outlines given in Appendix B2 show the pantograph static outline up to maximum working height.

The pantograph head profile shall conform to the dimensions of the appropriate pantograph static outline as described in Appendix B.2.

Agreement shall be sought from the RIM regarding the use of pantographs and their respective profiles/outlines.

NOTE:

The RIM can confirm the appropriate pantograph outline to use.

The pantograph head position along the vehicle shall not exceed the dimensions of the appropriate pantograph static outline as described in Appendix B.2.

NOTE:

The RIM may impose requirements on location of pantographs with respect to bogie centres of the vehicle.

4.8 Trip valve arms

Some of the rolling stock outlines include an extension of the outline for trip valve arms.

Trip valve arms, where fitted, shall conform to the dimensions specified in Appendix A under maximum static height and minimum static height conditions.

No other items shall occupy the area designated for trip valve arms.

4.9 Doors

4.9.1 Doors – Crew/Passenger

Rolling stock which features crew or passenger doors should be designed to open inwards (sliding or hinged) and not be able to open outwards so as not to infringe the rolling stock static outline. Hinged type doors shall not open outwards.

Rolling stock which features crew or passenger plug type doors have the risk of failing in the open conditions and infringing the rolling stock static outline. Some RIMs utilize rolling stock outlines that have allowances for open doors and may allow operation of failed open doors under special operating conditions. Examples of these are shown in Appendix B6 and B7 (based on Reference Vehicle 21 and Reference Vehicle 27). To note, some reference vehicle outlines, such as 38, are designed with reduced clearances and are not accepted with any infringements, including open plug doors.

Any plug type doors in the open position shall not exceed the applicable rolling stock swept outline.

The longitudinal position of doors shall be located appropriately to minimize platform gap variation on curved platforms (if required) and shall be as per the RIM and/or operators' requirements.

Passenger doors shall be fitted with a positive latching system to prevent doors from being opened accidentally whilst the vehicle is in motion.

4.9.2 Doors – Bulk commodity (bottom discharge)

Bottom discharge doors on bulk commodity wagons in the open position should be within the rolling stock outline at all times. Where this is not possible, bottom discharge doors in the open position shall not exceed the reference static outline under the following conditions; tare loading, condemn wheel diameter, maximum wear in bogie centre plates and other wear surfaces (which can reduce clearances to the lower rolling stock outline), suspension at tare condition and suspension compression to account for maximum dynamic travel (solid suspension is also acceptable).

Freight rolling stock with bottom discharge doors during discharge at an applicable load receiving site for the type of wagons may have doors that exceed the reference static outline but shall not drop below rail level in the minimum height conditions. Bottom discharge doors shall be fitted with positive latching systems to prevent inadvertent operation in service (except as required for loading operations).

4.9.3 Doors – Bulk commodity (roof hatches)

Roof mounted doors/hatches on bulk commodity wagons should be within the static rolling stock outline at all times (closed, when opening, and when open). Where this is not possible, roof mounted doors/hatches shall be within the static rolling stock outline in the closed and open positions and be fitted with a positive latching system to prevent inadvertent opening in service.

4.10 Hatches

External hatches should be designed such that when open they do not protrude from the static outline.

If this cannot be achieved, the hatch design shall include one or more of these features:

(a) Top hung (hinged at the top of the hatch).

(b) Redundancy in fastening systems.

(c) Secondary latch to open where the latch is designed with two positions, i.e. one fully latched and a secondary latched position.

(d) Swing stop (chain or strap).

(e) Visible lock indicators.

(f) Designed to be frangible or tear-away. Refer to expendable items in Section 4.4

4.11 Step treads

A step tread is the horizontal surface of a step or stair attached to a train or maintenance vehicle, designed for passengers or crew to step on during boarding or alighting. Step treads can be required to maintain platform gaps. Where step treads are required, they should be contained within the static envelope. Approval shall be sought from the RIM when step treads extend beyond the kinematic envelope.

4.12 Infrastructure rolling stock

Where rolling stock is equipped with movable elements that can exceed the static outlines, such as; steps, ploughs, tamping tynes, cranes, elevated work platforms, spray gear, test gear, etc., they shall have a nominated stowed position within the static outline to allow the vehicle to travel. The movable elements shall have a designed restraint system, with locking/interlocking, to prevent the movable elements from becoming loose or inadvertently moved unless under specifically defined conditions.

Section 5 Outline physical testing

5.1 General

A physical test shall be conducted to ensure that the vehicle conforms to the reference rolling stock outline.

All new vehicles shall be tested and any modified vehicles which can affect the outline configuration/performance of the vehicle shall be tested.

If new rolling stock or modified rolling stock be similar to complying rolling stock or approved rolling stock that is currently operating on a railway network, then the extent of evaluation against the requirements of this document may be reduced.

Commentary *C5.1*

AS 7509:2017 provides guidance for the dynamic behaviour requirements for locomotive, freight, passenger and infrastructure maintenance rolling stock. Section 2 describes physical testing requirements and modelling using computer simulations where suitable track condition are not available.

NOTE:

This includes the reference static outline, reference kinematic outline and reference swept outline.

The static outline test is a type test and routine test. If physical measurements of a representative number of vehicles, and technical argument over control of tolerances can demonstrate that the vehicles should consistently not exceed the reference static outline, the static outline test shall be applied to a sample of the rolling stock as agreed with the RIM.

NOTE:

It is anticipated that some measurements will be required on all vehicles, i.e. the routine test for the static outline will be a simplified version of the type test for the static outline.

The kinematic outline test is a type test.

The swept outline test is a type test, typically achieved through CAD modelling.

Generally, the sort of vehicle modifications that might impact on the static and kinematic characteristics would be suspension modifications, increase in vehicle centre of gravity height, change in bogie type or change in operating conditions (e.g., change in load, speed or cant deficiency).

Modification of the body or bogie can affect the static outline performance. Modifications of the suspension, vehicle mass or centre of gravity (CG), bogie type, or change in operating conditions can affect the dynamic kinematic performance

5.2 Static outline test

Static outline test measurements shall be made on straight and level track.

Static outline test measurements shall be made relative to the track centreline and the top of rail level.

The vehicle shall be measured in the maximum height condition and in the minimum height condition.

One method for the static outline test is to measure the clearance between the vehicle profile and a constructed check profile.

It is suggested that before the test commences a check is made to ensure that the vehicle body is sitting centrally within the range of its lateral suspension travel and between the rails, and the vehicle centred if necessary.

There can be slight height changes due to wheel tread taper that can affect measurements which reference from the rails if the vehicle is not centered on the track.

Some aspects of the vehicle maximum height condition (such as vehicle packed to compensate for future wheel wear or a container vehicle loaded with empty containers) may be simulated by adding or subtracting the appropriate allowances from the measured dimensions, or by lowering the check profile by an appropriate amount.

Some aspects of the vehicle minimum height condition such as springs fully compressed to bump-stops, condemned wheels and worn surfaces may be simulated by adding or subtracting the appropriate allowances from the measured dimensions, or by raising the check profile by an appropriate amount.

It is noted other physical type testing (such as bogie or vehicle swing testing) includes use of dummy solid cylinders to simulate solid suspension. These may be used to simulate the minimum height condition (in part for the suspension).

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

5.3 Kinematic outline tests

5.3.1 General

Design calculations shall be made to calculate the expected kinematic outline for the vehicle.

The design calculations should include vehicle movements due to maximum operating speeds, curve geometries, installed cant, cant deficiency and dynamic response of the vehicle, including mass and centre of gravity, to track irregularities.

Design shall be within the reference vehicle kinematic outline.

Where designs are shown to be within the reference outlines, the vehicle may progress to physical type testing.

Subject to acceptance by the RIM, physical testing might not be required where the design calculations show that:

(a) the maximum lateral translations and the maximum roll rotations have reached their physical limits (for example, where air gaps have been completely consumed, where bumpstops have gone solid, where suspension elements have gone solid or where CCSBs have gone solid);

(b) the maximum wear allowances of relevant components have been assessed;

(c) compliance with the safety against derailment criteria nominated in AS 7509 can be asserted; and

(d) the predicted kinematic outline of the candidate rolling stock is greater than 100 mm clearance at any point around the vehicle to that of the relevant reference vehicle.

This allowance does not exempt the vehicle from requirements of an appropriate bogie/suspension system that maintains appropriate wheel unloading performance, ride performance, kinematic performance, roll over performance, etc., to control the motion of the fully loaded vehicle.

NOTE:

Generally, this would be the fully loaded condition.

Physical kinematic outline testing comprises a static kinematic outline test and a dynamic kinematic outline test. The static testing provides assurance that the kinematic performance will likely be

acceptable and unlikely lead to unsafe performance (and agrees with the design), and dynamic testing confirms the kinematic performance.

Static kinematic testing is where the static vehicle is tested on a defined super-elevated or canted track (see Section 5.3.2), whilst dynamic kinematic testing is where the vehicle traverses a specified test track (of defined curve radii and installed super/cant) at defined testing speeds (see Section 5.3.3).

Static outline testing shall be successfully carried out, and the static requirements met, prior to attempting any dynamic kinematic testing.

The vehicle undergoing kinematic outline testing shall be assessed in the load condition that gives maximum sway, this usually corresponds to the maximum loaded condition or maximum gross mass.

During kinematic outline testing, the body roll relative to the wheelset and lateral translation of the body relative to the wheelset shall be measured.

Vehicles with friction damping should be tested with friction systems at worst case maintenance limits.

The results of the physical tests made shall be compared to the results of the design calculations for the corresponding case.

Where the results of the physical tests and design calculations do not align, further tests and/or analysis may be required until the design calculations are verified, i.e. the results of the design calculations replicate the results of the physical tests undertaken.

Dynamic kinematic outline tests are not required for infrastructure rolling stock where it is proposed to operate at speeds less than 15 km/h for vehicles up to and including 5 t gross mass, or less than 30 km/h for vehicles over 5 t gross mass.

5.3.2 Load condition for kinematic outline testing

The vehicle undergoing kinematic outline testing shall be assessed in the load condition that is expected to produce the maximum lateral sway. This condition typically corresponds to the maximum loaded configuration or maximum gross mass. When conducting Kinematic Outline Tests on loaded containers, the potential effects of load arrangement (including total weight, load height, and the resulting CG position) shall be taken into account. The test program should identify the load condition and CG arrangement that are likely to result in the most adverse sway or roll response, and testing should be carried out accordingly. Where it is not practicable to directly test the worst-case CG due to operational or logistical constraints, suitable extrapolation methods may be employed, provided the assumptions, calculations and safety margins are clearly documented.

Commentary *C5.3.1*

Generally, low speed infrastructure rolling stock should not require a kinematic outline test.

5.3.3 Static kinematic test

The vehicle shall be tested on straight and level track.

It is suggested that before the test commences, a check is made to ensure that the vehicle body is sitting centrally within the range of its lateral suspension travel and the vehicle centred if necessary.

The vehicle loading shall be such that it generates the maximum kinematic movement of the body, this is generally in the maximum loaded condition

The vehicle shall be raised on one side to simulate the required testing cant. The test cant is usually a maximum cant deficiency plus an allowance for dynamic movement in response to track irregularity that the vehicle will experience in operation.

Table 5-1 Minimum Test Cant for Different Rail Gauges

Gauge	Minimum test cant
Narrow	105 mm
Standard	160 mm
Broad	190 mm

Table 5-1, with the agreement of the RIM, is a list of test cants that shall be used in static kinematic tests. The values in Table 5-1 have been historically used in static kinematic testing. These tests cants are based on maximum installed cant values on the network (covering cant excess), and maximum cant deficiency plus track geometry and irregularities.

Cant shall be applied equally to all wheelsets of the vehicle during the kinematic sway static test.

NOTE:

See Appendix C for a description of the sway test.

The vehicle undergoing a kinematic sway static test shall be lifted in increments up to the maximum cant on one side, then lowered gently in increments to the level condition, then repeated by lifting on the opposite side of the vehicle.

By lifting both sides the complete hysteresis curve of lateral and roll movement versus applied cant will be recorded.

After lifting the vehicle in each direction, it might be necessary to lift the vehicle in the first direction again for a small cant input in order to close the hysteresis curve.

It is suggested that the measurements of vehicle lateral translation and body roll are recorded at each step/increment during the test such that any arising errors can be identified during the test.

Commentary *C5.3.2*

This allows the hysteresis curve to be observed during the test and any discontinuities in results can be investigated that can be due to instrumentation, the vehicle characteristics or the test conditions.

It is usual to measure the displacement of (at least) two positions on the body, at different heights, relative to the position of the vehicle wheelset.

These results may then be analysed to provide body roll and lateral translation of the body relative to the wheelset.

Vehicles fitted with air springs, the air springs shall be fully inflated and levelling valves shall be isolated such that the air springs neither inflate nor deflate for the duration of the kinematic static test.

Depending on the bogie arrangement, especially where primary and secondary suspension is used, the lateral and roll displacement might need to take into account the wheelset to bogie connection and the bogie to body connection (including primary and secondary suspension systems).

Note that the air system might need to be made specially airtight for the test vehicle to remain inflated for the duration of the test with air spring levelling valves isolated.

5.3.4 Dynamic kinematic sway test

The dynamic kinematic sway test shall be made over a test site that is representative of the routes on which the vehicle would be operating in terms of track irregularity and permits operation of the test vehicle to the maximum speed and cant deficiency required for the test.

The test route/site shall be agreed to by the RIM.

The test track shall be confirmed that track condition index do not exceed a TCI of 50 and contain no significant defects.

Dynamic kinematic testing shall take into account the design cant deficiency of the vehicle, the track geometry including curve radii and installed super/cant, and the operational speeds of the vehicle. These details can sometimes be obtained from the speed board regime detailed for the route but shall be confirmed with the RIM. The testing shall then be carried out at speeds which are above the normal operating speeds of the vehicle, to ensure appropriate safety factors are obtained for the kinematic performance. For NSW, the testing speeds have ensured at least 145% of the vehicle design cant deficiency is tested.

It should be noted that some reference outlines have special conditions and differ in their testing requirements. The RIM should be consulted to confirm kinematic outline requirements.

The dynamic kinematic sway test shall include the vehicle traversing test track/curves at speeds to generate the required cant deficiency.

Commentary *C5.3.3*

The perfect test curve is where curve radius, installed cant and line speed permit the candidate vehicle to curve at maximum cant deficiency and maximum speed simultaneously. The minimum requirement is that the test curve should permit maximum cant deficiency, and it is preferably that line speed is not less than 75% of the maximum speed of the candidate vehicle. Testing in excess of line speed is not intended.

This test is required since the maximum installed cant is often greater than the maximum permitted cant excess deficiency.

It is usual to measure the vertical and lateral translation of the primary and secondary suspension.

These results can then be analysed to provide body roll and lateral translation of the body relative to the wheelset.

5.4 Simulation of dynamic kinematic testing

A computer simulation may be accepted as an alternative to conducting the dynamic kinematic outline test. The simulation shall be carried out with an industry recognized simulation software, and the simulation shall be validated using data from measured dynamic responses of the vehicle.

5.5 Swept outline verification

Vehicle length, body overhangs and bogie centres shall be measured (together with static outline details) to ensure that the vehicle dimensions conform to details used in the analysis of the conformance to the swept outline (See Section 3.2.4 for more information).

Calculations should ensure the additional clearance for curves (horizontal and vertical) is not exceeded in the sharpest curve. This additional clearance can be a dimension or a percentage.

Section 6 Out-of-gauge rolling stock

Out-of-gauge rolling stock may be permitted to operate by the RIM, but might have operational constraints, limitations or special conditions placed upon it.

Where infrastructure rolling stock operates with equipment outside the static, kinematic or swept outline such as ploughs, lifting jibs, elevated platforms, etc., there shall be a means of ensuring that it is not driven in travel mode with this equipment exceeding any of the static, kinematic or swept outlines.

NOTE:

Within a possession, in work mode, it is sometimes necessary to travel with equipment outside the static, kinematic or swept outlines.

Section 7 Loads

Loading outlines and out of gauge loads are outside of the scope of this document and reference should be made to the relevant documents for each network; for example, the *RISSB Code of Practice for Loading of Rail Freight*.

The loading outline for loose, non-rigid or flexible loads is typically smaller than the applicable rolling stock (static) outline for a route.

The loading outline for rigid loads may be smaller or larger than the applicable rolling stock (static) outline for defined routes on some networks.

Section 8 Records

Test records shall be kept for each vehicle and shall include the dimensions of any out-of-gauge items.

Section 9 Maintenance

Rolling stock shall be maintained in a manner that ensures the static, swept, and kinematic outlines remain compliant with the requirements of this document for the duration of the vehicles' service life.

NOTE:

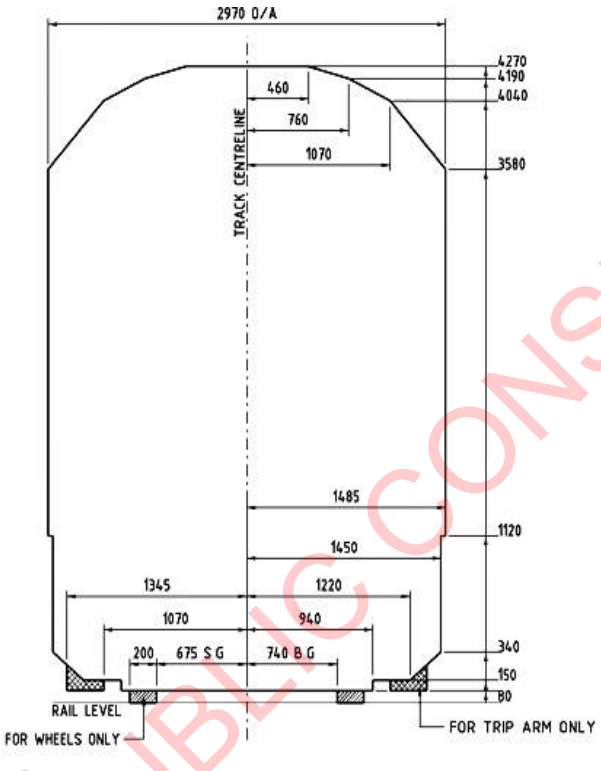
This includes maintenance of all features and components that influence the static and kinematic outlines, so that compliance is preserved throughout operational use.

Appendix A Reference Rolling Stock Outlines (Informative)

NOTE:

Wheel clearances are for information only to allow RIMs to make assessments of suitable structure outlines. RIMs will also make allowances for rail wear, track tolerances, safe clearances, etc.

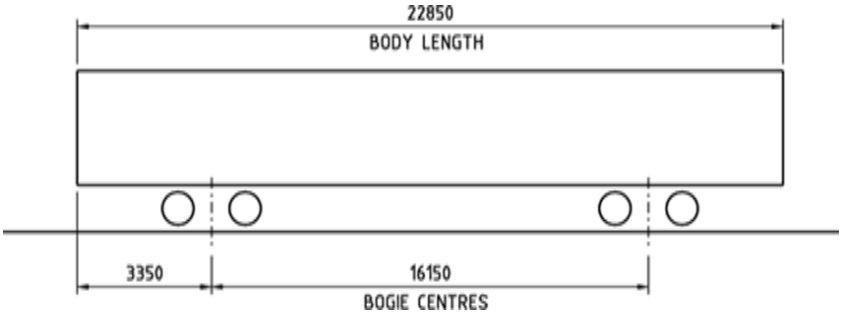
A.1 RISSB Reference Vehicle 1



Appendix Figure A.1-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 1.

