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Preface

This Standard was prepared by the Rolling Stock Outlines Development Group, overseen by the ARISO 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 ARISO:

(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.

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.

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'.

ARISO 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 ARISO 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 specifies reference vehicle outlines defined by prescribed physical dimensions, kinematic movements and the resulting three-dimensional swept envelopes generated during operation on straight and curved track in both horizontal and vertical planes.

The document specifies criteria for assessing candidate rolling stock to ensure that their physical dimensions, kinematic movements and throw effects remain within the swept envelopes generated by the nominated reference vehicle(s) for the relevant rail network, thereby preventing infringement of the reference vehicle outlines.

This document applies to the design, construction, maintenance and operation of passenger, locomotive, infrastructure maintenance and freight rolling stock, under all conditions of loading and wear.

This document applies to:

(a) new rolling stock;

(b) existing rolling stock undergoing modification where the modification can possibly affect outline characteristics; and

(c) rolling stock proposed to operate on a different network or on a different route within the same network.

This document 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 7501:2019, *Rolling Stock Compliance Certification*
- AS 7509:2026, *Rolling Stock Dynamic Behaviour*
- AS 7522:2025, *Access and Egress*
- AS 7633:2026, *Railway Infrastructure – Clearances*
- AS 7726:2023, *Interface between train control systems and rolling stock*

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
centre throw
curve throw towards the inside of a horizontal curve at the vehicle centre which is the position of maximum inwards curve throw for a uniform vehicle

1.3.4
curve throw
extent to which a transverse cross-section of a vehicle is displaced inwards or outwards from the track centreline on a perfectly aligned horizontal curve, or upwards and downwards on a perfectly aligned vertical curve, for zero cant and excluding dynamic effects

1.3.5
dynamic behaviour
the performance of the vehicle when moving along the track, specifically with regard to the forces and torques affecting the motion of the vehicle's principal mass elements such as body, bogie structural elements (where applicable) and wheelsets

1.3.6
end throw
curve throw towards the outside of a horizontal curve at the vehicle end which is the position of maximum outwards curve throw for a uniform vehicle

1.3.7
expendable item
feature on rolling stock that exceeds the required rolling stock outline but is considered acceptable by both rolling stock operator (RSO) and rail infrastructure manager (RIM) due to the low consequence if struck

1.3.8
horizontal swept outline
the kinematic outline of the vehicle, including the centre and end curve throw on a specified radius horizontal curve

1.3.9
infrastructure rolling stock
track machines and road-rail vehicles used for infrastructure maintenance or construction

1.3.10
kinematic envelope
the envelope generated by the kinematic outline, centre and end throw, and taking into account rolling stock and track tolerances

Note 1 to entry: The kinematic envelope changes in dimensions as it moves along the track due to track geometry.

1.3.11
kinematic outline
a two-dimensional cross-section of the shape of rolling stock that consists of the static outline plus the maximum permitted allowance for vertical bounce upwards, plus lateral and roll movements.

1.3.12
maximum designed cant deficiency
cant deficiency that the vehicle has been designed to operate with under normal operating conditions

1.3.13
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.

1.3.14
maximum installed cant
maximum track cant that exists on the routes over which the vehicle will operate

1.3.15
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.

1.3.16
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

1.3.17
obstacle deflectors
cowcatcher
pilot
extension of vehicle body underneath the headstock at a cab end to deflect large obstacles from the track

1.3.18
rail infrastructure manager (RIM)
As defined by Rail Safety National Law.

1.3.19
rail transport operator (RTO)
As defined by Rail Safety National Law.

1.3.20
reference kinematic outline
kinematic outline of a reference vehicle

1.3.21
reference rolling stock outline
three-dimensional size of a reference vehicle consisting of the reference static outline, reference kinematic outline and reference swept outline

1.3.22
reference static outline
static outline of a reference vehicle

1.3.23
reference swept outline
swept outline of a reference vehicle

1.3.24
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

1.3.25
rolling stock operator (RSO)
As defined by Rail Safety National Law.

1.3.26
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

1.3.27
track irregularity
an unintended deviation of the track's horizontal alignment, vertical alignment, cross-level, Cant and/or gauge from the design line of the track

1.3.28
track quality
a description of the degree of track irregularities present on a section of track

1.3.29
vertical swept outline
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

1.3.30
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 ARISO Glossary. Refer to:
https://www.ariso.org.au/glossary/

Section 2 Principles of rolling stock outlines

2.1 General

The maximum permitted size of rolling stock shall be defined for each route by the applicable reference rolling stock outline(s) specified by the RIM.

To operate over a defined route, rolling stock shall be demonstrated to occupy no more space than the applicable reference vehicle outline(s), including static, kinematic, horizontal swept and vertical swept outlines.

The RSO shall ensure that candidate rolling stock complies with the nominated reference vehicle outline(s), including kinematic movements and throw effects.

Commentary *C2.1*

The intent of this section is to control the risk of contact between rolling stock and infrastructure, or between adjacent vehicles, to an acceptable level by requiring conformance to defined reference rolling stock outline(s) for each route.

2.2 Modification of rolling stock

Rolling stock that have been accepted onto rail networks are expected to maintain the rolling stock outline in the original network accepted configuration. Modifications to the rolling stock 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 modifications 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) modifications to the suspension springs affecting the static and kinematic outline; or

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

Assessment of the modification shall include all aspects detailed in this document. However, modifications that are limited to specific areas of the rolling stock may have the assessment scope narrowed to the specific outline criteria that can be affected.

The modified rolling stock outline shall be accepted by the relevant RIM before it can operate on the network and might be subject to updated operating conditions.

In addition to the requirements of this document, modification or changes to rolling stock outlines or infrastructure clearances shall be managed in accordance with the relevant requirements of AS 7501:2019, AS 7509:2026 and AS 7633:2026

2.3 Rolling stock outlines

2.3.1 General

The rolling stock outline consists of four parts that define the vehicle's boundaries and movements including:

(a) Static outline;

(b) Kinematic outline;

(c) Horizontal swept outline; and

(d) Vertical swept outline.

2.3.2 Static outline

The static outline is a two dimensional envelope that bounds the vehicle's cross-sectional dimensions at the:

(a) maximum static height (including but not limited to tare mass, new wheels, maximum packing for future wear, near new wear surfaces and inflated air springs); and

(b) minimum static height (including but not limited to loading, solid suspension, deflated air springs, worn wheels and max worn wear surfaces).

Figure 1 shows the reference static outline with the vehicle outline in the vehicle's maximum and minimum heights.

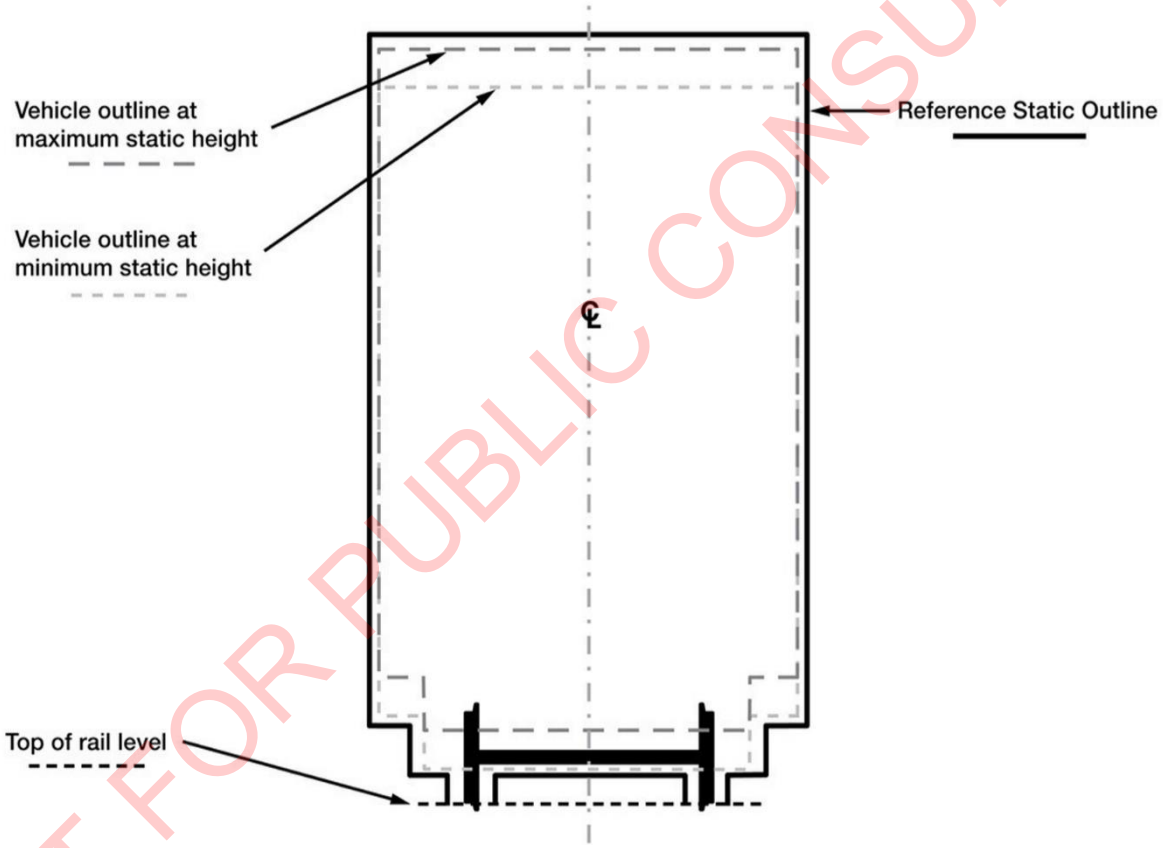


Figure 1 Static outline

NOTE:
Figure 1 is provided for illustrative purposes only.

2.3.3 Kinematic outline

The kinematic outline, as shown in Figure 2, 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; and

(d) maximum body roll about a defined roll centre.

While the kinematic outline is usually defined by the elements above, it might also be provided as another dimensioned drawing that directly incorporates these movement allowances, visually representing the maximum extent of vehicle displacement under dynamic conditions.

The reference kinematic outlines are each produced as a result of moving the corresponding reference static outline through the bounce upwards, lateral translation and body roll movements detailed in Appendix A, noting that the sequence in which these movements are applied can affect the resulting kinematic outline dimensions and should therefore be confirmed with the RIM.

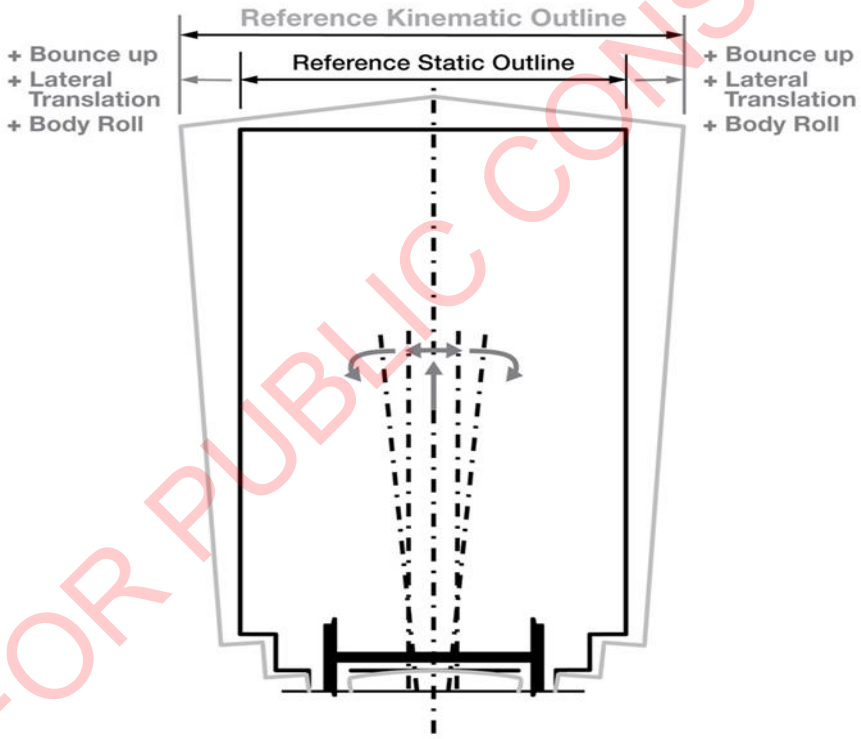


Figure 2 Kinematic outline

In Figure 2, 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 based on the suspension 'solid' in the minimum static height condition.

Commentary *C2.3.3*
The Kinematic Outline (grey) in Figure 2 is a simplified representation provided for illustration only. The shape of the Kinematic Outline is typically more complex and depends on the method of application of kinematic translations specified by the RIM.

2.3.4 Horizontal swept outline

2.3.4.1 General

The horizontal swept outline is created by augmenting the kinematic outline with the centre and end throws produced by a vehicle negotiating horizontal curves of specified radius. It represents the space allowed for rolling stock on curves and is used to assess horizontal clearances to structures, adjacent tracks and wayside equipment.

2.3.4.2 Horizontal curve throws

Horizontal curve throw is the lateral displacement of the vehicle body on a horizontal curve, comprising inner (centre) throw and outer (end) throw.

Centre throw shall be calculated from the bogie centres, and end throw shall be calculated from the worst-case bogie centre to end-of-body overhang.