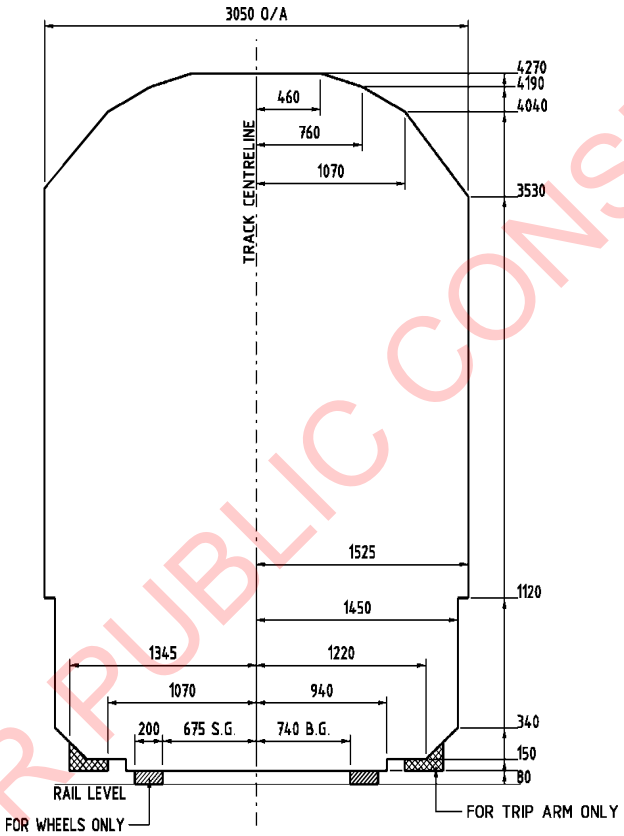
Appendix Table A.1 Kinematic Outline Translations for RISSB Reference Vehicle 1.

RISSB Reference Vehicle 1	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate A	40	2.0	610	50	20



Appendix Figure A.1-2 Swept outline vehicle dimensions for RISSB reference vehicle 1.

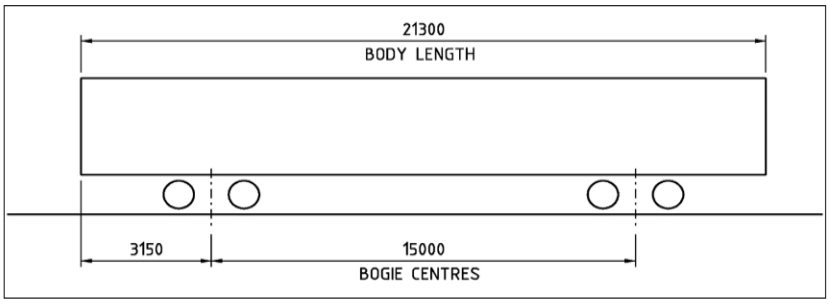
A.2 RISSB Reference Vehicle 2



Appendix Figure A.2-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 2

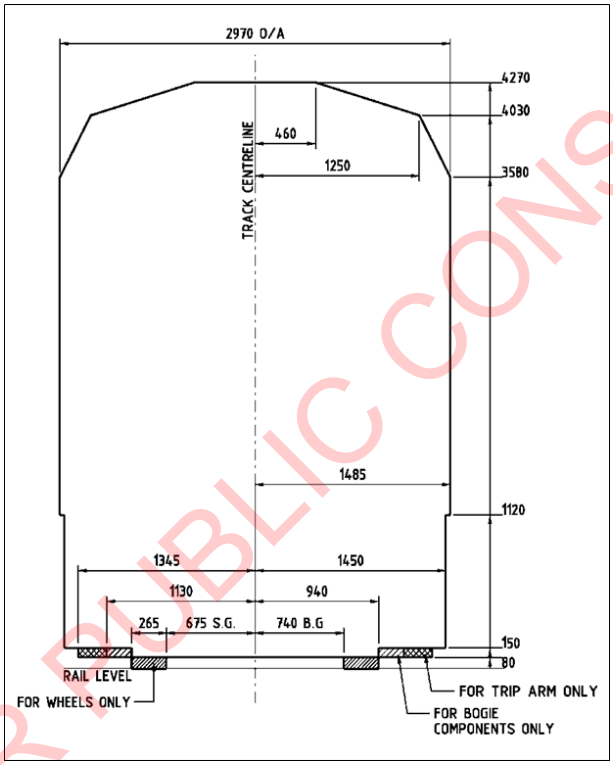
Appendix Table A.2 Kinematic Outline Translations for RISSB Reference Vehicle 2

RISSB Reference Vehicle 2	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate B	40	2.0	610	50	20



Appendix Figure A.2-2 Swept outline vehicle dimensions for RISSB reference vehicle 2.

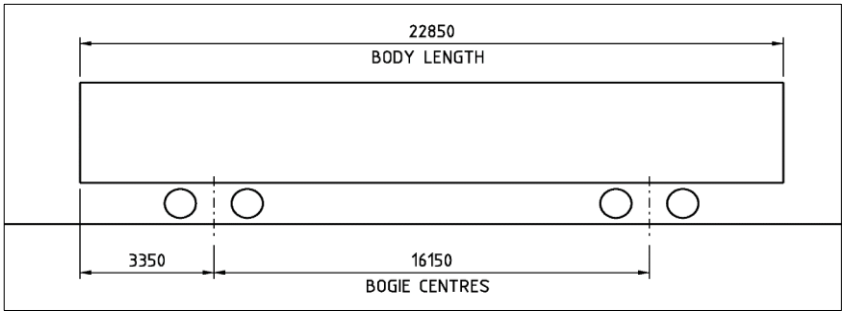
A.3 RISSB Reference Vehicle 3



Appendix Figure A.3-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 3

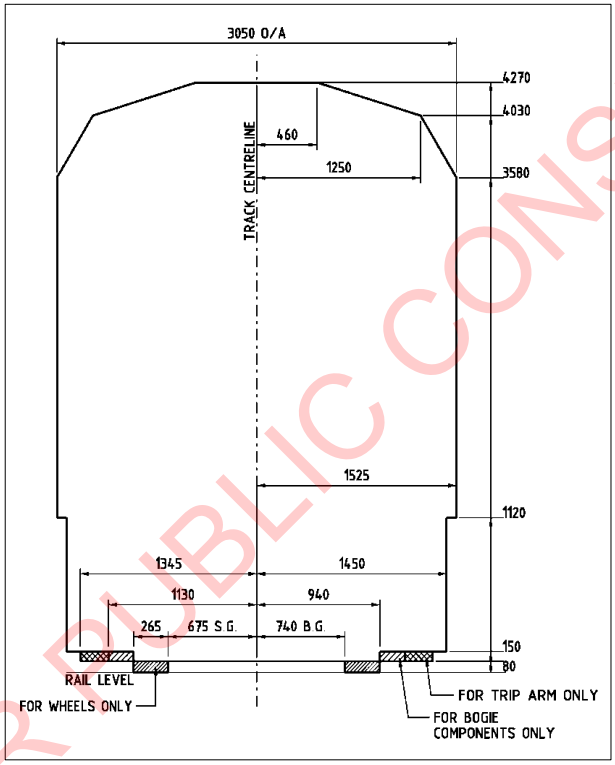
Appendix Table A.3 Kinematic Outline Translations for RISSB Reference Vehicle 3

RISSB Reference Vehicle 3	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate C	40	2.0	610	50	20



Appendix Figure A.3-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 3.

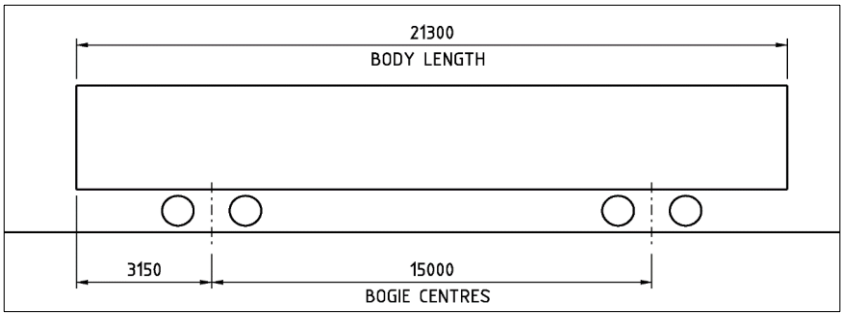
A.4 RISSB Reference Vehicle 4



Appendix Figure A.4-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 4.

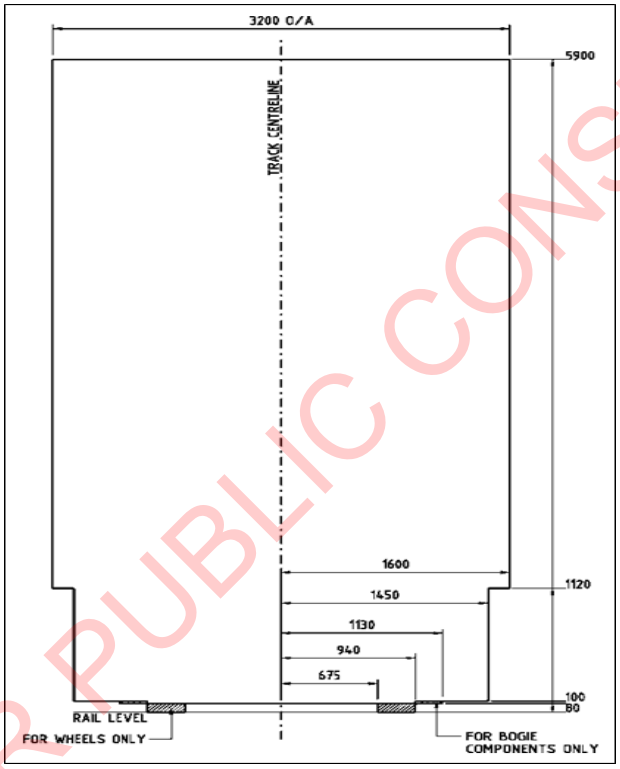
Appendix Table A.4 Kinematic Outline Translations for RISSB Reference Vehicle 4.

RISSB Reference Vehicle 4	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate D	40	2.0	610	50	20



Appendix Figure A.4-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 4.

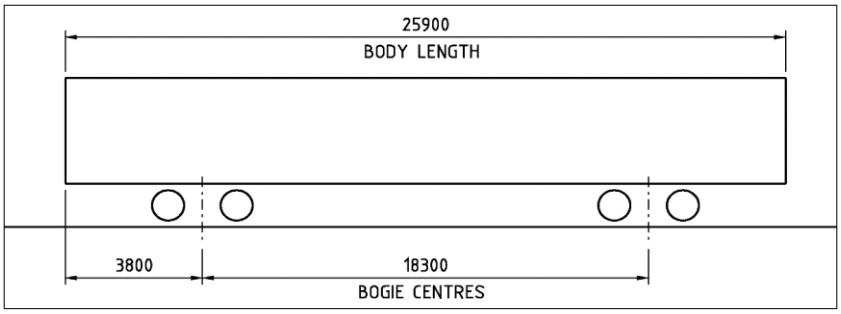
A.5 RISSB Reference Vehicle 5



Appendix Figure A.5-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 5

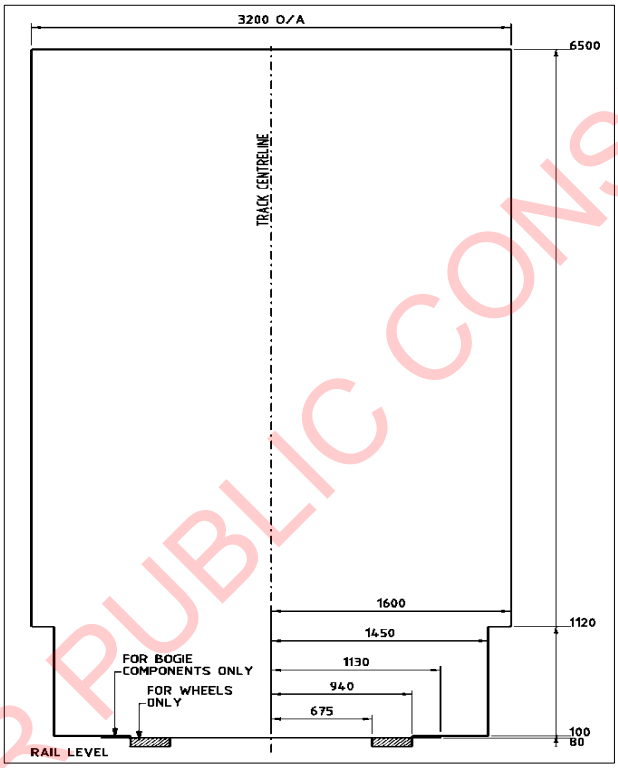
Appendix Table A.5 Kinematic Outline Translations for RISSB Reference Vehicle 5

RISSB Reference Vehicle 5	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate E	40	2.5	440	50	20



Appendix Figure A.5-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 5

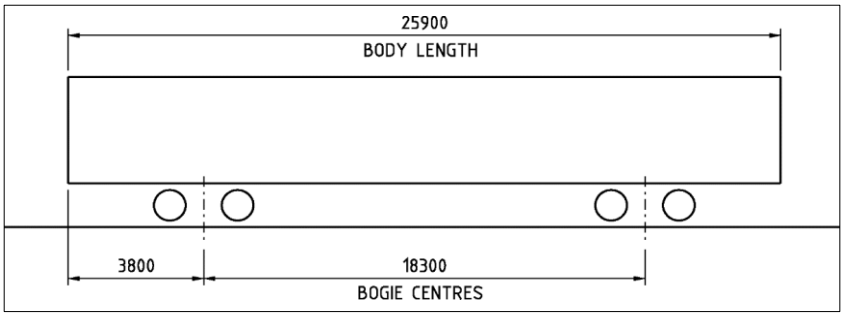
A.6 RISSB Reference Vehicle 6



Appendix Figure A.6-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 6

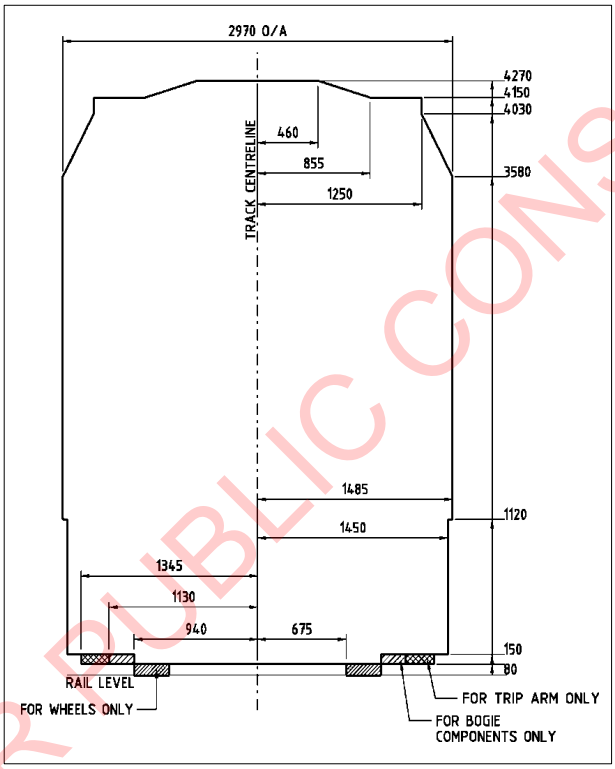
Appendix Table A.6 Kinematic Outline Translations for RISSB Reference Vehicle 6.

RISSB Reference Vehicle 6	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate F	40	2.5	440	50	20



Appendix Figure A.6-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 6

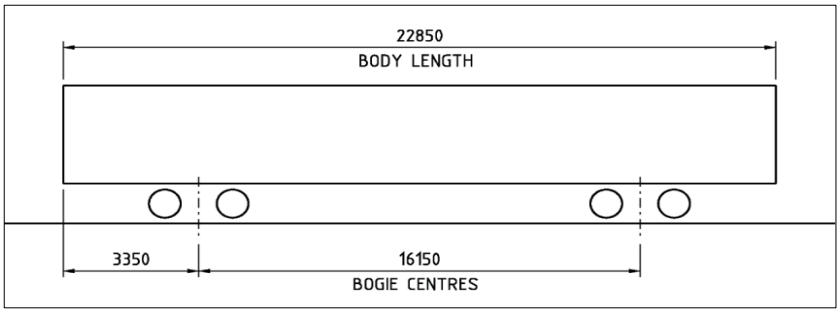
A.7 RISSB Reference Vehicle 7



Appendix Figure A.7-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 7

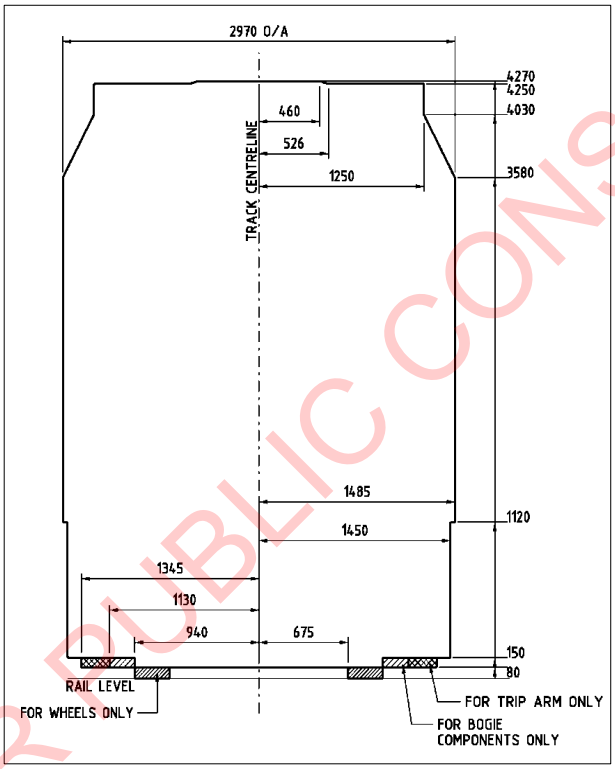
Appendix Table A.7 Kinematic Outline Translations for RISSB Reference Vehicle 7

RISSB Reference Vehicle 7	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
ARTC CY4150	40	2.0	610	50	20



Appendix Figure A.7-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 7.