Unless otherwise specified by the RIM, a 100 m horizontal curve radius shall be used for these calculations; where another radius is specified, that radius shall be used and recorded.

For compliance with this document, sufficiently accurate estimates of centre and end throws can be obtained using the equations given in Clause 3.4.4

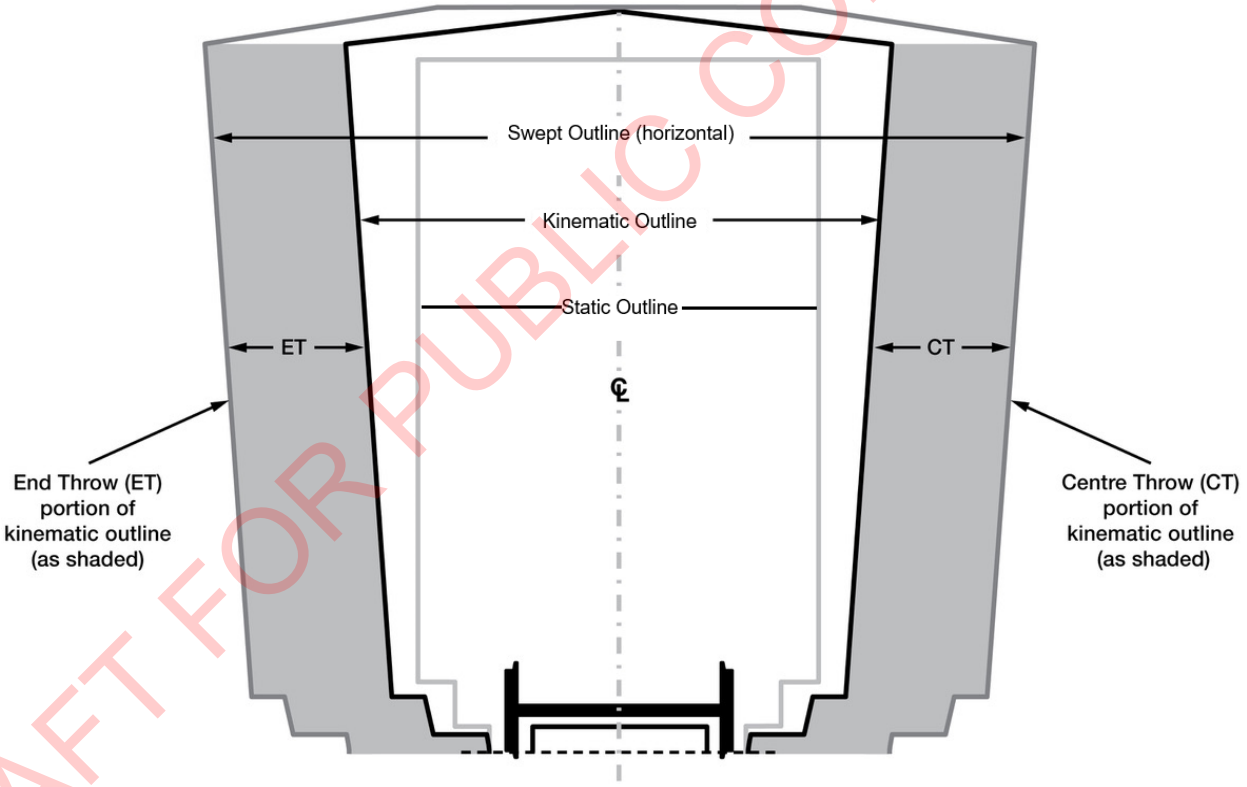


Figure 3 Horizontal swept outline

Commentary *C2.3.4.2*

The horizontal swept outline (grey) shown in Figure 3 is a simplified illustration. In practice, its shape is more complex and depends on the kinematic outline derivation method specified by the RIM, with end and centre throws differing in magnitude.

2.3.5 Vertical swept outline

The vertical swept outline consists of two limits calculated on a 300-metre radius curve by default (or as specified by the RIM):

(a) upper static outline plus bounce upwards and upper vertical curve throw; and

(b) lower static outline plus lower vertical curve throw, assessed for both crest and sag curves.

Both crest and sag vertical curves shall be assessed when determining the vertical swept outline limits, see Figure 4.

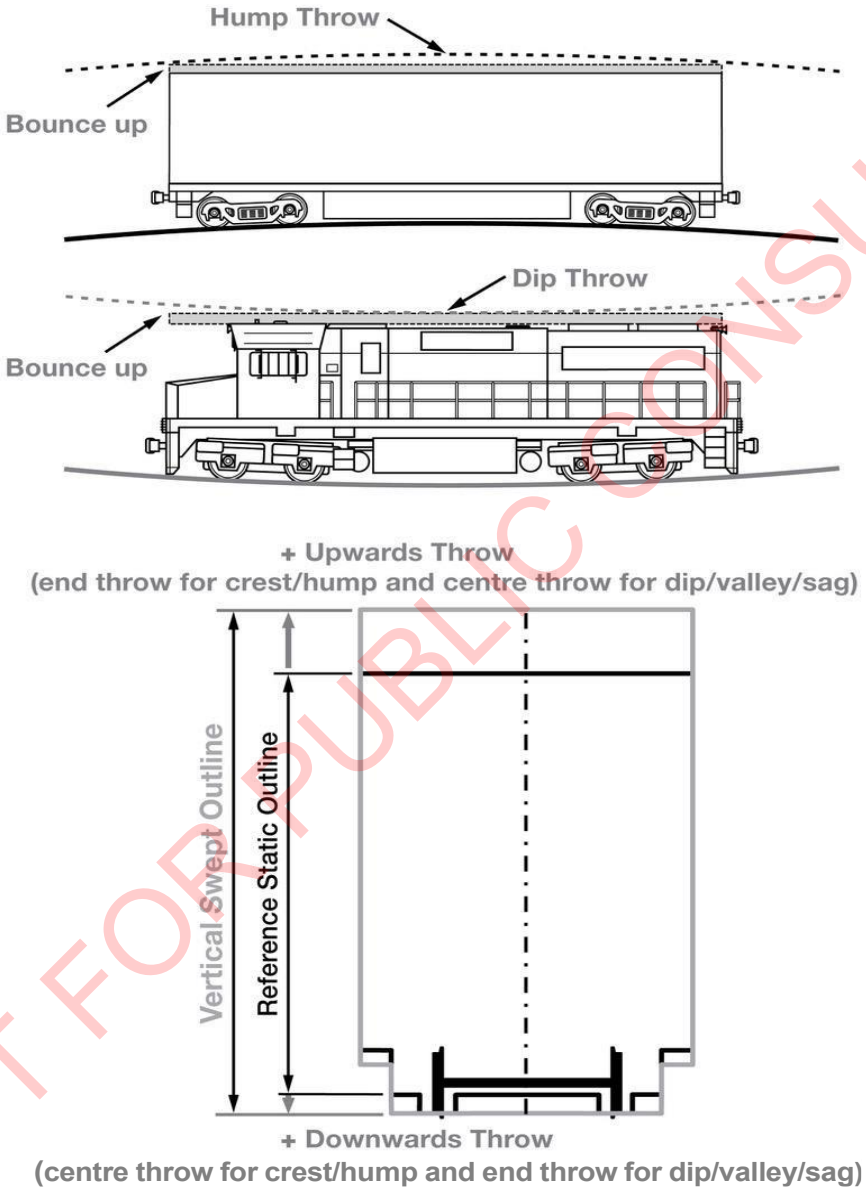


Figure 4 Vertical swept outline

The upper portion of the static outline used for inputs shall be the maximum vehicle height, and the lower portion shall be the minimum vehicle height, see Clause 3.4.1

The upper vertical swept limit shall equal the static outline plus upward bounce plus the upper vertical curve throw on the adopted vertical curve radius.