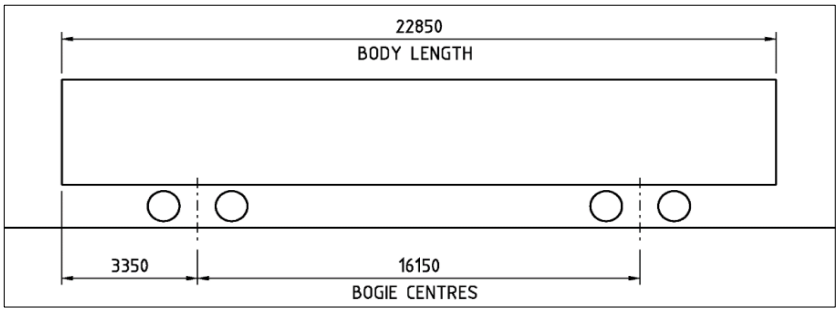
A.8 RISSB Reference Vehicle 8



Appendix Figure A.8-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 8

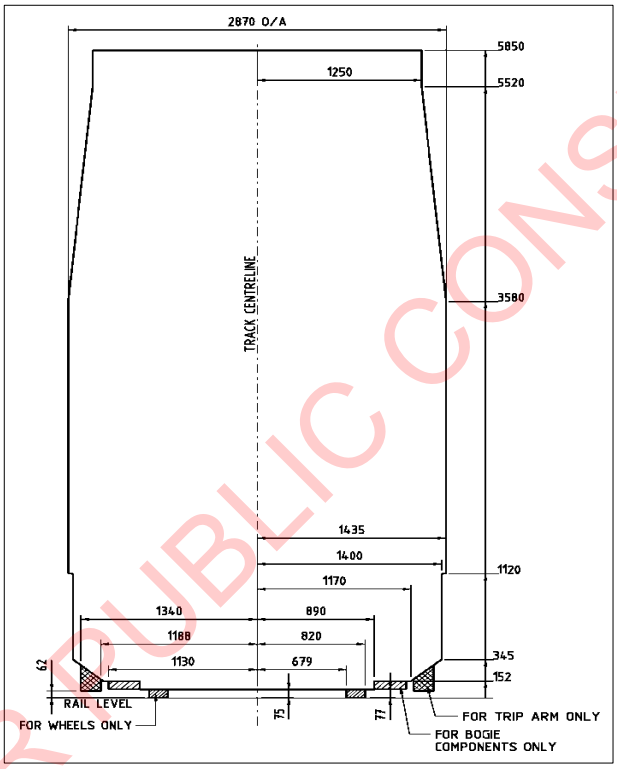
Appendix Table A.8 Kinematic Outline Translations for RISSB Reference Vehicle 8

RISSB Reference Vehicle 8	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
ARTC CZ	40	2.0	610	50	20



Appendix Figure A.8-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 8

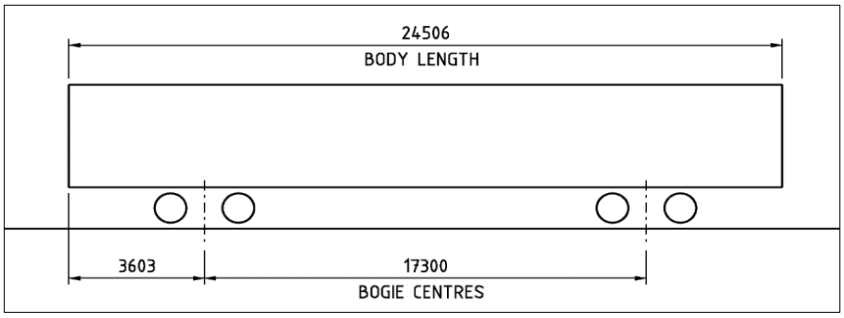
A.9 RISSB Reference Vehicle 9



Appendix Figure A.9-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 9

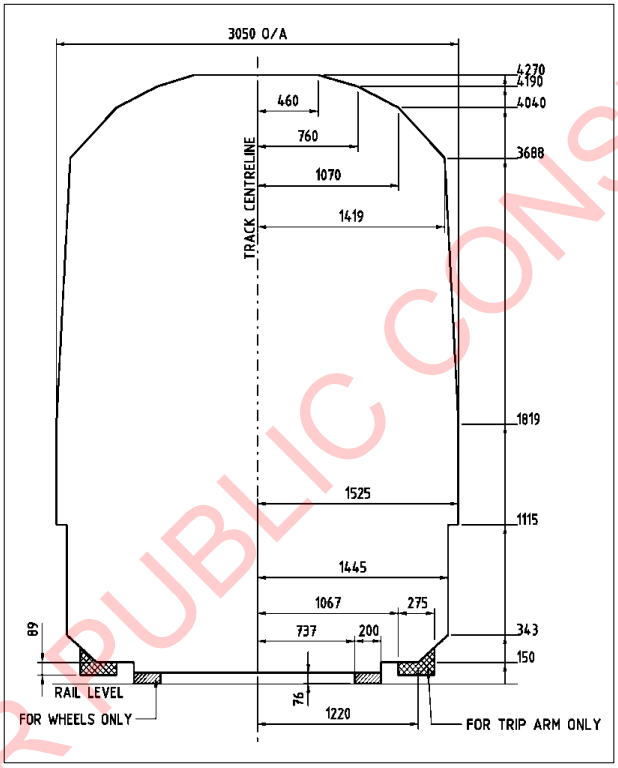
Appendix Table A.9 Kinematic Outline Translations for RISSB Reference Vehicle 9

RISSB Reference Vehicle 9	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Double Stack Container	60	2.5	440	50	20



Appendix Figure A.9-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 9

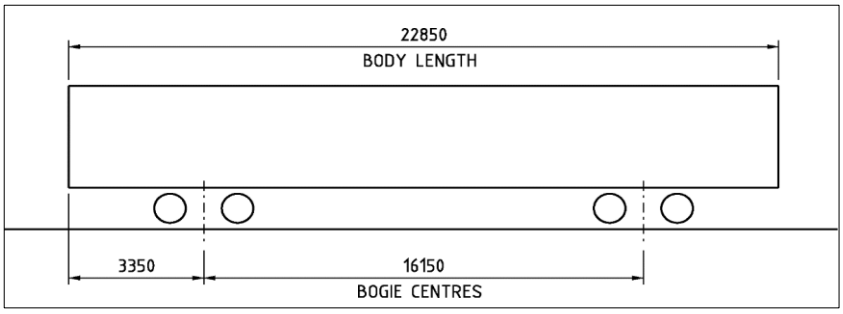
A.10 RISSB Reference Vehicle 10



Appendix Figure A.10-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 10

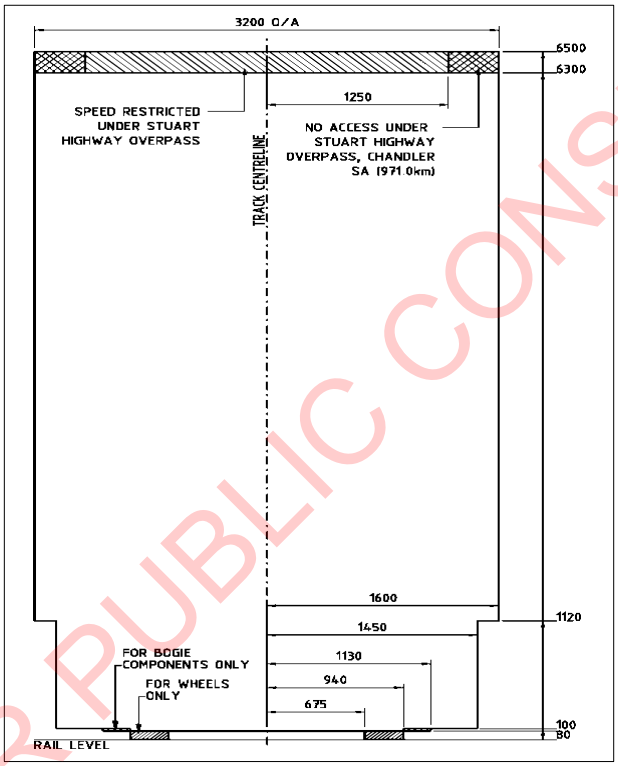
Appendix Table A.10 Kinematic Outline Translations for RISSB Reference Vehicle 10

RISSB Reference Vehicle 10	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Melbourne Broad Gauge Suburban Car	45	2.0	600	50	18



Appendix Figure A.10-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 10

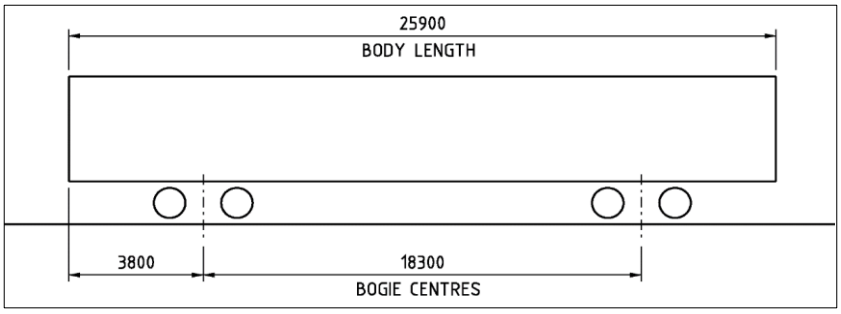
A.11 RISSB Reference Vehicle 11



Appendix Figure A.11-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 11

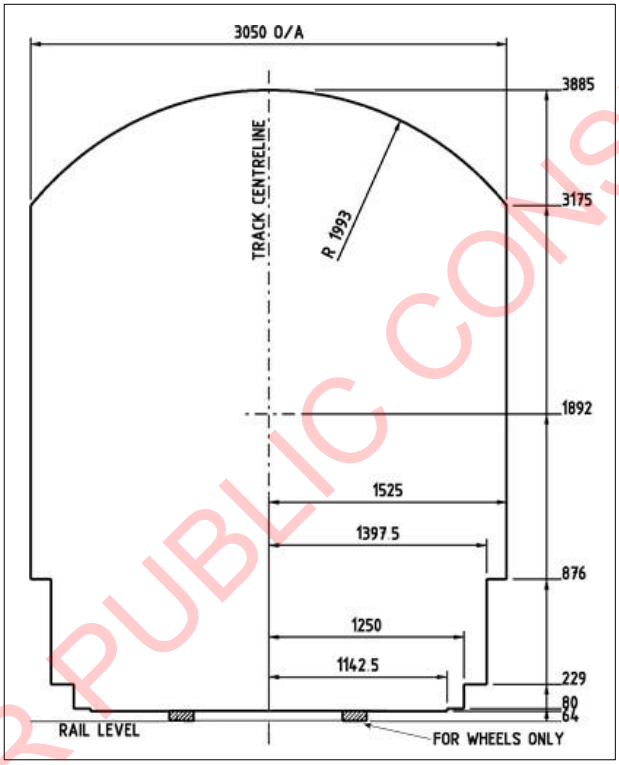
Appendix Table A.11 Kinematic Outline Translations for RISSB Reference Vehicle 11.

RISSB Reference Vehicle 11	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Tarcoola to Darwin	40	2.5	440	50	20



Appendix Figure A.11-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 11

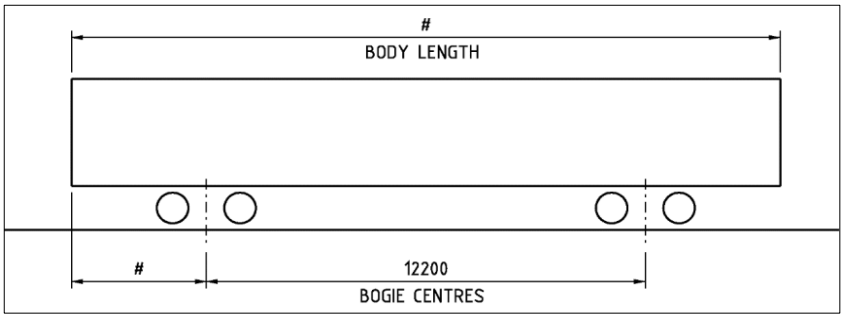
A.12 RISSB Reference Vehicle 12



Appendix Figure A.12-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 12.

Appendix Table A.12 Kinematic Outline Translations for RISSB Reference Vehicle 12.

RISSB Reference Vehicle 12	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Tasmania	40	2.5	440	50	(?)

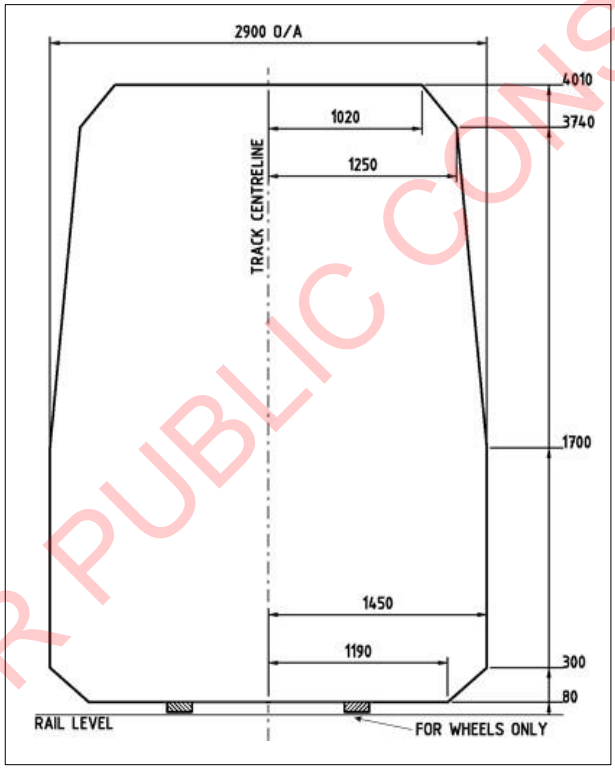


Appendix Figure A.12-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 12

NOTE:

Dimensions for body overall length and body length beyond bogie pivots are not defined.

A.13 RISSB Reference Vehicle 13

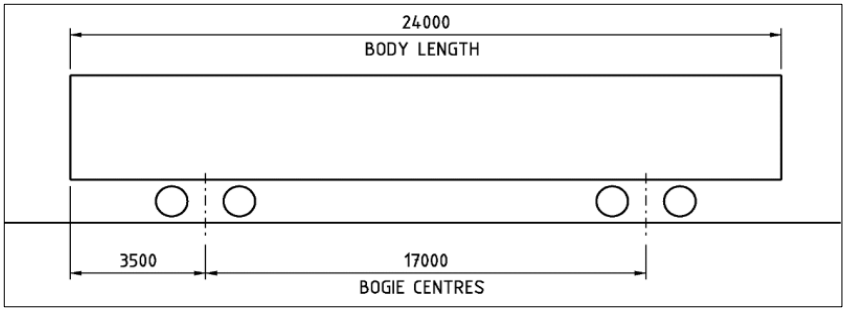


Appendix Figure A.13-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 13

Appendix Table A.13 Kinematic Outline Translations for RISSB Reference Vehicle 13

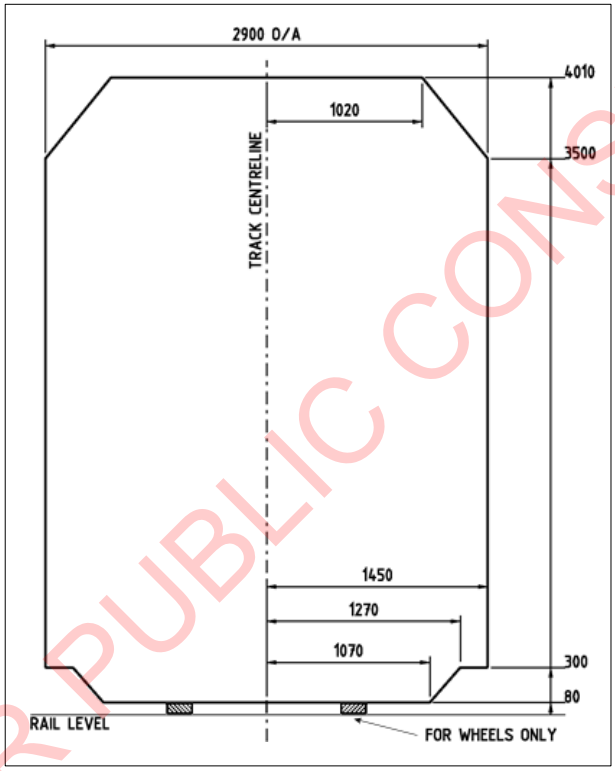
RISSB Reference Vehicle 13	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Perth Narrow Gauge Railcar	51	3.5	1,000	50	15

NOTE: 51 mm Lateral Translation for Perth Narrow Gauge Railcar excludes 10 mm allowance for yaw (no other outlines have stated allowances for yaw).



Appendix Figure A.13-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 13

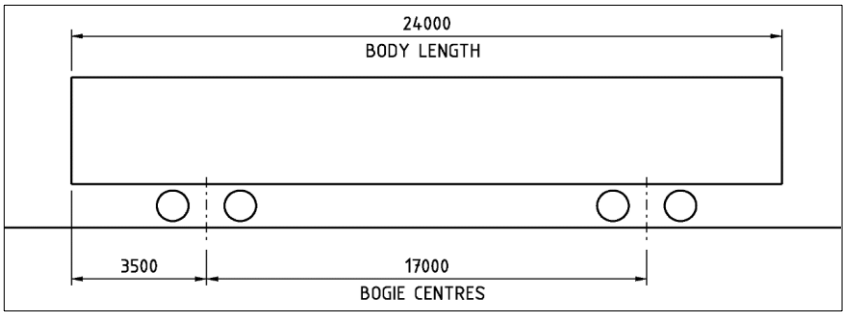
A.14 RISSB Reference Vehicle 14



Appendix Figure A. 14-1Static rolling stock outline dimensions for RISSB Reference Vehicle 14

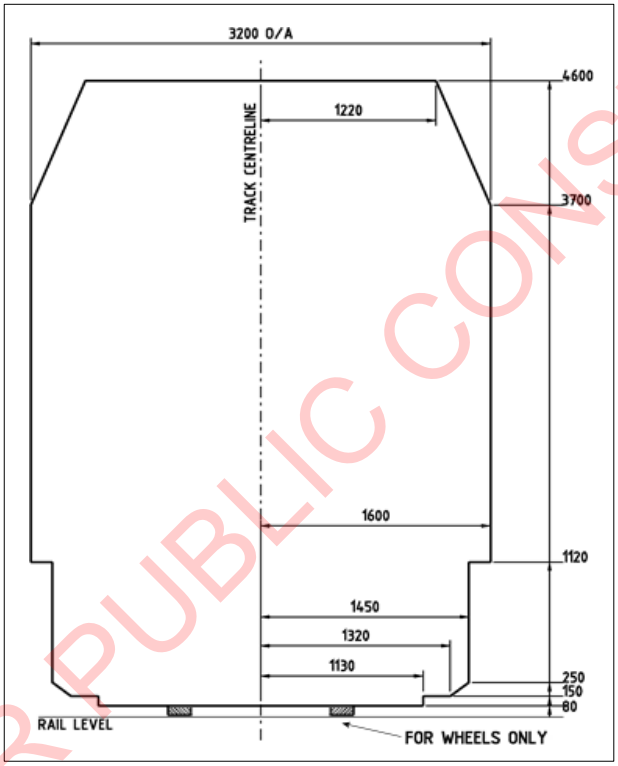
Appendix Table A.14 Kinematic outline translations for RISSB Reference Vehicle 14

RISSB Reference Vehicle 14	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Perth Narrow Gauge Work Train	20	1.0	610	25	20



Appendix Figure A.14-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 14

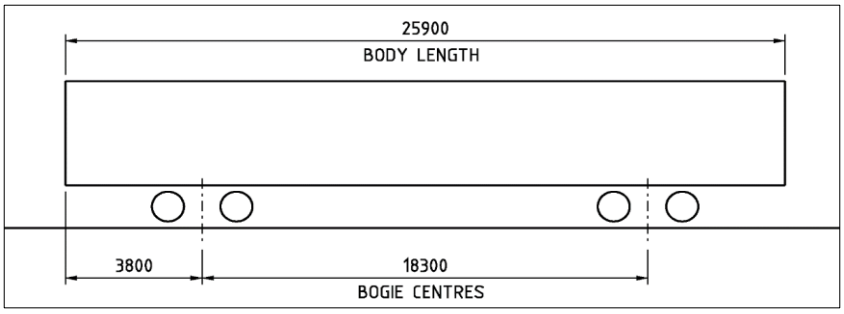
A.15 RISSB Reference Vehicle 15



Appendix Figure A.15-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 15

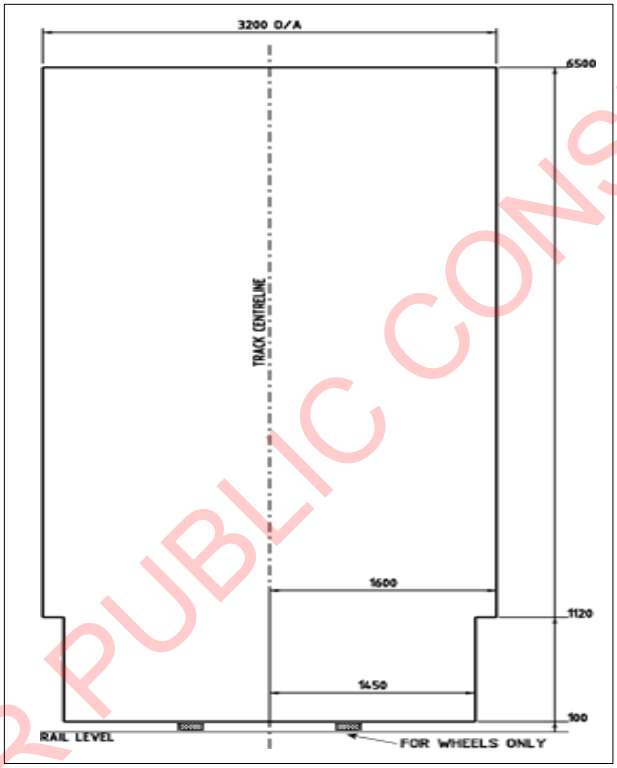
Appendix Table A.15 Kinematic Outline Translations for RISSB Reference Vehicle 15

RISSB Reference Vehicle 15	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
WA Dual & Standard Gauge East Perth - Midland	40	2.5	440	50	20



Appendix Figure A.15-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 15

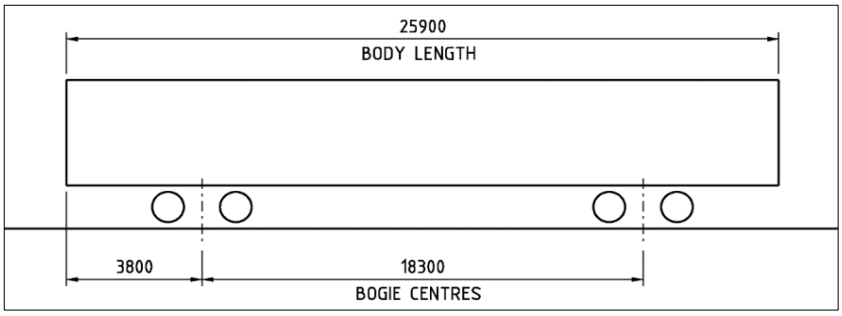
A.16 RISSB Reference Vehicle 16



Appendix Figure A.16-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 16

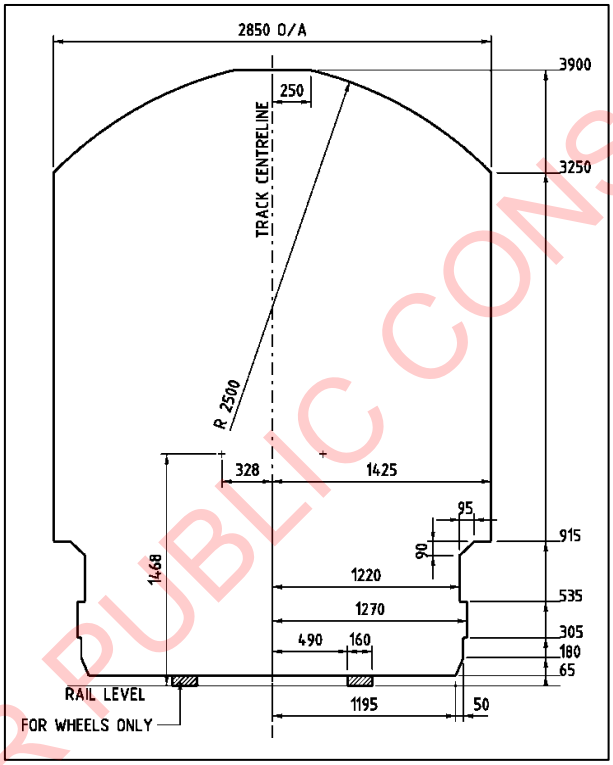
Appendix Table A.16 Kinematic Outline Translations for RISSB Reference Vehicle 16

RISSB Reference Vehicle 16	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
WA Dual & Standard Gauge North Fremantle - Robb Jetty	40	2.5	440	50	20



Appendix Figure A.16-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 16.