The lower vertical swept limit shall equal the static outline plus the lower vertical curve throw on the adopted vertical curve radius.

Underframe fittings and underslung equipment shall not exceed the reference vertical swept outline on straight track for vertical curves down to the specified radius.

Any departures from the default radius or method shall be agreed with the RIM prior to assessment and clearly recorded in the compliance evidence.

NOTE:

Figure 4 is provided for illustrative purposes only.

2.4 Reference vehicles

Appendix A lists reference vehicles and their rolling stock outlines based on those used by RIMs when the document was created.

Organisations wishing to add new or amended reference vehicles to this document should contact ARISO.

RIMs shall be consulted to determine the appropriate reference rolling stock outline(s) applicable to the routes on which a new or modified vehicle is proposed to operate.

A reference vehicle defines:

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

(b) the maximum 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.

Non-conformance of a vehicle to the reference rolling stock outline(s) for a route shall be subject to RIM approval (i.e. derogation) and potential application of operating restrictions where required.

A RIM may specify multiple reference outlines for a defined route, and the effective permitted outline will be the sum combination of the component reference outlines. Therefore, a new or modified vehicle can have features that differ from any one outline, but comply with the combined outline for any one defined route

Commentary *C2.4*

Not all reference rolling stock outlines defined in this document are for new vehicles; Some reference outlines are only applicable to legacy/heritage rolling stock.

Section 3 Assessment and verification of rolling stock outlines

3.1 General

Rolling stock outline assessment ensures that new and modified vehicles are designed, verified and operated in accordance with applicable reference rolling stock outlines (static, kinematic and swept).

The assessment process comprises design review, technical analysis and verification or validation activities, and compliance evidence for each stage may be required by the RIM for acceptance.

For candidate rolling stock the assessment of conformance requires:

(a) identification of the applicable reference outline(s). This can occur during specification or design of new rolling stock, or when requesting access to a new network or track section from a RIM;

(b) calculation and documentation of the relevant static dimensions and dynamic characteristics of the vehicle for new and modified rolling stock, the dynamic

translations should be calculated using worst case assumptions for track geometry to prevent the need for re-testing when requesting access to new networks;

(c) comparison of the candidate vehicle's outlines with those of the reference outline(s) using the selected method to demonstrate conformance; and

(d) Once the candidate rolling stock has been built, or modified, then:

(i) measurement of the static size of every vehicle shall be undertaken to ensure their physical size meets design expectations; and

(ii) on a sample vehicle from the batch produced, physical measurement (or validated theoretical quantification) of the vertical, lateral and roll movements of the vehicle on its suspension under defined input conditions to ensure performance meets assumptions made during the design stage.

3.2 Assessment of design conformance

At the design stage, the rolling stock shall be assessed for conformity with reference rolling stock outlines, including static, kinematic and swept outlines as specified in this document.

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

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

(a) 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;

(b) 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 to offset the greater kinematic movements such that the reference kinematic outline can be met; and

(c) 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 is limited to the width of the reference static outline.

Assessment of design conformance shall be carried out through analysis, modelling (such as CAD simulations) and technical justification, to confirm the vehicle does not exceed outline boundaries relevant to the network.

Vehicle dimensions and kinematic characteristics shall be compared with the chosen reference vehicle and its outlines. The RIM shall specify or confirm the appropriate reference vehicle.

Compliance can be demonstrated by:

(a) having a static outline within the reference static outline; and

(b) having a kinematic outline within the reference kinematic outline; and

(c) by having horizontal and vertical swept outlines within the limits of the reference swept outlines, noting the horizontal swept outline includes kinematic translations.

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

3.3 Verification of conformance

All newly constructed vehicles, and any vehicles with modifications that might impact outline conformance, shall undergo verification activities to confirm, inform, or expand upon the results of design conformance analysis.

Where the design of a vehicle is similar to previously approved vehicles, the scope of verification activities may be reduced subject to agreement with the Rail Infrastructure Manager (RIM).

The results of outline assessment and verification, including supporting technical evidence, shall be documented and submitted to the RIM.

3.4 Ongoing assurance

Any modification likely to affect a vehicle's static or kinematic outline characteristics such as changes to the body, bogie, suspension, mass, centre of gravity, operating speed, or load shall trigger re-assessment and re-verification of the impacted aspects of the design.

The Rolling Stock Operator (RSO) shall notify the RIM of any proposed modifications to previously accepted rolling stock that might adversely affect the rolling stock's static, kinematic, or swept outlines.

The RIM shall assess any changes to infrastructure or network configuration on routes used by previously accepted rolling stock for potential impacts on clearances. Where changes to infrastructure or network configuration are identified, the RIM shall consult the relevant RSOs and can request updated rolling stock outline and clearance assessments as necessary to ensure continued safe operation and compliance at the infrastructure interface.

3.5 Conformance to a reference vehicle

3.5.1 Conformance to static outlines

For rolling stock to comply with a reference static outline it shall:

(a) not exceed the reference static outline at any position around the perimeter of the cross-section;

(b) comply in all conditions between the maximum and minimum static height and its dimensions under the defined conditions.

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 (including any underframe camber and expected manufacturing tolerances on overall width, height and length) and maintenance tolerances (including the expected vertical height differences associated with wheel diameter changes and any expected long term creep of suspension components associated with aging).

3.5.2 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, excluding wheel clearance;

(b) maximum upwards vertical translation (bounce);

(c) the minimum vertical translation is already factored into the vehicle static outline; and

(d) maximum body roll relative to the body centre of rotation.

The RIM shall nominate the method of combining these conditions to form the vehicle kinematic outline.

By default, all points on the perimeter of the vehicle kinematic outline shall be defined by the worst-case combination of any of the possible values of dynamic translation (minimum to maximum).