A.17 RISSB Reference Vehicle 17

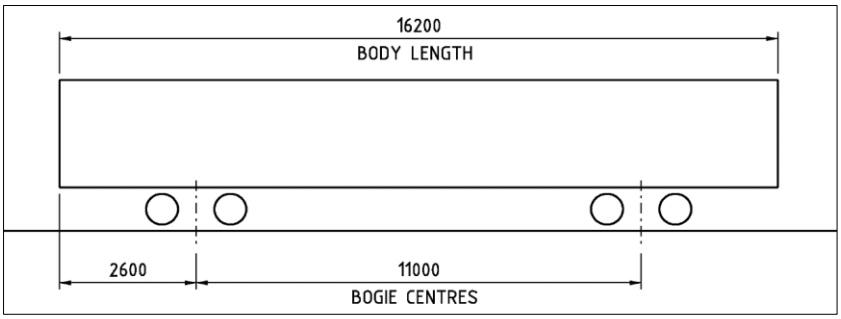


Appendix Figure A.17-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 17

Appendix Table A.17 Kinematic Outline Translations for RISSB Reference Vehicle 17

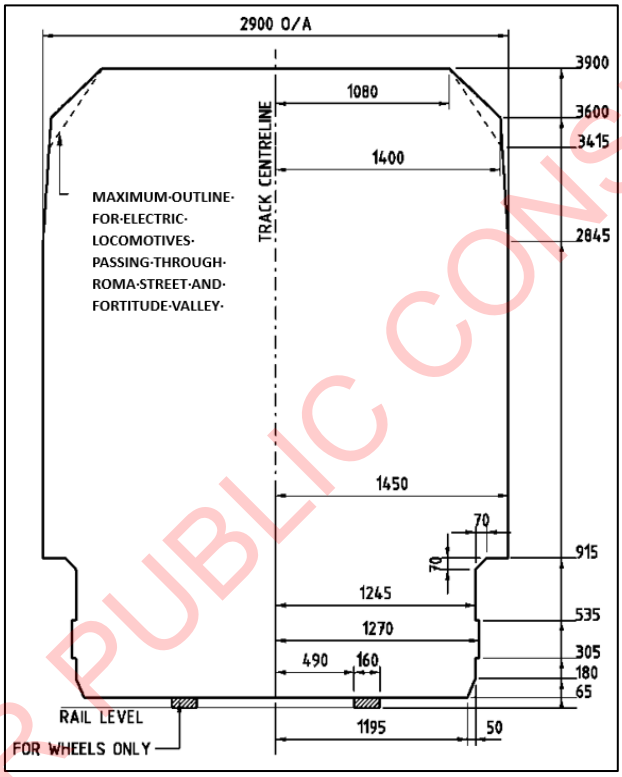
RISSB Reference Vehicle 17	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Non-Electric Rolling stock	43	1.2538	1,100	50/25	11

NOTE 1:
+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.
NOTE 2:
Bounce is 50 mm for civil infrastructure clearance and 25 mm for electrical infrastructure clearance.



Appendix Figure A.17-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 17.

A.18 RISSB Reference Vehicle 18



Appendix Figure A.18-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 18

Appendix Table A.18 Kinematic Outline Translations for RISSB Reference Vehicle 18

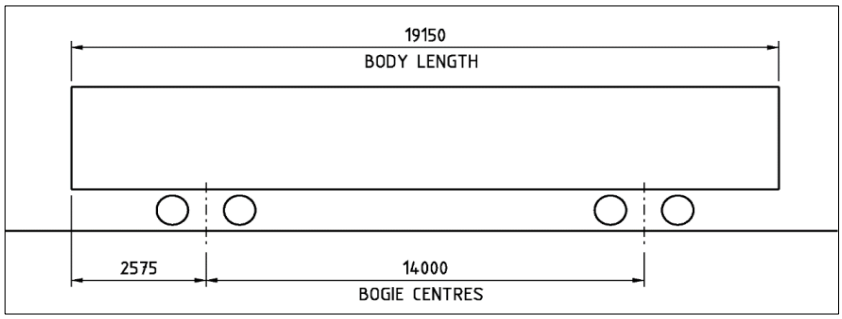
RISSB Reference Vehicle 18	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Electric Locomotive	43	1.2540	1,100	50/2541	11

Commentary *C.A.18-1*

+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

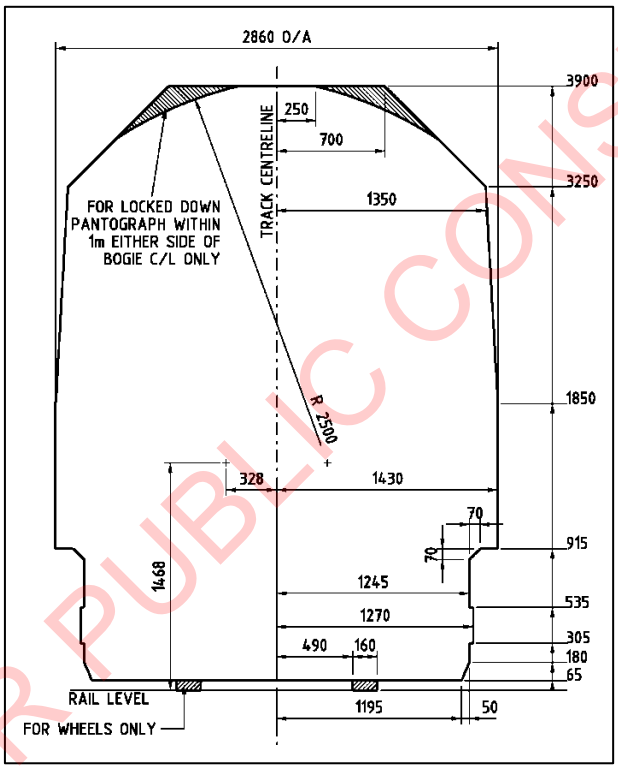
Commentary *C.A.18-2*

Bounce is 50mm for civil infrastructure clearance and 25mm for electrical infrastructure clearance.



Appendix Figure A.18-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 18

A.19 RISSB Reference Vehicle 19



Appendix Figure A.19-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 19

Appendix Table A.19 Kinematic Outline Translations for RISSB Reference Vehicle 19

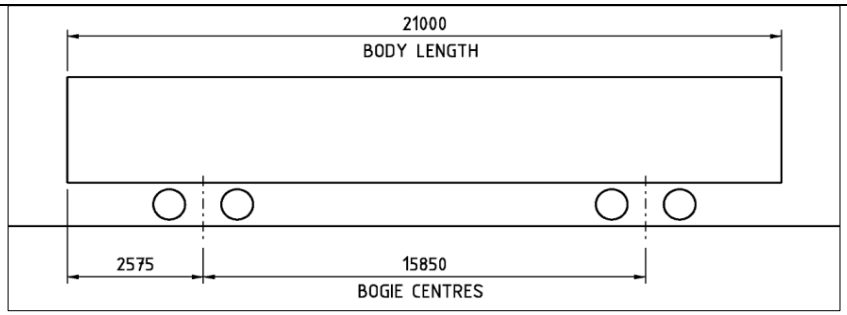
RISSB Reference Vehicle 19	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Electric Multiple Unit	43	1.25	1,100	50/25	11

Commentary *C.A.19-1*

+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

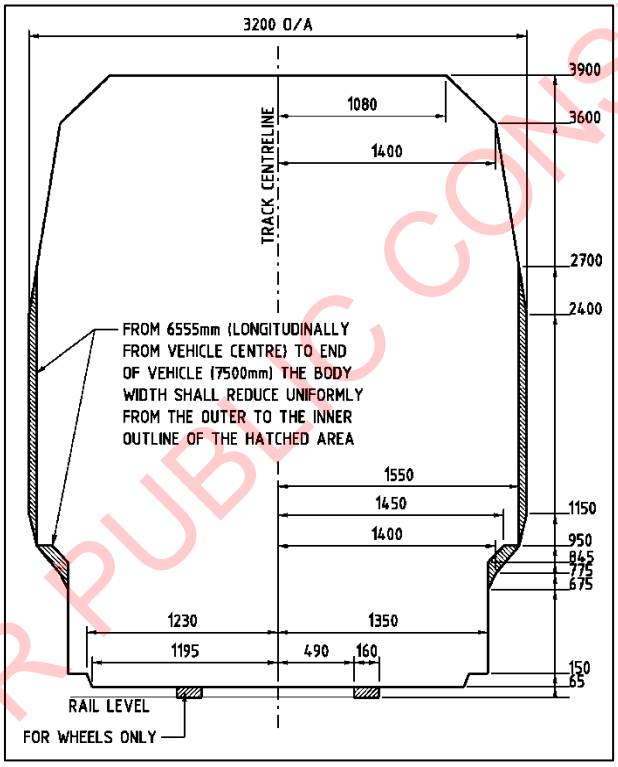
Commentary *C.A.19-2*

Bounce is 50 mm for civil infrastructure clearance and 25 mm for electrical infrastructure clearance



Appendix Figure A.19-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 19

A.20 RISSB Reference Vehicle 20



Appendix Figure A.20-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 20

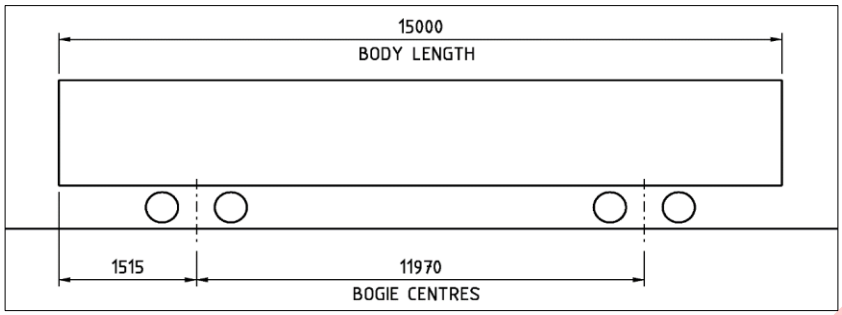
Appendix Table A.20 Kinematic Outline Translations for RISSB Reference Vehicle 20

RISSB Reference Vehicle 20	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Central Coal Network	40	2.044	610	50/25	11

Commentary *C.A.20-1* +/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

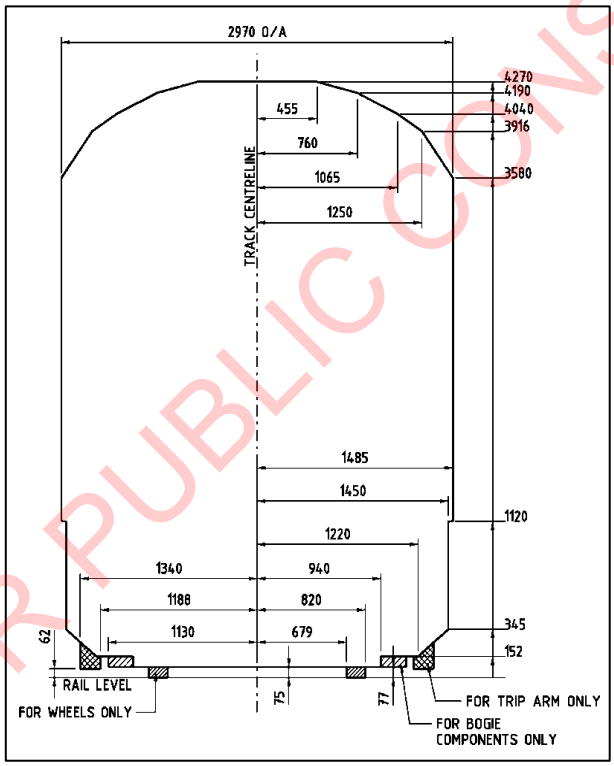
Commentary *C.A.20-2*

Bounce is 50 mm for civil infrastructure clearance and 25 mm for electrical infrastructure clearance.



Appendix Figure A.20-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 20

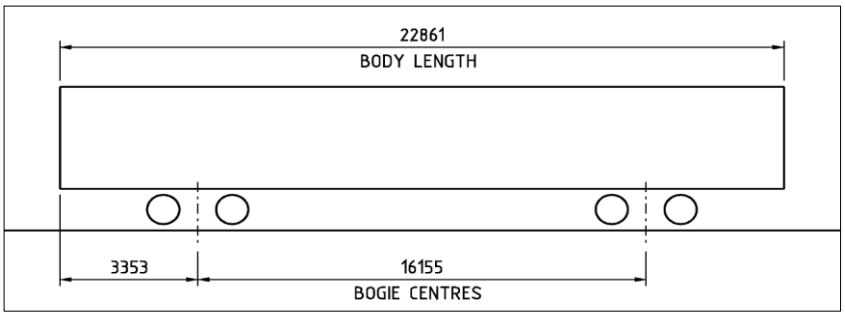
A.21 RISSB Reference Vehicle 21



Appendix Figure A.21-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 21

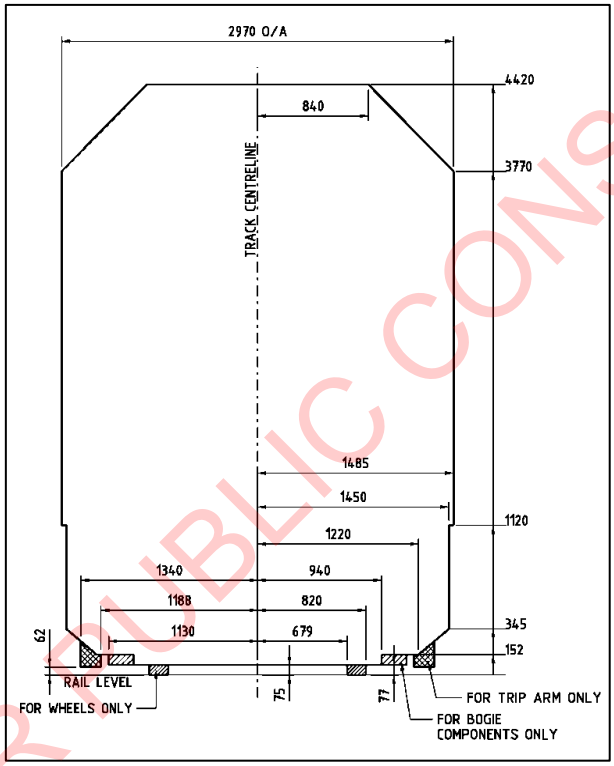
Appendix Table A.21 Kinematic Outline Translations for RISSB Reference Vehicle 21

RISSB Reference Vehicle 21	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Narrow Non-Electric	60	2.0	610	50	20.5



Appendix Figure A.21-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 21

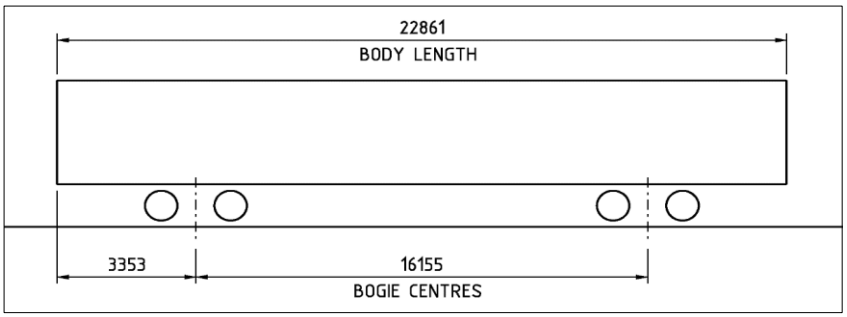
A.22 RISSB Reference Vehicle 22



Appendix Figure A.22-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 22

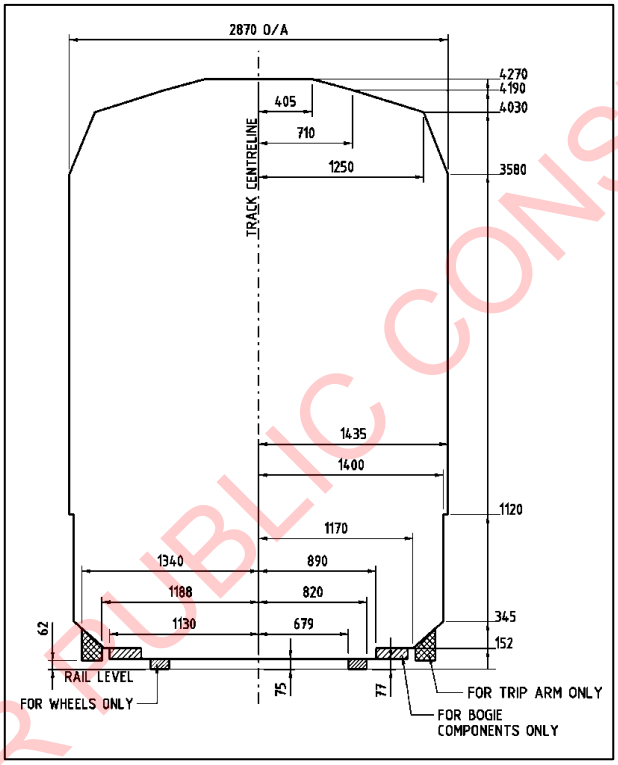
Appendix Table A.22 Kinematic Outline Translations for RISSB Reference Vehicle 22

RISSB Reference Vehicle 22	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Narrow Electric	60	2.0	610	50	20.5