The above dynamic translations shall be those calculated and verified for the vehicle in response to assumed worst-case stimulus of the track geometry applicable to the reference outline(s). Section 5 describes standard methods for verification of a vehicle's dynamic translations.

Maximum lateral and vertical translations can be assumed to be the at the physical limits of travel of the relevant mechanical connections.

The dynamic translations shall take into account expected degraded modes of the vehicle in which operation is permitted, such as deflated airbags, or deactivation of active tilt control in the case of tilt trains.

In order to retain safe clearances, the assessment of dynamic translations for the kinematic outline shall take into account the effects of crosswinds and pressure pulses from passing trains, with particular consideration for high-sided and/or lightweight vehicles operating on exposed routes (see AS 7509:2026).

Kinematic calculation for the vehicle shall use the roll centre height applicable to the vehicle as a result of its design, and not the roll centre applicable to the reference outline. Vehicle roll centre is typically verified by measurement of spring deflections under roll stimulus.

Commentary *C3.5.2-1*

A speed restriction may be applied by the vehicle designer or RSO to control the maximum dynamic translation in degraded modes of operation

Commentary *C3.5.2-2*

The RIM accounts for wheel-rail movement, track construction and maintenance tolerances, track geometry and any other variables related to the position and orientation of the rail head within the transit space.

3.5.3 Conformance to horizontal and vertical swept outlines

For rolling stock to comply with the reference horizontal and vertical swept outline it shall not:

(a) exceed the reference horizontal swept outline at any position around the perimeter for the specified horizontal curve radius. This assessment uses the assumption of level track for simplicity, although kinematic translations are applied for both the vehicle under assessment and the reference outline in derivation of the horizontal swept outline; and

(b) exceed the reference vertical swept outline at any position around the perimeter for the specified vertical curve radii (both crest and sag curves). This assessment assumes no horizontal curves or cant.

The vehicle shall be deemed-to-comply with these requirements if:

(c) the vehicle conforms to the reference static and reference kinematic outlines; and

(d) the vehicle’s bogie centres and end overhangs are not greater than those of the reference vehicle.

If the deemed-to-comply criteria are not satisfied, compliance shall be demonstrated where the calculated horizontal and vertical swept outlines of the vehicle lie within the applicable reference

horizontal and vertical swept outline using either of the methods described below in Clauses 3.5.4.1 and 3.5.4.2.

The following parameters shall be documented to verify compliance of the horizontal swept outline:

(e) the maximum vehicle body width along the vehicle length;

(f) the body length of the vehicle;

(g) the bogie centre spacing;

(h) the minimum curve radius adopted for assessment (default: 100 m, unless otherwise agreed);

(i) the calculated centre throw and end throw projections for the minimum curve radius;

(j) the calculation method and formulae used;

(k) the resulting maximum and minimum lateral swept limits;

(l) documented build and maintenance tolerances incorporated into the assessment; and

(m) any agreed departures from the default curve radius, tolerances or assessment methods, recorded and endorsed by the RIM.

The following parameters shall be documented to verify compliance of the vertical swept outline:

(n) the maximum and minimum vehicle heights;

(o) the upward bounce allowance;

(p) the adopted vertical curve radius;

(q) the calculation method; and

(r) the resulting vertical swept limits.

(s) any agreed departures from the default curve radius, tolerances or assessment methods, recorded and endorsed by the RIM.

3.5.4 Calculation methods – Horizontal and vertical swept outlines

3.5.4.1 Rectangular vehicle outlines method

This method may be used under the assumption that the vehicle being assessed has the same (maximum) lateral and vertical dimensions for the entire length of the vehicle. All reference vehicles have this property by default. This assumption produces the maximum swept outlines at the midpoint, fixed cross-section, between bogie centres and at the ends of the vehicle and is conservative as it will tend to over-estimate the vehicle's swept outlines.

The approximate equation for end throw below is for vehicles that have the same overhang at both ends i.e., that are longitudinally symmetrical. All reference outlines are longitudinally symmetrical by default. If the vehicle is not longitudinally symmetrical, it may be assessed using the assumption that the longer overhang applies to both ends by increasing the dimension 'L', where:

(a) CT = Centre Throw

(b) ET = End Throw

(c) B = Bogie centres

(d) L= Body length

(e) R = Curve radius

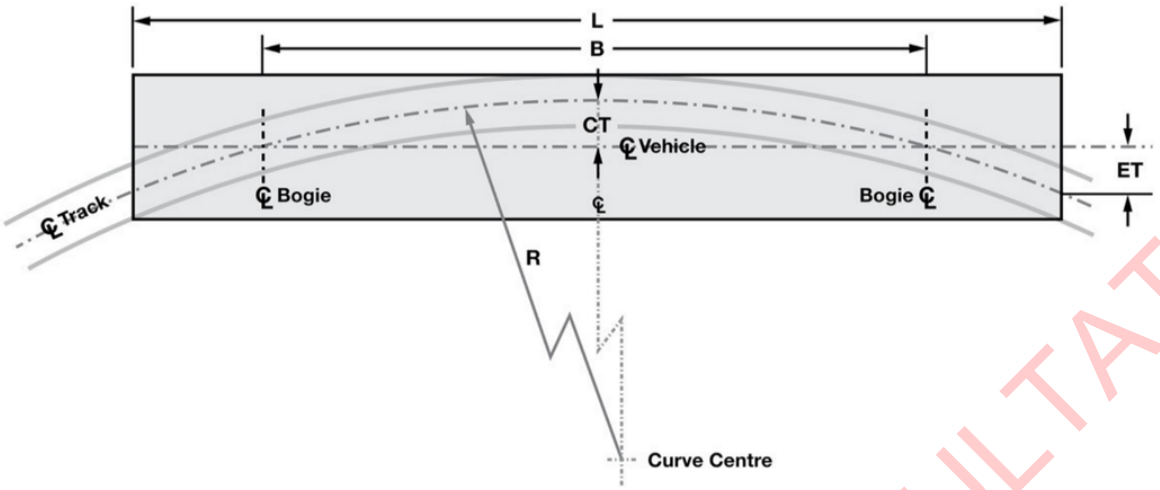


Figure 5 Centre and end throw

For vehicles with a constant rectangular cross-section, maximum throws can be assessed at the centre and ends using the subsequent equations.

Equation 3-A Centre throw

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

Equation 3-B Approximate end throw

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

The centre throws and end throws shall be added to the maximum horizontal (including kinematic) and vertical dimensions of the vehicle, to assess the maximum horizontal extents of the horizontal swept outline and the maximum vertical extents of the vertical swept outline.

For the horizontal dimension, the outline is usually symmetrical and in such cases a quantity half of the maximum width of the kinematic outline may be used. For the vertical dimension, the distances between bogie points of rotation and the top and underside limits of the vehicle respectively are not symmetrical, and therefore each combination of crest and sag curves and top and underside of vehicle shall be assessed separately.

The horizontal dimensions used for this assessment shall be based on the kinematic outline, as per the definition of horizontal swept outline in Clause 2.3.4

The vertical dimensions used for this assessment shall be based on the static outline, as per the definition of vertical swept outline in Clause 2.3.5

Assuming a laterally symmetrical vehicle, the following cases shall be considered:

(a) Horizontal swept outline end throw.
(b) Horizontal swept outline centre throw.
(c) Vertical swept outline centre throw of underside of vehicle on crest.
(d) Vertical swept outline centre throw of top side of vehicle on sag.
(e) Vertical swept outline end throw of underside of vehicle on sag.
(f) Vertical swept outline end throw of top side of vehicle on crest.

In each case the following criteria shall be satisfied:

$$Throw_{vehicle} + Dimension_{vehicle} \leq Throw_{reference} + Dimension_{reference}$$

Conformance with these criteria may be demonstrated via calculation or diagrammatically using CAD.

The equation for end throw provided is a close approximation of end throw on the radial axis of the curve but is not identical. An exact calculation of the maximum horizontal extents of the horizontal swept outline and the maximum vertical extents of the vertical swept outline on the radial axis of the curve may be used instead.

3.5.4.2 Variable vehicle outlines method

A vehicle may have a greater maximum extents of the swept outlines than the reference swept outlines when assessed using the method provided in Clause 3.5.4.1 but still conform to the reference swept outline due to narrowing of the ends or centre of the vehicle body. In this case the extents of the outlines shall be assessed at all points between the body centre and the respective limit points of the vehicle under assessment and the reference vehicle.

The approximate end throw equation provided in 3.5.4.1 can be adapted to provide a continuous function of x where x = 0 is at the midpoint between bogie centres and x increases towards the vehicle endpoint.

Approximate throw *T* at position x from the centre:

$$T(x) = \frac{(2x)^2 - B^2}{8R}$$

The vehicle's local horizontal or vertical dimension at x, is defined as Y(x, z) where z is the orthogonal axis to Y. For example, if Y is describing the horizontal dimension of the vehicle, then z is a vertical axis which allows for different values of Y at different heights. Conversely, when considering Y as the vertical dimension, z would be the horizontal axis.

Combine the absolute value of T(x) with the vehicle's local horizontal or vertical dimension at x, Y(x, z), to obtain an approximation of the total horizontal or vertical extents of the swept outline at x:

D(x, z) = |T(x)| + Y(x, z)

Conformance requires that the following cases to be considered:

(a) Horizontal swept outline.

(b) Vertical swept outline centre throw of underside of vehicle on crest.

(c) Vertical swept outline centre throw of top side of vehicle on sag.

(d) Vertical swept outline end throw of underside of vehicle on sag.

(e) Vertical swept outline end throw of top side of vehicle on crest.

In each case, the following criteria shall be satisfied:

For all z,

$$\max_{x \in [0, limit]} D_{vehicle}(x, z) \leq \max_{x \in [0, limit]} D_{reference}(x, z).$$

In plain English, this can be stated as "For every value of z, the maximum of $D_{vehicle}(x, z)$over all x in the range $[0, limit]$ is less than or equal to the maximum of $D_{reference}(x, z)$ over the same range."

For example, in the horizontal case for each z coordinate on the vertical axis, the maximum horizontal sweep is calculated over the complete range of x values for each vehicle and must be less for the vehicle under assessment than for the reference vehicle.

For case (a), Y(x, z) describes the horizontal dimensions of the vehicle. For cases (b) – (e), Y(x, z) describes the vertical dimensions of the vehicle.

The horizontal dimensions used for this assessment shall be based on the kinematic outline, as per the definition of horizontal swept outline in Clause 2.3.4

The vertical dimensions used for this assessment shall be based on the static outline, as per the definition of vertical swept outline in Clause 2.3.5

Y(x, z) may be represented by composite mathematical functions, a set of discrete points, or a CAD model, to ensure all protrusions and local maxima are captured.

Conformance with these criteria may be demonstrated by calculation using the above equations for all relevant cases or diagrammatically using CAD. The horizontal swept outline and the vertical swept outline shall be assessed independently.

This approach allows for bodies that narrow toward the centre or at the ends, provided the three-dimensional envelopes of the horizontal and vertical swept outlines never exceed the corresponding three-dimensional envelopes of the swept reference outlines.

The equation for throw provided is a close approximation of throw on the radial axis of the curve but is not identical. An exact calculation of the maximum lateral extents of the horizontal swept outline and the maximum vertical extents of the vertical swept outline on the radial axis of the curve may be used instead.

Section 4 Specific items

4.1 Wheels

To qualify as wheel-related equipment, components shall be in close proximity to the wheels to ensure they are not significantly affected by vertical or horizontal curve throw.

The static outline area designated for wheels also defines the kinematic and swept outlines for wheel-related equipment such as wheel guards, derail catch bars and sanding gear.

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

Trackside equipment nominated by the RIM shall remain clear of any wheel-related equipment within the 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 Expendable items

Expendable items are exterior parts of rolling stock that extend beyond the standard outline but are approved as any contact is unlikely to cause significant damage or safety risk.

The following conditions are required:

(a) expendable items shall be treated as part of the vehicle static outline for the purposes of this document;

(b) modification of a vehicle outline, including expendable items, shall be managed in accordance with Clause 2.2 in consultation with the RIM;

(c) where reference outlines define designated areas for expendable items, approval procedures shall be established in consultation with the RIM;

(d) components outside the reference rolling stock outline may be treated as expendable items where infringement consequences are low;

(e) expendable items shall be minimized by design and not used as design features in new rolling stock;

(f) expendable items shall not be permitted where clearance restrictions prohibit their use;

(g) expendable items shall be designed, constructed and maintained to prevent:

(i) damage to infrastructure or rolling stock;

(ii) injury to rail workers or the public; and

(iii) unsafe operating conditions.

(h) expendable items shall not:

(iv) disrupt rail utilities functionality (e.g., cable or signal troughing);

(v) become projectiles;

(vi) become partially detached; or

(vii) cause unsafe operating conditions due to loss of equipment function (e.g., lighting, communications, beacons);

Typical expendable items include:

(i) mirrors;

(j) non-warning speakers;

(k) periscopes;

(l) exhaust rain caps;

(m) flexible guards or sheeting used to contain debris or sparks; and

(n) flexible cap fillers on step treads.

NOTE:

Some outlines do not allow any expendable items due to clearances associated with their operation.

4.4 Obstacle deflectors (cowcatchers)

Obstacle deflectors, also known as cowcatchers, shall be adjustable so that height above rail can be set to the intended functional height or height range despite factors such as wheel wear, body-bogie packing, loading, etc.

The lower portion of the intended functional height of the obstacle deflector shall be included in the vehicle's static outline.