Appendix Figure A.22-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 22

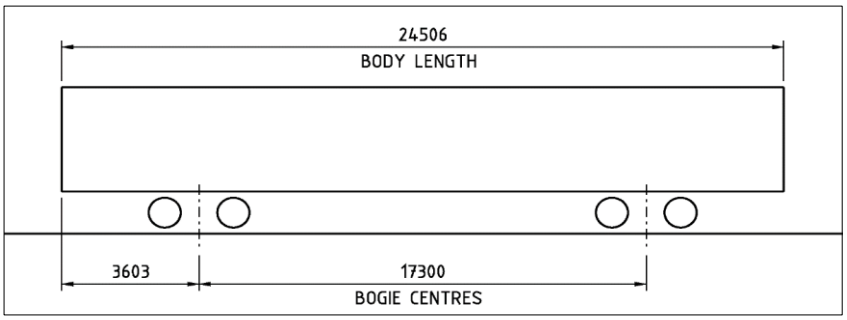
A.23 RISSB Reference Vehicle 23



Appendix Figure A.23-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 23

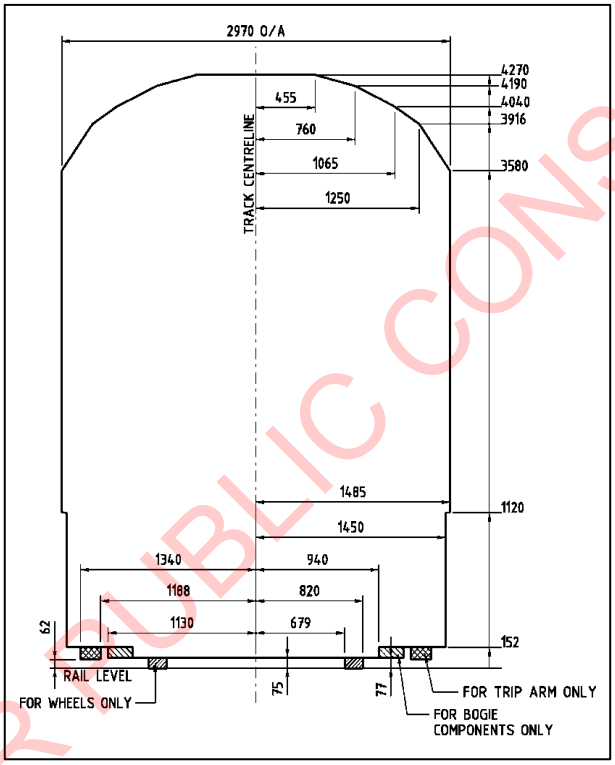
Appendix Table A.23 Kinematic outline translations for RISSB Reference Vehicle 23

RISSB Reference Vehicle 23	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Narrow Container	60	2.0	610	50	20.5



Appendix Figure A.23-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 23

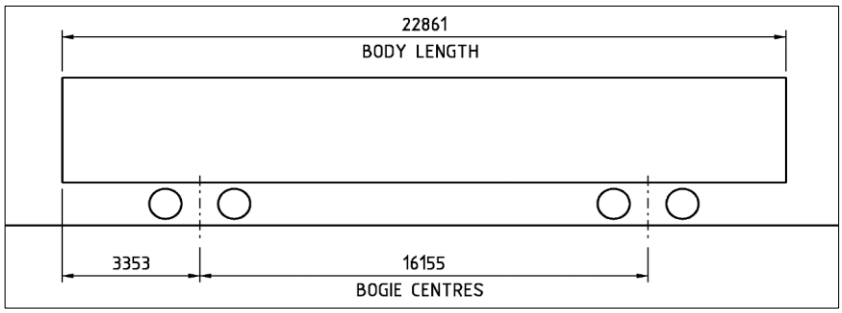
A.24 RISSB Reference Vehicle 24



Appendix Figure A.24-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 24

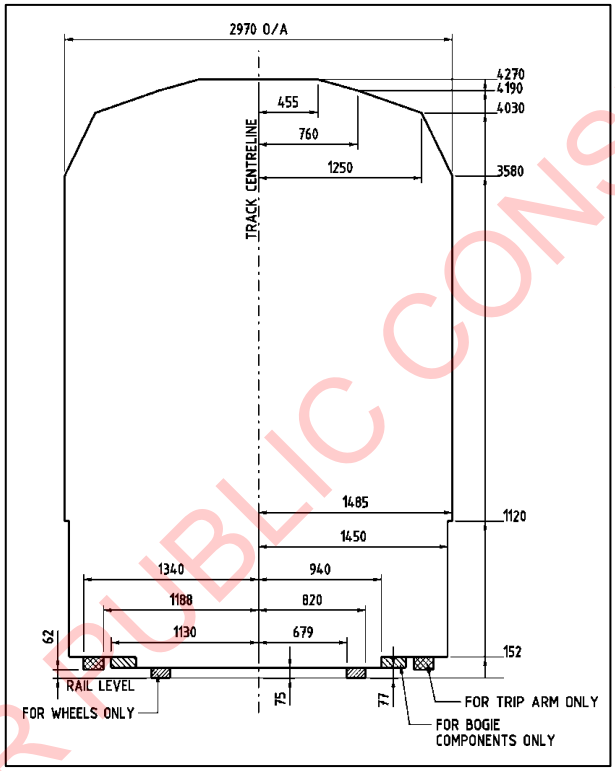
Appendix Table A.24 Kinematic Outline Translations for RISSB Reference Vehicle 24

RISSB Reference Vehicle 24	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Narrow Square	60	2.0	610	50	20.5



Appendix Figure A.24-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 24

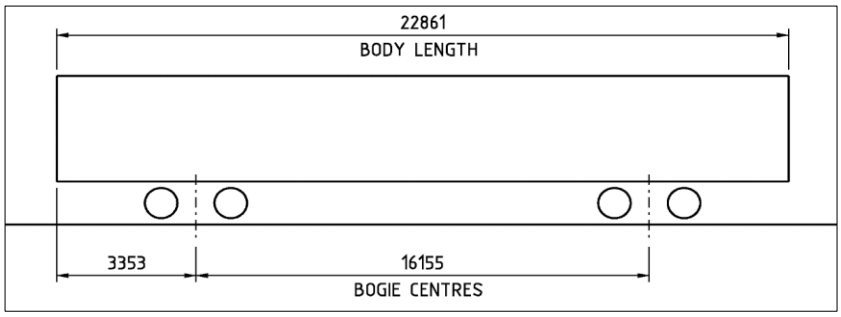
A.25 RISSB Reference Vehicle 25



Appendix Figure A.25-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 25

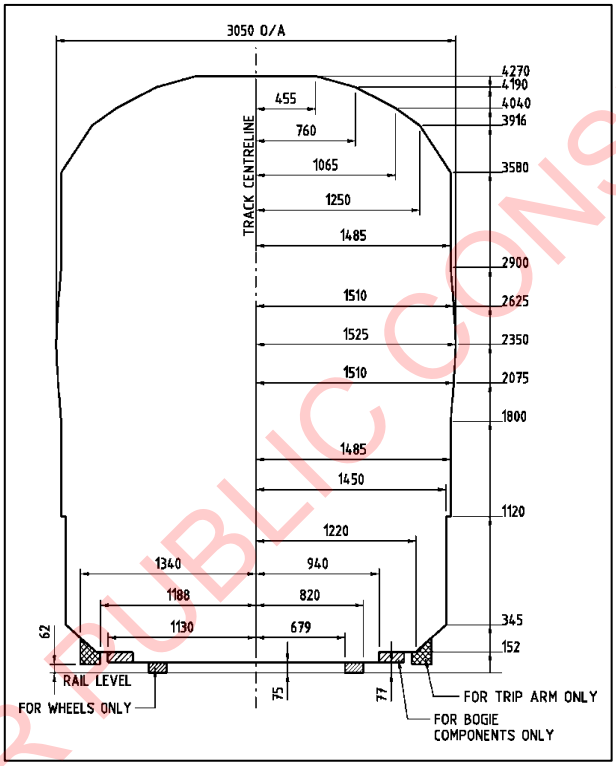
Appendix Table A.25 Kinematic outline translations for RISSB Reference Vehicle 25

RISSB Reference Vehicle 25	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Intersystem	60	2.0	610	50	20.5



Appendix Figure A.25-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 25

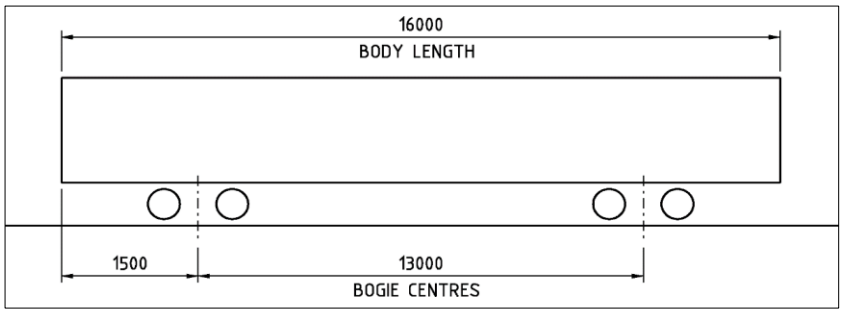
A.26 RISSB Reference Vehicle 26



Appendix Figure A.26-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 26

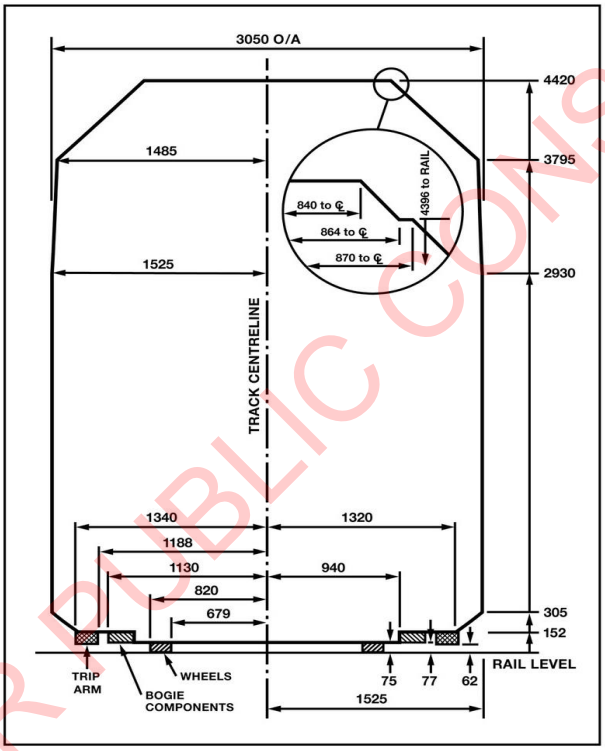
Appendix Table A.26 Kinematic Outline Translations for RISSB Reference Vehicle 26

RISSB Reference Vehicle 26	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Narrow Hopper	60	2.0	610	50	20.5



Appendix Figure A.26-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 26

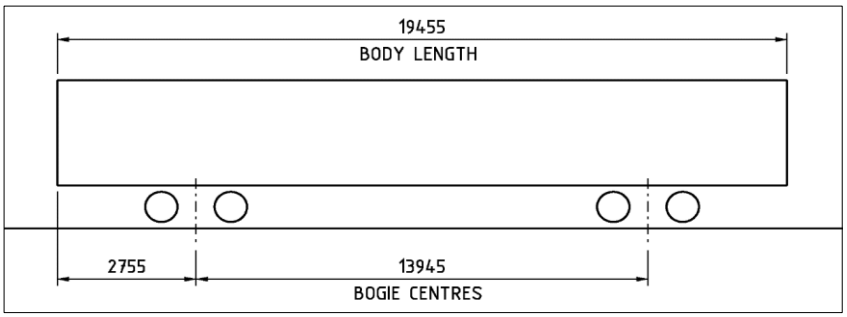
A.27 RISSB Reference Vehicle 27



Appendix Figure A.27-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 27

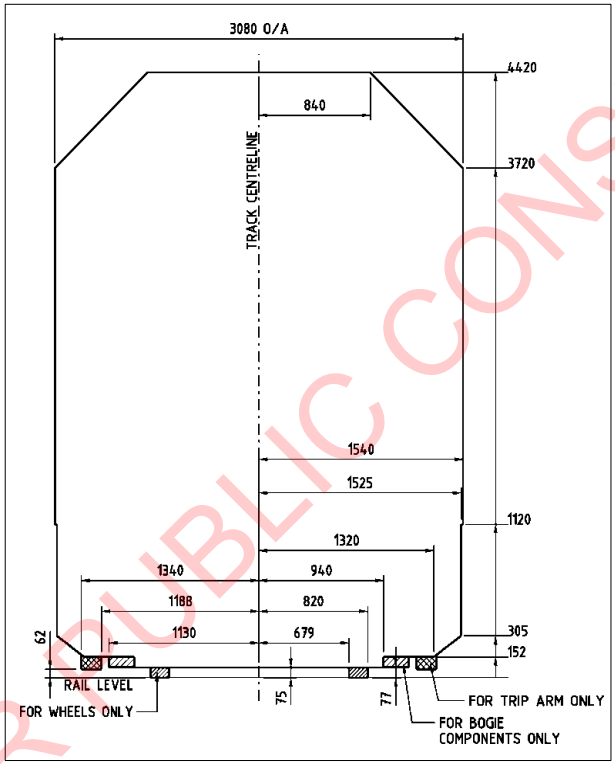
Appendix Table A.27 Swept Outline Vehicle Dimensions for RISSB Reference Vehicle 27

RISSB Reference Vehicle 27	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Medium Electric	60	2.0	610	50	20.5



Appendix Figure A.27-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 27

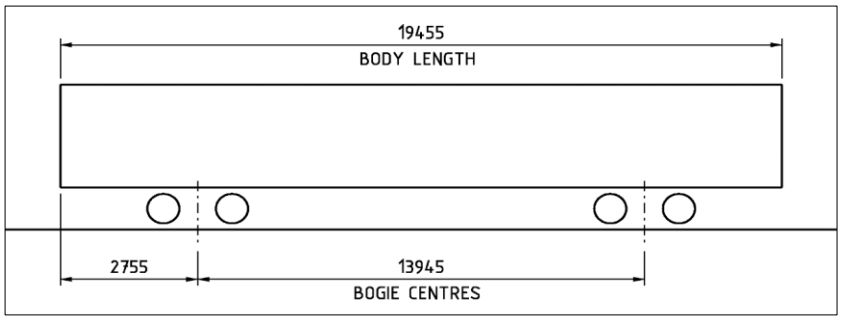
A.28 RISSB Reference Vehicle 28



Appendix Figure A.28-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 28

Appendix Table A.28 Kinematic Outline Translations for RISSB Reference Vehicle 28

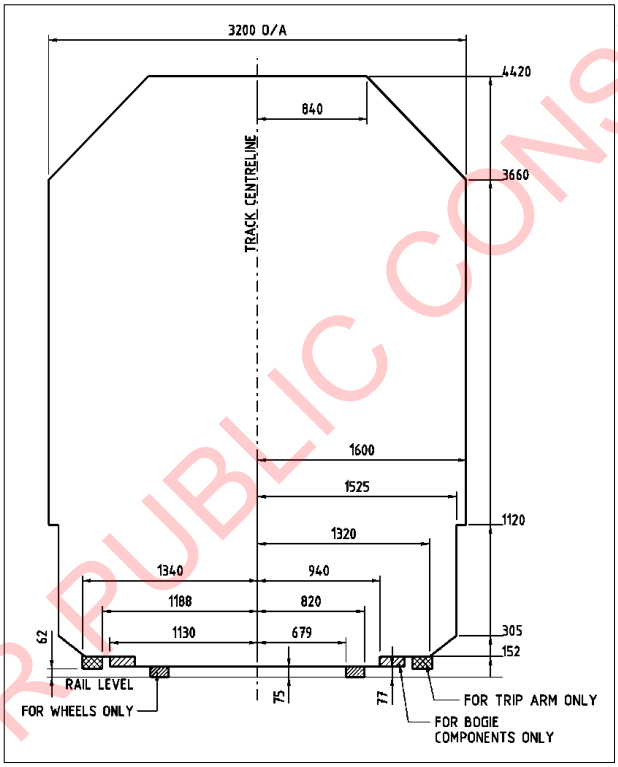
RISSB Reference Vehicle 28	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Extended Medium	60	2.0	610	50	20.5



Appendix Figure A.28-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 28

NOTE: Reference vehicle 28, NSW Extended Medium is only for existing legacy/historic vehicles.

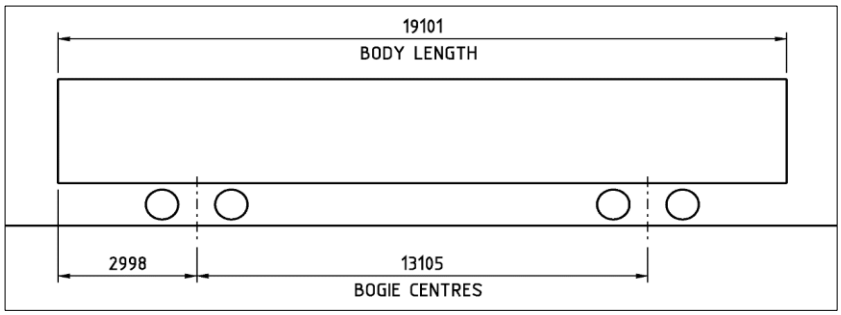
A.29 RISSB Reference Vehicle 29



Appendix Figure A.29-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 29

Appendix Table A.29 Kinematic Outline Translations for RISSB Reference Vehicle 29

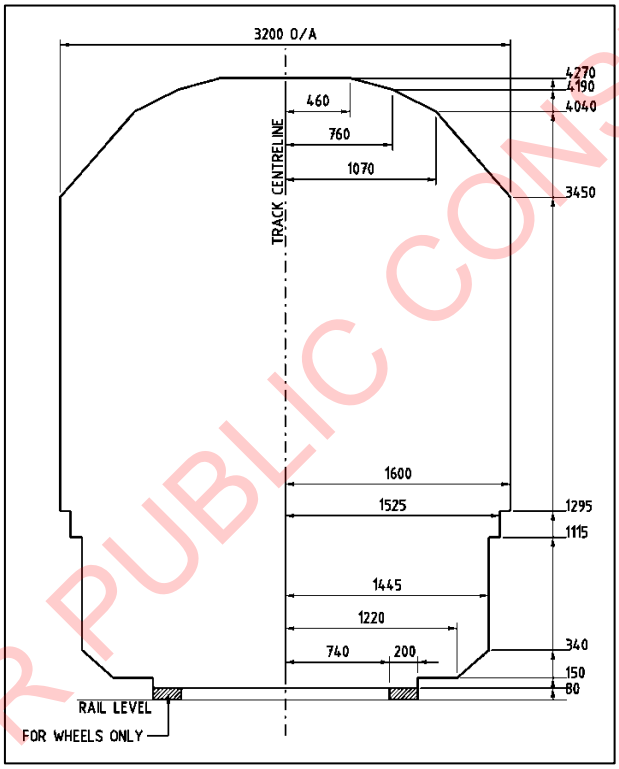
RISSB Reference Vehicle 29	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Wide Electric	60	2.0	610	50	20.5



Appendix Figure A.29-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 29

Note: Reference vehicle 29, NSW Extended Medium is only for existing legacy/historic vehicles.