4.5 Rolling stock and train control system interface

Equipment related to train control systems (e.g., balises, transponders, antennas) shall conform to AS 7726:2023 and shall be located such that all applicable rolling stock static, kinematic and swept outline and network clearance requirements are satisfied.

4.6 Pantographs

For pantographs in their lowered position, all parts of the pantograph and associated equipment shall not exceed the appropriate reference outline as described in Appendix A or as advised by the relevant RIM.

The ARISO pantograph outlines given in Appendix B.2 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 or as advised by the relevant RIM.

The RSO shall gain approval from the RIM regarding the use of pantographs and their respective profiles/outlines.

The pantograph head position along the vehicle shall not exceed the dimensions of the appropriate pantograph static outline as described in Appendix B or as advised by the relevant RIM.

Commentary *C4.6*

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

4.7 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 or as advised by the relevant RIM under minimum static height conditions.

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

4.8 Doors

4.8.1 Crew/passenger doors

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 that open outwards shall not infringe the rolling stock static outline when open as specified in AS 7522:2025

Any door which when open increases the vehicle outline, such as plug type doors, shall feature door-closed detection with a suitable response from the rolling stock such as a traction interlock or alarm.

Some RIMs utilize reference outlines that have allowances for open doors and may allow operation of rolling stock with open doors in these positions under special conditions (such as degraded operation).

NOTE:

Refer to AS 7522:2025 for requirements rolling stock crew and passenger doors.

4.8.2 Bulk commodity (bottom discharge) doors

Bottom discharge doors on bulk commodity wagons shall be treated as being in any open condition (range of motion) for the sake of vehicle outline assessment.

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).

4.8.3 Bulk commodity (roof hatches) doors

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.

4.9 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; or

(f) designed to be frangible or tear away. See Clause 4.3.

4.10 Step treads

A step tread is the structure attached to a vehicle designed for passengers or crew to step on during boarding or alighting. Step treads might be required to project from the vehicle outline to maintain platform gaps, for example to meet the requirements of the Disability Standards for Accessible Public Transport (DSAPT).

Step treads should always be counted as part of the static outline of a vehicle but may be treated as expendable items if they meet the requirements of Clause 4.3

NOTE:

Refer to AS 7522:2025 for requirements of treadplates.

4.11 Infrastructure rolling stock

Where rolling stock includes movable elements that might exceed static outline such as steps, ploughs, tamping tynes, cranes, elevated work platforms, spray gear, or test gear, these elements shall be stowed within the static outline for travel.

Movable elements shall have a designed restraint system, including locking or interlocking mechanisms, to prevent them from becoming loose or moving unintentionally, except under specifically defined conditions.

Section 5 Outline verification

5.1 Static outline test

Static outline test measurements shall be taken on straight, level track relative to the track centreline and top of rail.

The vehicles shall be tested in tare conditions.

The vehicle design shall be verified in max and min load conditions as a type test. This can be achieved through calculations or computer simulations.

Vehicle static outline shall be verified as a type test.

Commentary *C5.1*

One method is to measure the clearance between the vehicle and a constructed check profile.

Before testing, confirm the vehicle body is centred within its lateral suspension travel and between the rails.

Small height changes from wheel tread taper might affect rail-referenced measurements if the vehicle is off-centre.

Maximum height conditions (e.g., packed suspension or empty container loading) may be simulated by adjusting measured dimensions or lowering the check profile.

Minimum height conditions (e.g., fully compressed springs or worn wheels) may be simulated by adjusting measured dimensions or raising the check profile.

Dummy solid cylinders used for other physical tests may also simulate minimum height suspension conditions.

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

5.2 Kinematic outline assessment

5.2.1 General

Kinematic outline assessment requires design calculations to determine expected kinematic vehicle movement.

Calculations shall assume the same total cant deficiency or excess as is used for the static kinematic test, as described in Clause 5.3 of this document, and worst case loading conditions.

Calculations shall be performed so that the expected kinematic outline of the candidate vehicle can be compared with the kinematic outline of the reference vehicle.

Physical testing may proceed if the results indicate the kinematic outline of the candidate vehicle is expected to conform with that of the reference vehicle.

The RIM may waive physical testing if calculations show:

(a) the maximum lateral translation and roll rotation have reached physical limits (e.g., air gaps and bumpstops fully compressed);

(b) adequate clearance to the kinematic outline; and

(c) maximum wear of components have been assessed.

Physical kinematic outline testing includes:

(d) static kinematic test (vehicle on defined super-elevated track); and

(e) dynamic kinematic test (vehicle at test speeds on defined track).

Static testing shall be completed before dynamic testing.

Tests shall measure body roll and lateral translation relative to the wheelset, and friction-damped vehicles shall use worst-case maintenance friction settings.

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 might be required until the design calculations are verified, i.e. the results of the design calculations replicate the results of the physical tests undertaken.

The RIM may provide an exemption to dynamic kinematic outline tests 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.

Commentary *C5.2*

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

5.2.2 Load condition for kinematic outline test

The vehicle undergoing kinematic outline testing shall be assessed in the load condition that is expected to produce the maximum kinematic movement. This condition typically corresponds to the maximum loaded configuration or maximum gross mass.

When conducting kinematic outline tests on loaded containers, the effects of load arrangement, including total mass, load height and the resulting centre-of-gravity (CG) vertical and horizontal position shall be taken into account.

The test procedure should identify the load condition and CG configuration that is expected to produce the most adverse kinematic movement and tests should be performed for this condition.

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, using correlated results or models.

5.3 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 consistent with the requirements in Clause 5.2 of this document.

The vehicle shall be raised on one side to simulate the required testing cant. The test cant is usually a maximum cant deficiency or excess plus an allowance (typically 45%) for dynamic movement in response to track irregularity that the vehicle might experience in operation.

Table 5-1 Minimum Test Cant for Different Rail Gauges (Includes Dynamic Allowance)

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 test cants are based on maximum installed or designed cant values on the network plus dynamic movement to account for track geometry and minor irregularities.

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

Commentary *C5.3-1*

See Appendix C for a description of the static kinematic test.

The vehicle undergoing a static kinematic test should 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 sequentially.

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.

Measurement of vehicle lateral translations and body roll should be recorded at a minimum of two positions on the vehicle body at different heights and longitudinal positions, relative to the positions of the wheelsets.

The recorded measurements shall be analysed to provide body roll and lateral translation of the body relative to the wheelset.

For 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 static kinematic 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.

5.4 Dynamic kinematic test

5.4.1 General

RIMs can request dynamic kinematic testing in addition to static kinematic testing for operations on the network.

Dynamic testing might not be required if the static testing satisfies the RIM requirements and is typically only required for more complex vehicles.

The dynamic kinematic test allows assessment of the kinematic outline under service conditions.