A.30 RISSB Reference Vehicle 30



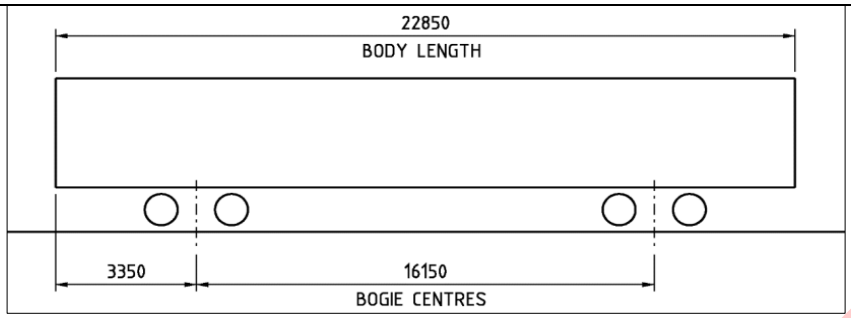
Appendix Figure A.30-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 30

Appendix Table A.30 Kinematic Outline Translations for RISSB Reference Vehicle 30

RISSB Reference Vehicle 30	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Adelaide Broad Gauge Passenger Car	40	2.0 or 2.5	610 or 440	50	20

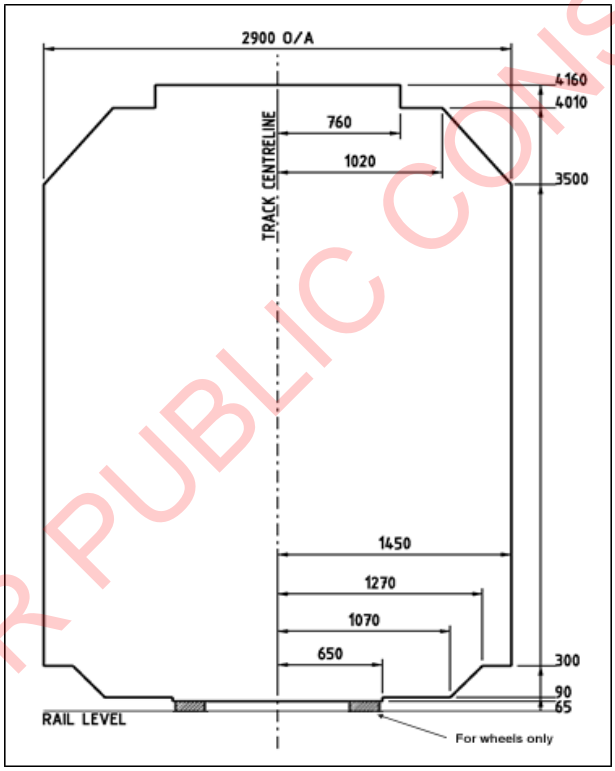
Commentary *C.A.30*

Roll of 2.0° is applied to the body about a roll centre 610 mm above rail level and roll of 2.5° is applied to the body about a roll centre 440 mm above rail level. For each point around the resulting profile, the worst of each case is taken to produce the kinematic outline.



Appendix Figure A.30-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 30.

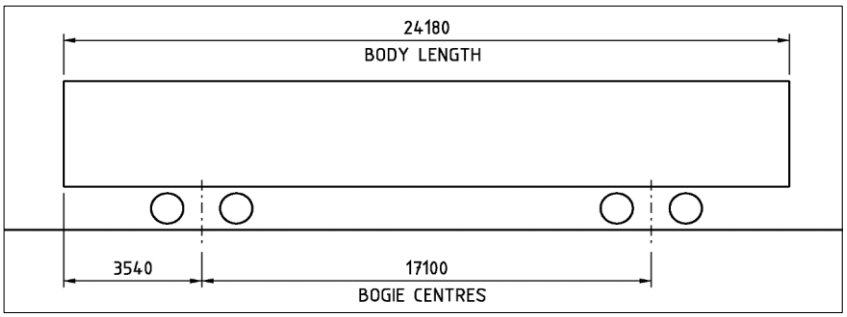
A.31 RISSB Reference Vehicle 31



Appendix Figure A.31-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 31

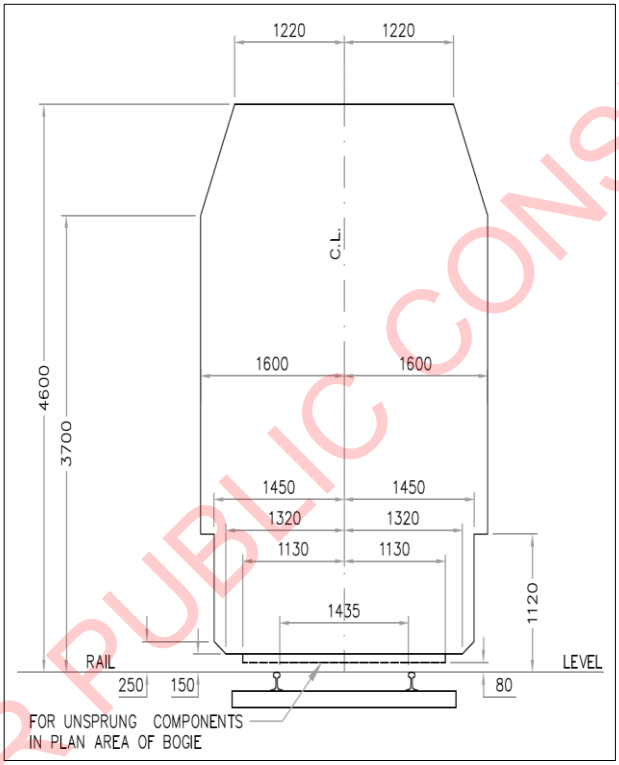
Appendix Table A.31 Kinematic outline translations for RISSB Reference Vehicle 31

RISSB Reference Vehicle 31	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
WA Narrow Gauge Passenger	40	2.5	440	50	20



Appendix Figure A.31-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 31

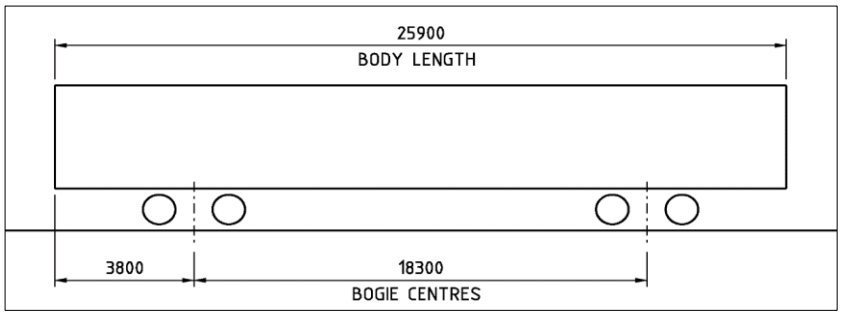
A.32 RISSB Reference Vehicle 32



Appendix Figure A.32-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 32

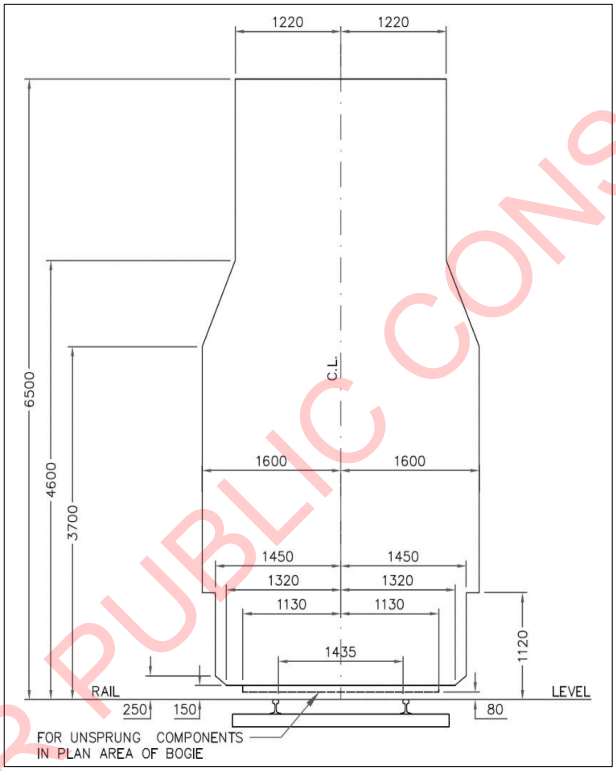
Appendix Table A.32 Kinematic outline translations for RISSB Reference Vehicle 32

RISSB Reference Vehicle 33	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Brookfield Rail WA Standard Gauge General	40	2.0	610	50	20



Appendix Figure A.32-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 32

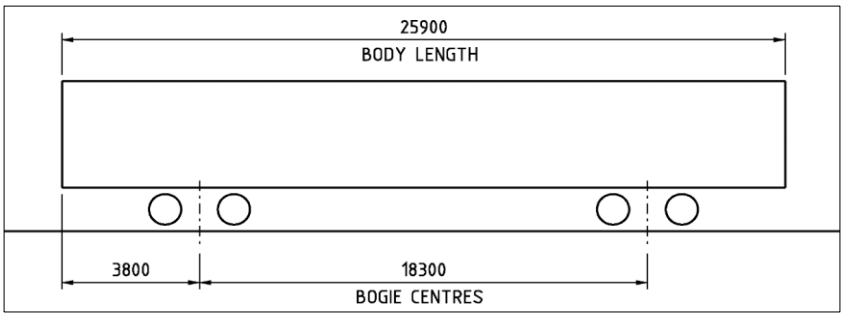
A.33 RISSB Reference Vehicle 33



Appendix Figure A.33-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 33

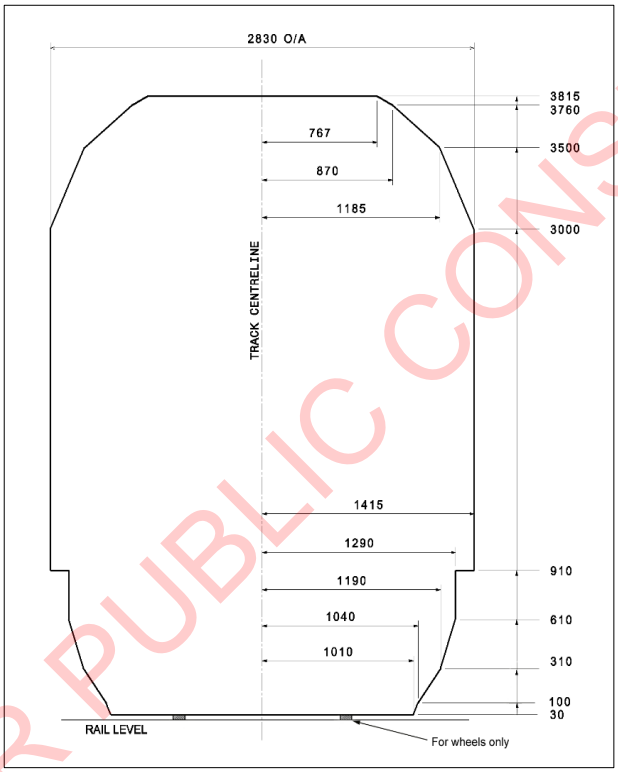
Appendix Table A.33 Kinematic Outline Translations for RISSB Reference Vehicle 33

RISSB Reference Vehicle 34	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Brookfield Rail WA Standard Gauge Double Stack Container	40	2.5	440	50	20



Appendix Figure A.33-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 33

A.34 RISSB Reference Vehicle 34



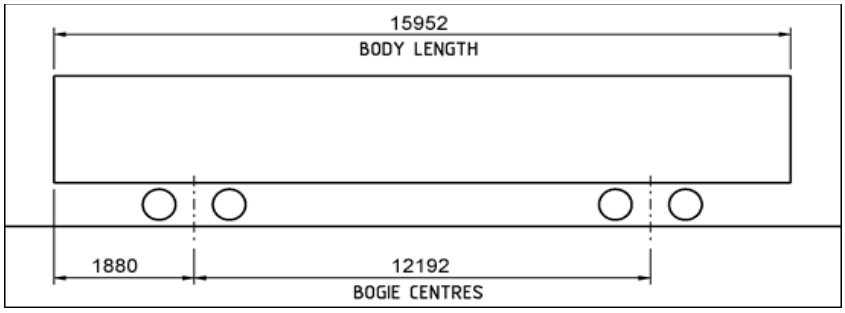
Appendix Figure A.34-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 34

NOTE:
This is a universal outline, larger outlines exist for specific routes

Appendix Table A.34 Kinematic Outline Translations for RISSB Reference Vehicle 34

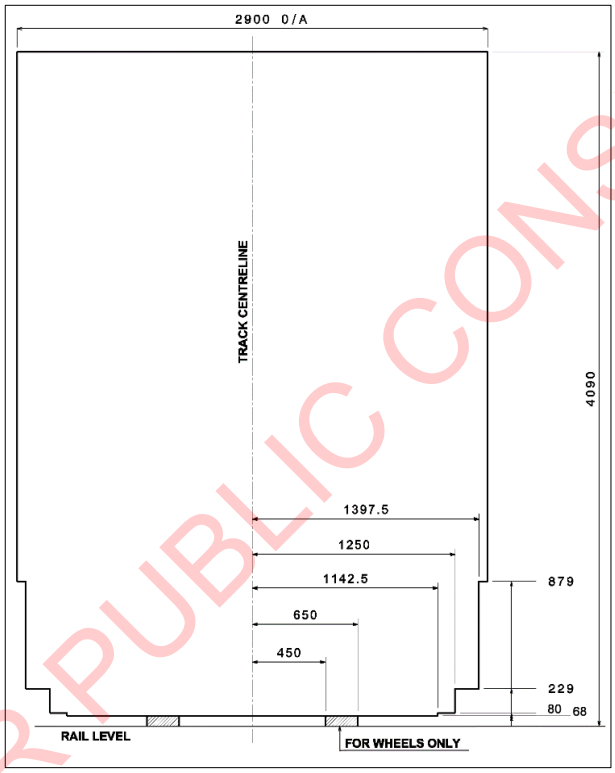
RISSB Reference Vehicle 35	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
KiwiRail	Kinematic gauge is used on a case-by-case basis				

NOTE:
KiwiRail do not currently have a universal kinematic outline.



Appendix Figure A.34-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 34

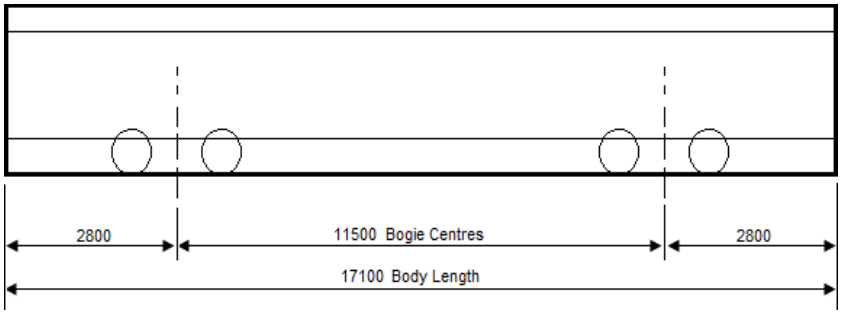
A.35 RISSB Reference Vehicle 35



Appendix Figure A.35-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 35

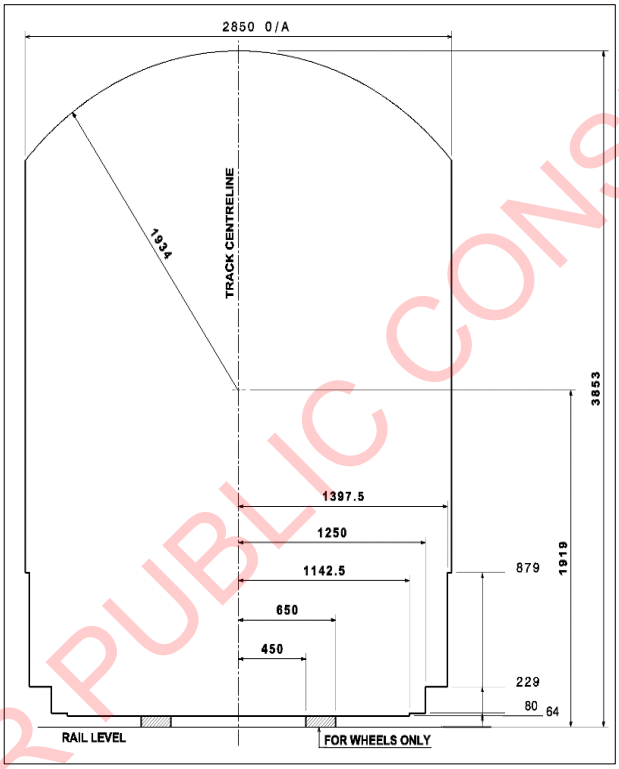
Appendix Table A.35 Kinematic Outline Translations for RISSB Reference Vehicle 35

RISSB Reference Vehicle 36	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
TasRail – All lines except Melba	50	2	610	50	68



Appendix Figure A.35-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 35

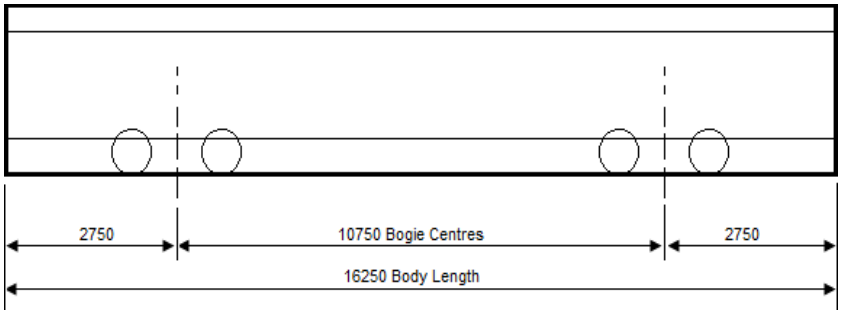
A.36 RISSB Reference Vehicle 36



Appendix Figure A.36-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 36

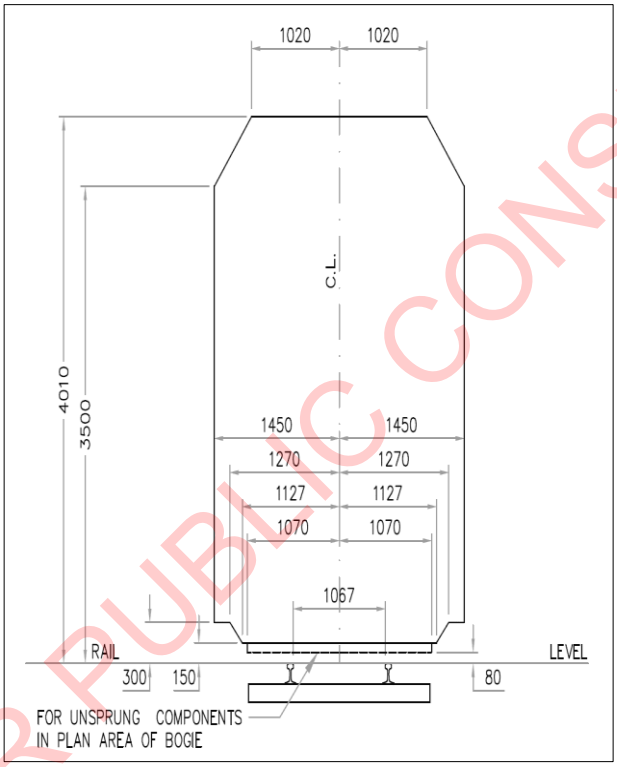
Appendix Table A.36 Kinematic Outline Translations for RISSB Reference Vehicle 36

RISSB Reference Vehicle 36	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
TasRail – Melba Line	50	2	610	50	64



Appendix Figure A.36-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 36

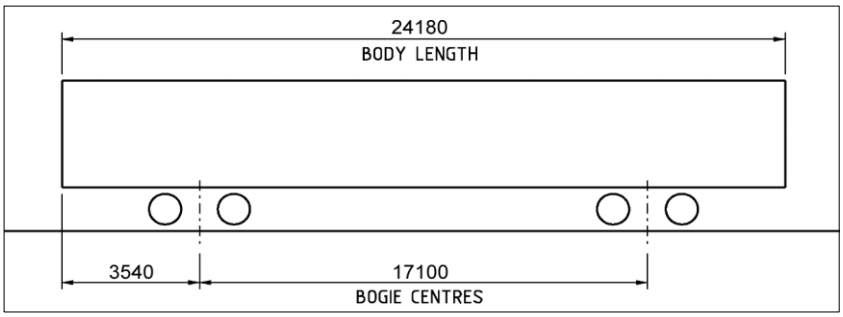
A.37 RISSB Reference Vehicle 37



Appendix Figure A.37-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 37

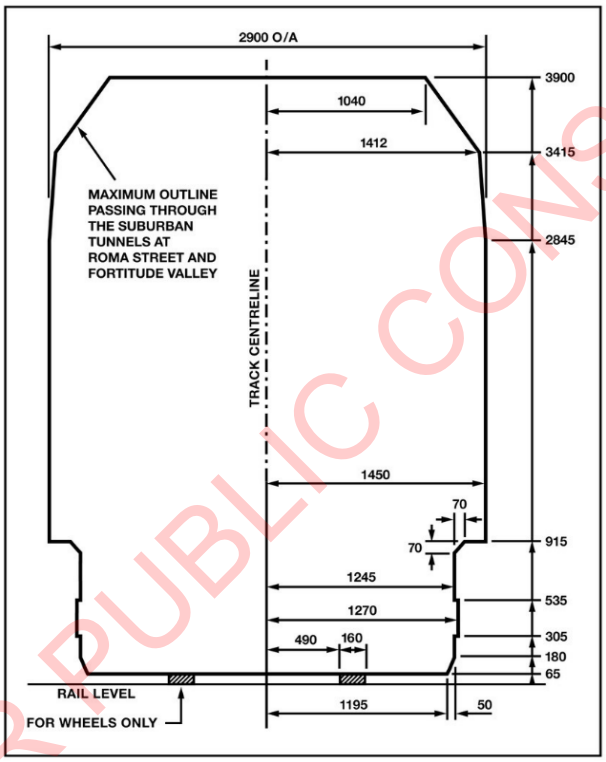
Appendix Table A.37 Static Rolling Stock Outline Dimensions for RISSB Reference Vehicle 37

RISSB Reference Vehicle 34	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Brookfield Rail WA Narrow Gauge	40	2.0	610	50	20



Appendix Figure A.37-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 37

A.38 RISSB Reference Vehicle 38



Appendix Figure A.38-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 38

Appendix Table A.38 Kinematic Outline Translations for RISSB Reference Vehicle 38

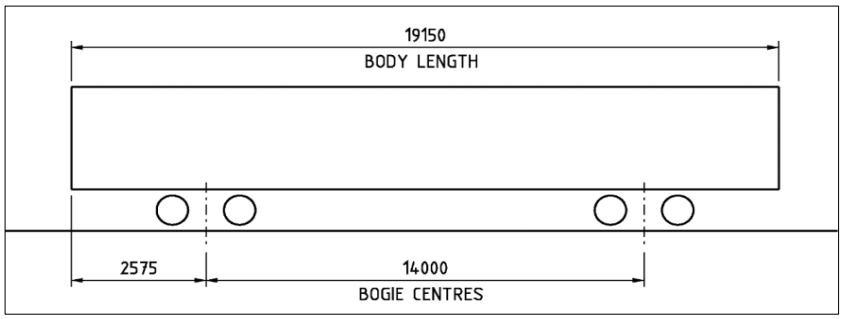
RISSB Reference Vehicle 18	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Electric Locomotive	43	1.2540	1,100	50/2541	11

Commentary *C.A.38-1*

+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

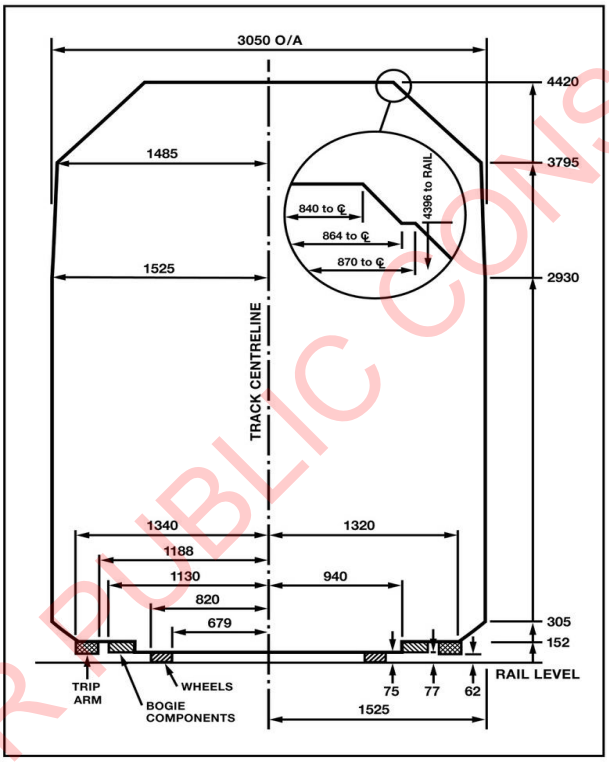
Commentary *C.A.38-2*

Bounce is 50 mm for civil infrastructure clearance and 25 mm for electrical infrastructure clearance.



Appendix Figure A.38-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 38

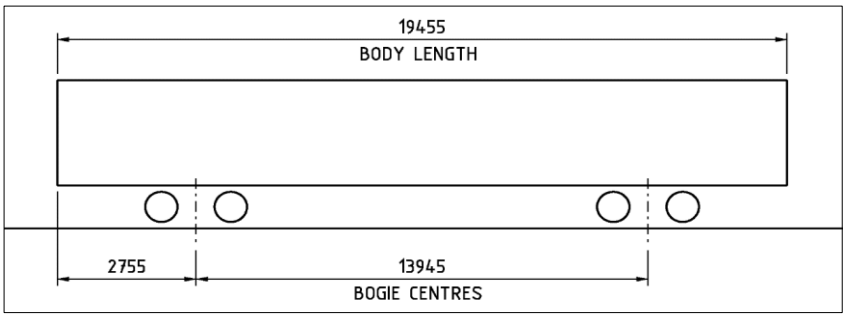
A.39 RISSB Reference Vehicle 39



Appendix Figure A.39-1 Static rolling stock outline dimensions for RISSB Reference Vehicle 39

Appendix Table A.39 Swept Outline Vehicle Dimensions for RISSB Reference Vehicle 39

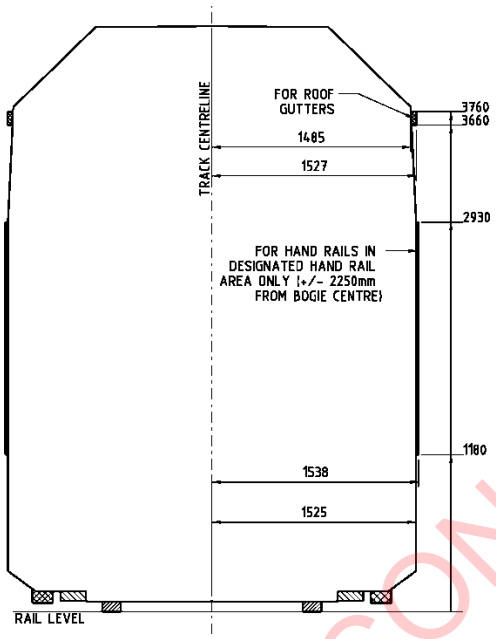
RISSB Reference Vehicle 38	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Sub-Medium Electric	50	1.3	610	40	20.5



Appendix Figure A.39-2 Swept outline vehicle dimensions for RISSB Reference Vehicle 39

Appendix B Specific Items (Informative)

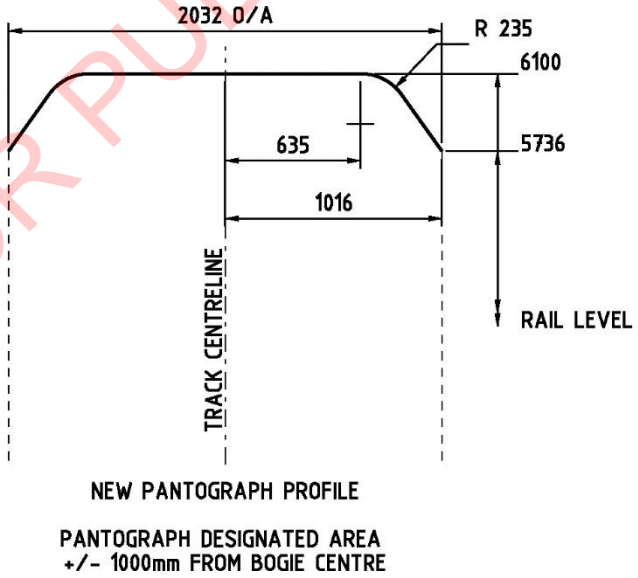
B.1 Expendable items



Appendix Figure B.1-1 Expendable items for RISSB Reference Vehicle 28

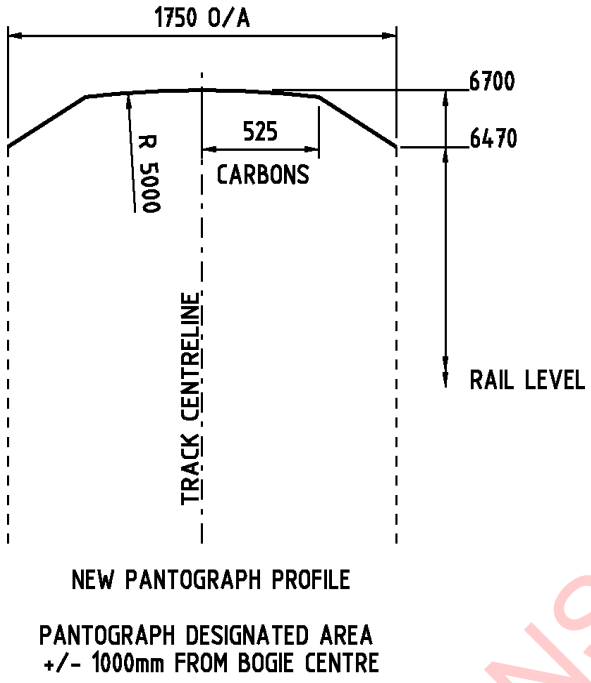
Commentary *C.B.1*
The 1,538 mm dimension line refers to maximum width handrail area from vehicle centreline.

B.2 Pantographs



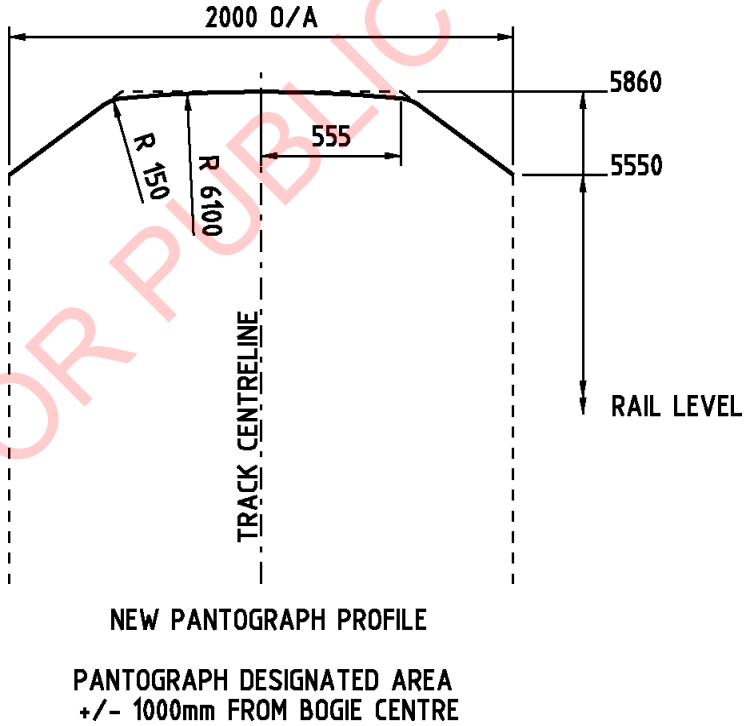
Appendix Figure B.1-2 RISSB pantograph outline 1

Commentary *C.B.2-1*
New pantograph profile.



Appendix Figure B.2-2 RISSB pantograph outline 2

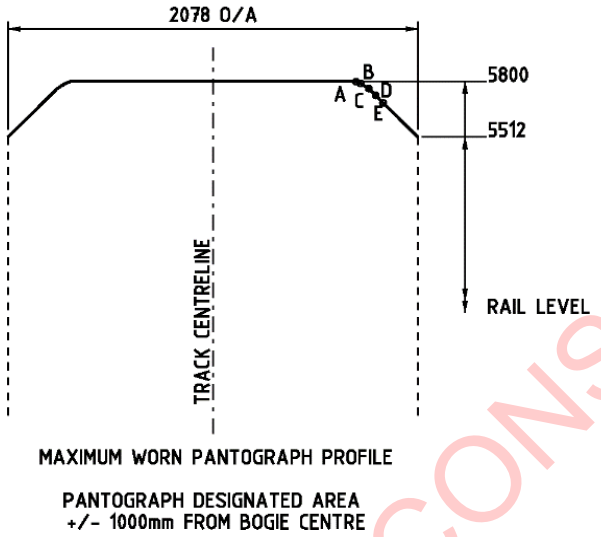
Commentary *C.B.2-2*
This is a new pantograph profile.



Appendix Figure B.2-3 RISSB pantograph outline 3

Commentary *C.B.2-3*
This is a new pantograph profile.

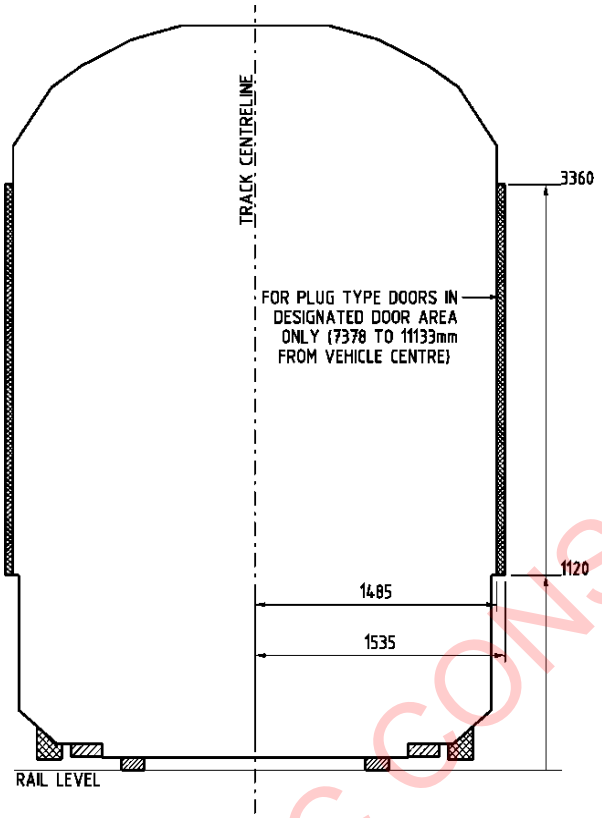
PAN CO-ORDINATES		
	LATERAL	VERTICAL
A	724	5,800
B	747	5,791
C	789	5,764
D	824	5,729
E	861	5,690



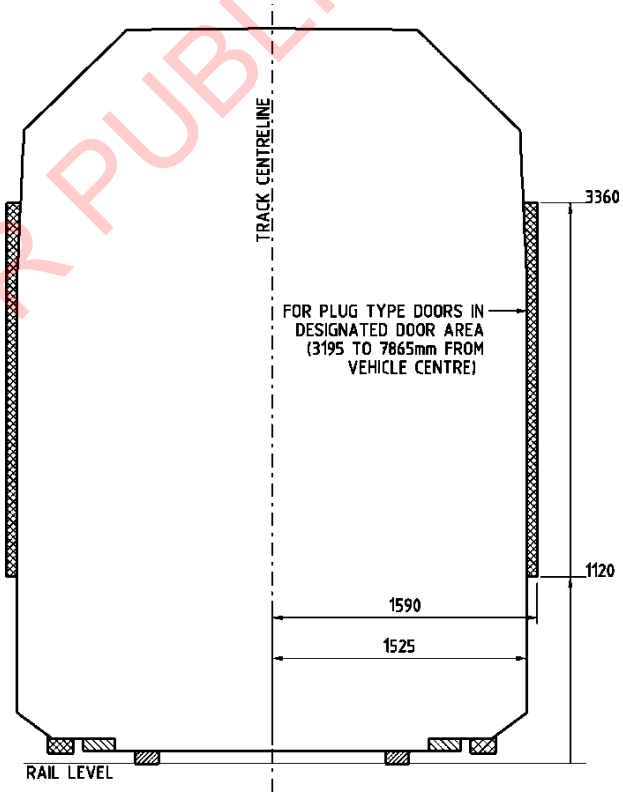
Appendix Figure B.2-4 RISSB pantograph outline 4

Commentary *C.B.2-4*
Maximum worn pantograph profile.

B.3 Doors



Appendix Figure B.3-1 Out of gauge outline for failed plug doors on RISSB Reference Vehicle 21.



Appendix Figure B.3-2 Out of gauge outline for failed plug doors on RISSB Reference Vehicle 27

Appendix C Static Kinematic Test (Normative)

C.1 Static Kinematic Test

A static kinematic outline test is required to determine the roll and lateral displacements of a vehicle standing on a simulated maximum cant track. Table 1 Maximum test cant per gauge for the amount of cant to be tested.

The intent of this test is to ensure that the vehicle is able to operate up to its design speed including cant deficiency, without becoming foul of the kinematic rolling stock outline.

C.2 Equipment and setup

The following equipment and test site requirements apply:

A straight level test site, preferably with rails embedded in concrete. The top of the rail should be level within ± 3 mm over the length of the vehicle.

Suitable jacking equipment to lift the wheels of the test vehicle.

Suitable steel and/or aluminium packers to be inserted beneath wheels of the test vehicle to simulate the specified track superelevation.

Stringline and plumb bob. Tape measure and steel rule.

C.3 Static kinematic outline test

C.3.1 Test vehicle configuration

The test vehicle should be setup in a condition to maximize the vehicle's centre of gravity (e.g., on locomotives fuel tanks should be near empty). Friction wedges and other damping devices should be engaged and operational.

All brakes should be fully released, to allow the suspension system to operate freely, and chocks applied to the vehicle to prevent it moving.

C.3.2 Test procedure

The test procedure for the static kinematic test is as follows:

(a) Check that the test vehicle is in the condition that gives maximum centre of gravity from rail level.

(b) Put a red flag on the front and rear of the test vehicle and place a chock/ wedge at each side of one rail wheel on the opposite side of the vehicle to the side being jacked.

(c) Using a stringline and plumb bob, set up a vertical datum point on the vehicle. Measure and record the length of the stringline and the lateral offset (if any).

(d) Lift and pack all wheels on one side of the vehicle incrementally to applicable maximum cant, at increments not exceeding 50 mm.

(e) Before each increment in packing measure and record the stringline lateral displacement w.r.t the vertical datum point.

(f) Before each increment in packing, measure the record the lateral bump stop clearance across the lateral bump stop brackets for each side.

(g) It is recommended that bogie roll is measured and/or primary and secondary spring vertical displacements during the test. This is useful for any subsequent

analysis to understand why a vehicle may have failed the test, and also to validate test results from a simulation model.

(h) Lower the vehicle gently in increments back to the level condition.

(i) Repeat steps c) to g) on the other side of the vehicle.

(j) The vehicle should be lifted on the first side again for a few increments until the hysteresis curve is closed.

Commentary *C.C.3.2-1*

Item C: Surveys or laser measurements might be considered as acceptable alternates, with prior approval of the RIM.

Commentary *C.C.3.2-2*

Item D: The vehicle could slide laterally against flange during lifting. Ensure all rams and packing are securely placed/aligned. Stop and realign packing where necessary.

Calculate and total body roll and effective lateral displacement for every packing increment using the following equations:

Equation C.3.2-A

$$A_C = arctan\left(\frac{P_a}{S_w}\right)$$

Equation C.3.2-B

$$A_{RT} = arcsin\left(\frac{LDv}{Ls}\right)$$

Equation C.2.2-C

$$BR_T = AR_T - A_C$$

Equation C.2.2-D

$$LD = \frac{ABR - ABL}{2}$$

Equation C.2.2-E

$$D_a = \left(\frac{D_{a\,left} - D_{a\,right}}{2}\right)$$

Equation C.2.2-F

$$LD_{E\,Left} = LD + D_a$$

Equation C.2.2-G

$$LD_{E\,Right} = -(LD + D_a)$$

Where:

ARCR = Cant Angle.

ARRTR = Total roll angle including track cant.

ABRLR = Average bump stop clearance LHS (mm).

ABRRR = Average bump stop clearance RHS (mm).

BRRTR = Total body roll.

DRaR = axle box/side frame displacement (mm).

LD = Lateral displacement (mm).

LDRER = Effective lateral displacement (mm).

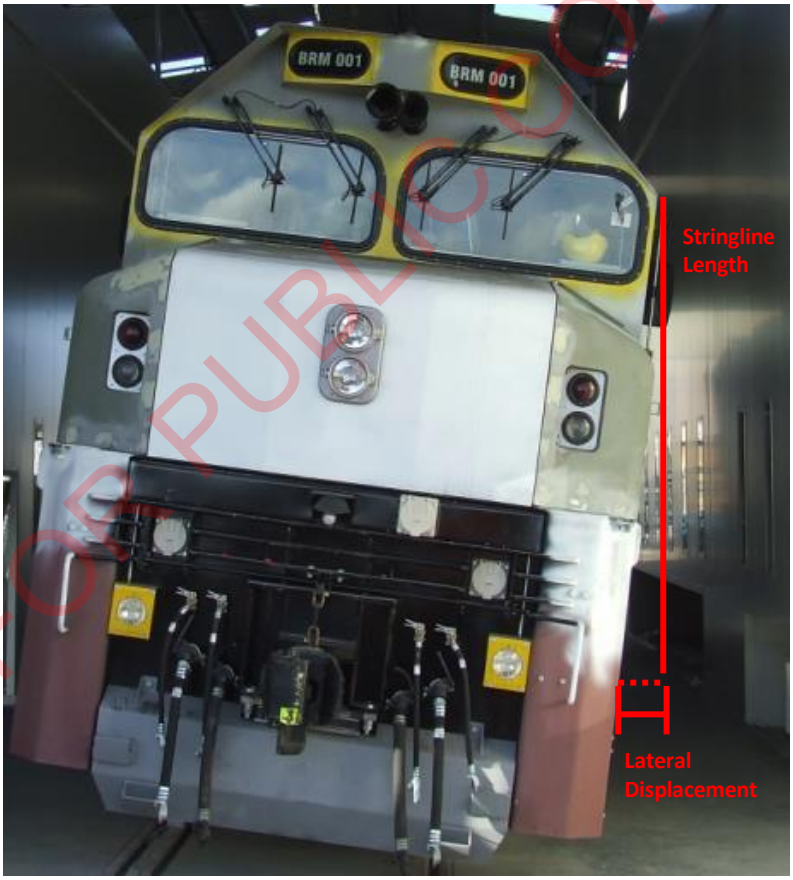
LDRVR = Lateral displacement (with respect to vertical datum) (mm).

LRSR = Length of stringline (mm).

Pa = Applied packing (mm).

SRWR = Lateral wheel spacing (distance between rail contact patches) (mm).

Appendix Figure C-1 Static kinematic test setup (wheels packed to maximum test cant)



Appendix Figure C-2 Interpretation of body roll

C.4 Test results (Example for standard gauge using plumb bob)

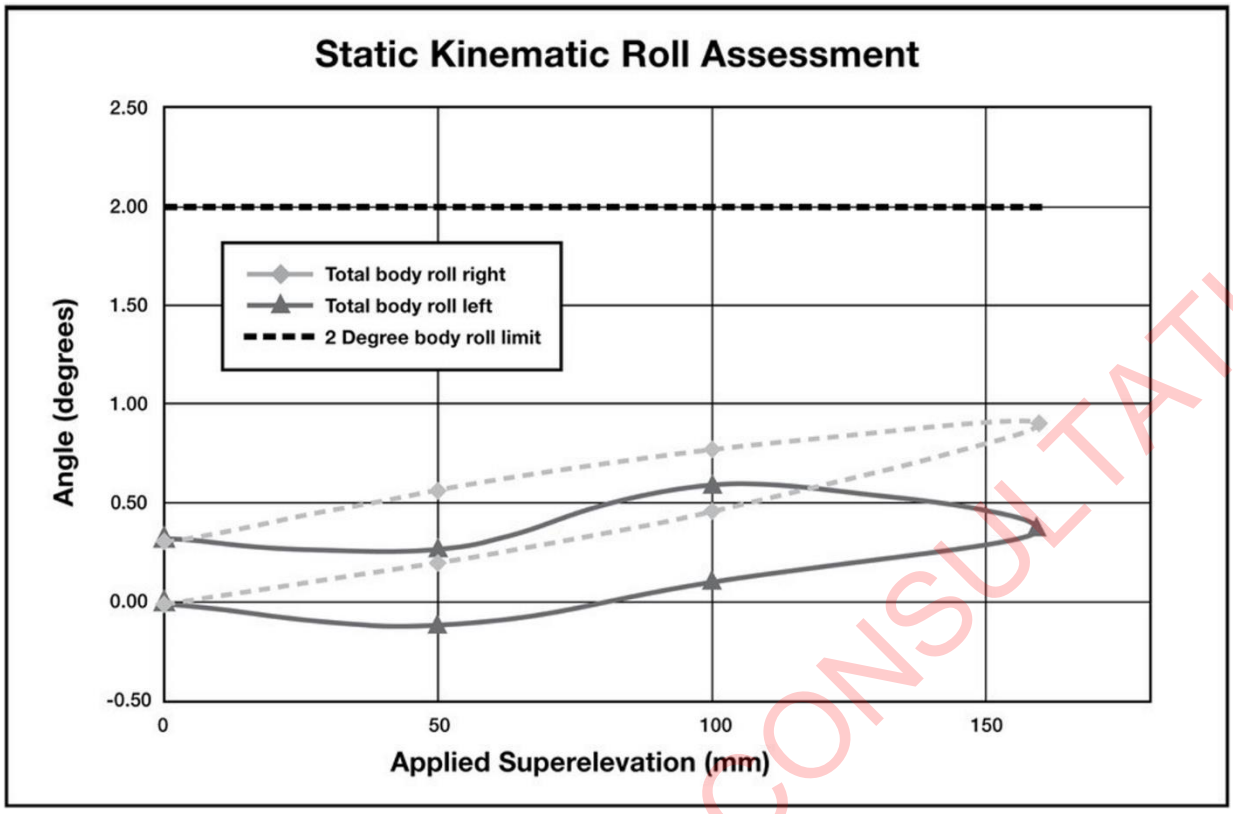
C.4.1 Roll assessment

Appendix Table C-1 Roll (right) Measurements

Applied superelevation (mm)	Superelevation angle (deg)	Lateral displacement w.r.t. datum (mm)	Total measured roll angle including super (deg)	Total body roll (deg)
0	0	0	0	0
50	1.91	33	1.8	-0.11
100	3.82	72	3.93	0.11
160	6.12	119	6.51	0.38
100	3.82	81	4.42	0.6
50	1.91	40	2.18	0.27
0	0	6	0.33	0.33

Appendix Table C-2 Roll (left) Measurements

Applied superelevation (mm)	Superelevation angle (deg)	Lateral displacement w.r.t. datum (mm)	Total measured roll angle including super (deg)	Total body roll (deg)
0	0	0	0	0
50	1.91	41	2.12	0.21
100	3.82	83	4.29	0.47
160	6.12	136	7.04	0.91
100	3.82	89	4.6	0.78
50	1.91	48	2.48	0.57
0	0	6	0.31	0.31



Appendix Figure C-3 Plot of body roll vs applied superelevation

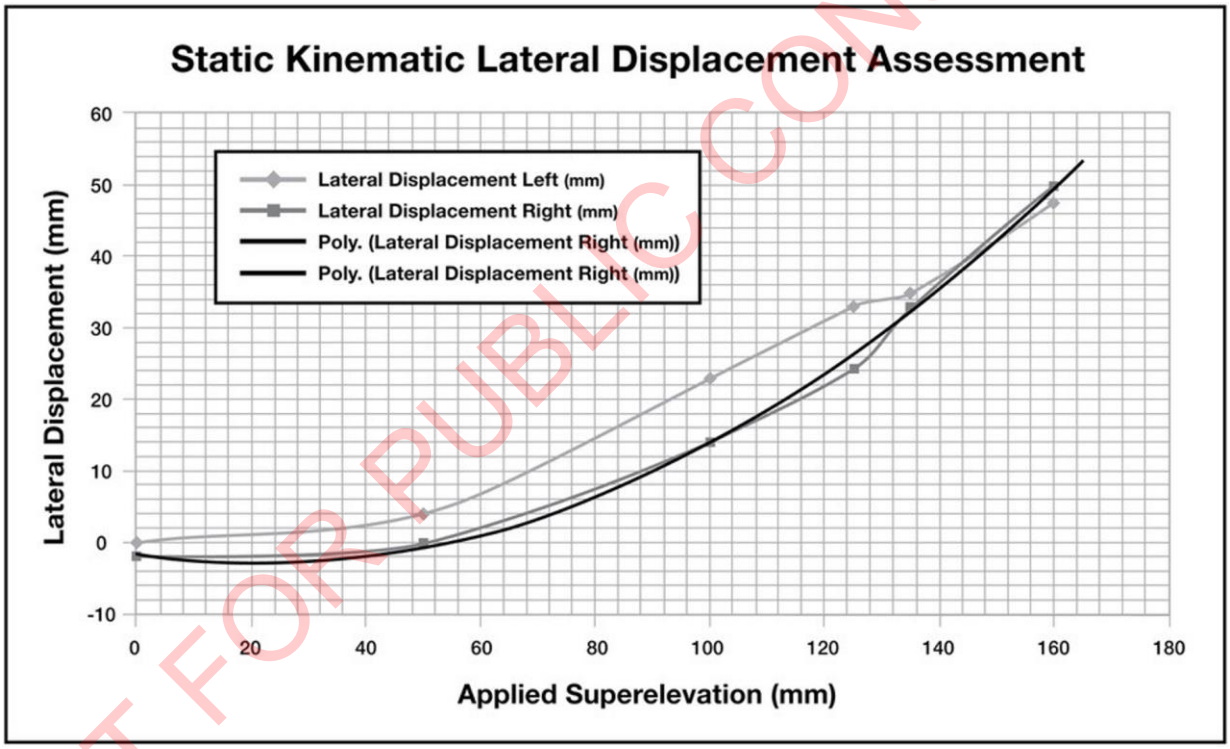
C.4.2 Lateral displacement assessment

Appendix Table C-3 Lateral Displacement (right) Measurements

Applied superelevation (mm)	Average bump stop clearance (mm)	Axle box/side frame clearance (mm)	Effective lateral displacement (mm)
0	Right = 35	6	0
	Left = 35	6	
50	Right = 33	6	3
	Left = 39	6	
100	Right = 13	10	22.5
	Left = 48	0	
160	Right = 1	12	50
	Left = 89	0	

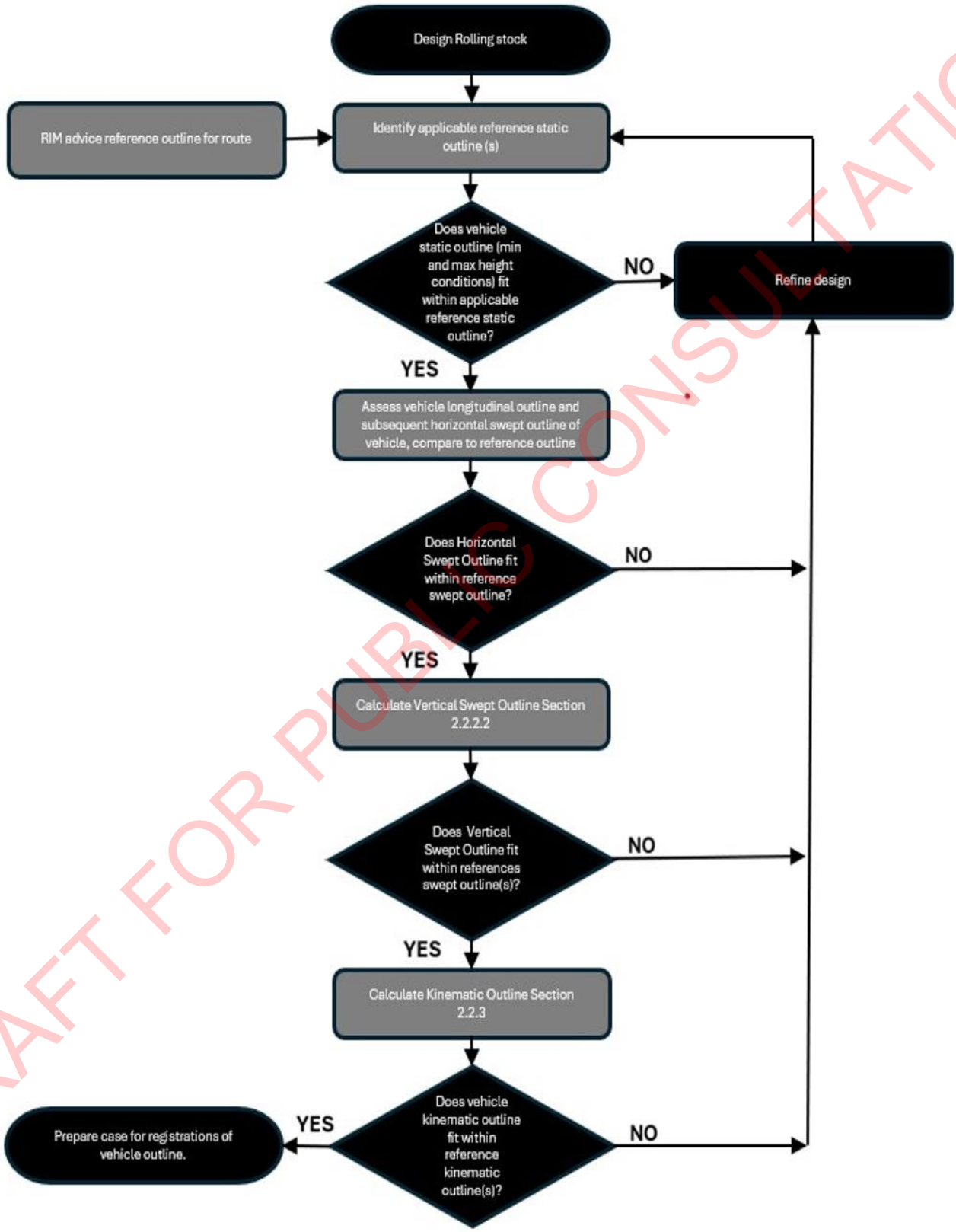
Appendix Table C-4 Lateral Displacement (left) Measurements

Applied superelevation (mm)	Average bump stop clearance (mm)	Axle box/side frame clearance (mm)	Effective lateral displacement (mm)
0	Right = 33.5	6	-2
	Left = 37	6	
50	Right = 35.5	6	0.5
	Left = 35	6	
100	Right = 39	0	14
	Left = 21	10	
160	Right = 85	0	47.5
	Left = 0	10	



Appendix Figure C-4 Plot of body lateral displacement vs applied superelevation

Appendix D Outline Assessment Process Flow Chart (Informative)



Appendix E Hazard Register (Informative)

Hazard Reference	Hazard Description
5.2.1.7	Out of gauge train - Hit wayside structure - Harm to infrastructure by rolling stock
5.2.1.32	Out of gauge train - Dewirement - Harm to overhead power system - Harm to infrastructure by rolling stock
5.2.1.36	Pan head too narrow - Contact wire runs off edge of pan head - Dewirement - Harm to overhead power system - Harm to infrastructure by rolling stock
5.2.1.42	Bogie suspension inadequate
5.2.1.43	Pantograph located too far from a bogie centre - Pan head translation or sway excessive - Contact wire runs off edge of pan head - Dewirement - Harm to overhead power system - Harm to infrastructure by rolling stock
5.8.1.7	Out of gauge train - Side swipe by other train – Collision
5.8.1.12	Train overhang from extremity axles too long – at turnouts - Train foul - Side swipe by other train – Collision
5.31.1.1	Rolling stock not tested/verified for gauge compliance - Out of gauge train
32.5	Rolling stock modification creates out of gauge - Out of gauge train
5.31.1.3	Rolling stock operating on incorrect/forbidden route - Out of gauge train
32.8	Excessive sway - Out of gauge train
32.9	Critical component failure - Out of gauge train
32.10	Rolling stock too high - Out of gauge train
32.11	Rolling stock too low - Out of gauge train
32.12	Rolling stock too wide - Out of gauge train
5.31.1.4	Tilt system failure - Critical component failure - Out of gauge train
5.31.1.5	Tilt system failure - Excessive sway - Out of gauge train
5.31.1.10	Bogies too tall - Rolling stock too high - Out of gauge train
32.21	Cyclic top irregularities resulting in sway of vehicles - Excessive Sway - Out of gauge train
5.31.1.13	Rear-view mirrors extended too far - Rolling stock too wide - Out of gauge train
5.31.1.19	Outward hinging doors - Poorly restrained equipment - Out of gauge train
32.33	Cyclic top irregularities resulting in bogie or body pitching/bouncing - Rolling stock too high - Out of gauge train
5.31.1.23	Conveyors, plows, etc. on track machines - Plant - Poorly restrained equipment - Out of gauge train
5.31.1.25	Crane jibs - Plant - Poorly restrained equipment - Out of gauge train

Hazard Reference	Hazard Description
5.31.1.26	Inadequate suspension - Cyclic top irregularities resulting in sway of vehicles - Excessive sway - Out of gauge train
5.31.1.27	Inadequate suspension - Cyclic top irregularities resulting in bogie or body pitching/bouncing - Rolling stock too high - Out of gauge train
5.31.1.30	Cowcatcher not adjusted for adequate rail clearance - Rolling stock too low - Out of gauge train
5.31.1.31	Bogies not being fitted
5.31.1.32	Fully/over worn wheels - Rolling stock too low - Out of gauge train
5.31.1.33	Overloaded - Rolling stock too low - Out of gauge train
5.31.1.34	Spring failure - Rolling stock too low - Out of gauge train
5.44.1.22	Poorly restrained equipment causing impact with out of gauge train protrusions on moving trains (Person beside train (on track or platform) - Impact with part of train)
5.2.1.7	Out of gauge train - Hit wayside structure - Harm to infrastructure by rolling stock
5.2.1.32	Out of gauge train - Dewirement - Harm to overhead power system - Harm to infrastructure by rolling stock
5.2.1.36	Pan head too narrow - Contact wire runs off edge of pan head - Dewirement - Harm to overhead power system - Harm to infrastructure by rolling stock
5.2.1.42	Bogie suspension inadequate
5.2.1.43	Pantograph located too far from a bogie centre - Pan head translation or sway excessive - Contact wire runs off edge of pan head - Dewirement - Harm to overhead power system - Harm to infrastructure by rolling stock
5.8.1.7	Out of gauge train - Side swipe by other train – Collision
5.8.1.12	Train overhang from extremity axles too long – at turnouts - Train foul - Side swipe by other train – Collision
5.31.1.1	Rolling stock not tested/verified for gauge compliance - Out of gauge train
32.5	Rolling stock modification creates out of gauge - Out of gauge train
5.31.1.3	Rolling stock operating on incorrect/forbidden route - Out of gauge train
32.8	Excessive sway - Out of gauge train
32.9	Critical component failure - Out of gauge train
32.10	Rolling stock too high - Out of gauge train
32.11	Rolling stock too low - Out of gauge train
32.12	Rolling stock too wide - Out of gauge train
5.31.1.4	Tilt system failure - Critical component failure - Out of gauge train
5.31.1.5	Tilt system failure - Excessive sway - Out of gauge train

Hazard Reference	Hazard Description
5.31.1.10	Bogies too tall - Rolling stock too high - Out of gauge train
32.21	Cyclic top irregularities resulting in sway of vehicles - Excessive Sway - Out of gauge train
5.31.1.13	Rear-view mirrors extended too far - Rolling stock too wide - Out of gauge train
5.31.1.19	Outward hinging doors - Poorly restrained equipment - Out of gauge train
32.33	Cyclic top irregularities resulting in bogie or body pitching/bouncing - Rolling stock too high - Out of gauge train
5.31.1.23	Conveyors, plows, etc. on track machines - Plant - Poorly restrained equipment - Out of gauge train
5.31.1.25	Crane jibs - Plant - Poorly restrained equipment - Out of gauge train
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5.31.1.27	Inadequate suspension - Cyclic top irregularities resulting in bogie or body pitching/bouncing - Rolling stock too high - Out of gauge train
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5.31.1.34	Spring failure - Rolling stock too low - Out of gauge train
5.44.1.22	Poorly restrained equipment causing impact with out of gauge train protrusions on moving trains (Person beside train (on track or platform) - Impact with part of train)

Bibliography

The documents listed below are for informative purposes.

- AS 7501, *Rolling Stock Compliance Certification*
- AS 7633, *Railway Infrastructure Clearances*
- AS 7636, *Infrastructure Structures*