The dynamic kinematic test shall be conducted on track representative of the intended operating routes, reflecting typical track irregularities and allowing the vehicle to operate at the maximum speed and cant deficiency required for the test.

The RIM shall nominate specific test curves.

The dynamic kinematic test shall include the

(a) vehicle curving at maximum test cant deficiency at a speed as close as possible to the vehicle's maximum speed; and

(b) vehicle stationary on maximum installed cant. (this can be derived from the static testing).

Vertical and lateral displacement of both primary and secondary suspensions are typically measured.

The kinematic outline of the candidate vehicle shall be quantified by either:

(c) direct measurement that captures the vertical and lateral displacement of the vehicle body relative to the wheelsets, in order that the most conspiring spatial position of the vehicle body can be established relative to the plane and centre of the track; or

(d) indirect measurement, where the maximum body roll angle can be established during dynamic testing and later replicated during a subsequent static test such that the spatial position of the vehicle body can be established relative to the plane and centre of the track.

The results are then analysed to assess compliance with the kinematic outline of the reference vehicle.

5.4.2 Similarity

With the agreement of the RIM, verification evidence for candidate vehicle may be accepted as valid for the vehicle under assessment, provided it can be demonstrated that the relevant technical characteristics of the vehicle under assessment are the same as those of the candidate vehicle and static and dynamic outline performance data is available for that candidate vehicle.

5.4.3 Alternative dynamic kinematic verification

In circumstances where the desired dynamic test speed or cant deficiency cannot be achieved on available track, the RIM may accept alternate verification methods. Acceptable alternatives verification methods include:

(a) static kinematic tests with dynamic allowances applied;

(b) validated computer simulation, using input data representative of worst-case configurations; or

(c) analytical extrapolation from available test data.

In all cases, the chosen method shall provide representative or conservative assessment of sway, roll and lateral displacement.

The technical rationale, assumptions and any safety margins shall be documented.

5.4.4 Simulation of dynamic kinematic verification

A simulation or calculation-based approach may be used as an alternative to dynamic kinematic testing, provided that:

(a) the model inputs reflect the worst-case operating envelope with respect to load, centre of gravity, suspension characteristics and cant deficiency including the dynamic allowance

(b) results are correlated, against available static and/or dynamic test data;

(c) the methodology, input assumptions and margins for uncertainty or dynamic movement are documented and

(d) the simulation demonstrates that under the test condition dynamic scenario, the rolling stock maintains compliance with reference kinematic outlines.

Refer to AS 7509:2026 for additional requirements for simulation verification.

5.4.5 Test route and site selection

The test track segment shall represent the actual route geometry.

Prior to testing, the RIM shall confirm that the prevailing track geometry does include any condition or feature that would compel a travel speed restriction.

The RIM shall approve test routes or sites.

The RIM shall confirm and provide the relevant geometric and operational parameters.

The ideal test curve matches radius, cant and speed so that maximum cant deficiency and the vehicle's maximum approved speed occur simultaneously.

Vehicles shall at least demonstrate operation at maximum cant deficiency at test condition line speed not less than 75% of the candidate vehicle's maximum speed.

Commentary *C5.4.5*

For this purpose of this document, TCI is a dimensionless indicator of overall track geometry condition over a defined length, calculated from parameter condition indices (PCIs) for top, twist, gauge, alignment and other specified parameters. Each PCI is derived from statistical analysis of measured geometry, and the TCI is the sum or documented weighted sum of the applicable PCIs, where lower values indicate better track, and TCI ≤ 50 defines the target quality band.

5.4.6 Minimum acceptable test conditions

If ideal conditions cannot be achieved, reduced-speed testing is acceptable only if:

(a) the maximum design cant deficiency is nevertheless achieved;

(b) test speed is at least 75% of the maximum operational speed;

(c) if test speed is below 80% operational speed; and

(d) for high-speed vehicles (>160 km/h), when test speed is below 90% of operational, supplementary wind tunnel or CFD analysis is required to assess crosswind effects.

5.4.7 Test methodology

Testing shall be conducted at speeds to achieve the required cant deficiency.

The RIM shall provide measured track data prior to the test to achieve the required test cant deficiency.

Calculations should be conducted for the selected route to determine the cant deficiency and the speeds required to achieve the required cant deficiency.

The calculated speed may exceed the allowable track speed and this test speed shall be confirmed acceptable for the track section.

The vehicle should be operated at or close to these speeds as possible during the test.

Sufficient instrumentation shall be used to determine total body roll and lateral translation to determine overall kinematic parameters.

Vertical movement at known distances from the vehicle centreline may be used to determine roll. Care should be taken when selecting locations that measurements measure genuine roll and not deflections of components or pure vertical travel.

It is suggested that other instrumentation should be installed to measure subcomponent roll or movement, to enable more detailed analysis of results particularly in the correlation of any models.

5.4.8 Data analysis and outcomes

Kinematic, static and the curve radius test data provides empirical measurement of the swept outline, i.e. the maximum dynamic space occupied by the vehicle as it negotiates aligned and canted track at speed.

Test data shall be used to verify and, where necessary, refine the design calculations and confirm or adjust the vehicle outline, including any required changes to the vehicle, infrastructure, or operating envelope.

Note:

Refer to AS 7509:2026 for additional test requirements.

5.5 Swept outline verification

Measured data from the static outline test, including vehicle length, body overhang and bogie centres shall be used to confirm conformity with the swept outline analysis parameters and to calculate compliance with the swept outline. See Clause 3.5.3 for more information.

Section 6 Out-of-gauge rolling stock

Out of gauge loads are outside the scope of this document. Refer to the relevant network documents or *RISSB Code of Practice – Loading of Rail Freight*.

Out-of-gauge rolling stock includes vehicles that exceed reference vehicle outlines but are operated under special conditions.

The RIM may permit out-of-gauge rolling stock to operate, subject to operational constraints or special conditions.

Infrastructure maintenance rolling stock with deployable equipment (e.g., cranes, tampers, etc.) may exceed outlines when deployed but shall not move when equipment is deployed beyond the static outline, subject to RIM requirements.

Section 7 Loads

Loading outlines are outside the scope of this document. Refer to the relevant network documents or *RISSB Code of Practice – Loading of Rail Freight* .

Section 8 Records

RSOs shall maintain records for each rolling stock unit intended for operation on a network, in accordance with this document and related standards.

Required records include but are not limited to:

(a) dimensional measurement records for each rolling stock vehicle, captured under all prescribed loading and suspension conditions;

(b) test reports for both static and, where required, kinematic outline verification, documenting methods, results and equipment;

(c) drawings and diagrams illustrating critical cross-sections, tolerances and any deviations from standard references;

(d) certificates or documentary evidence of design compliance, construction conformance and, where applicable, on-track test confirmation;

(e) a register or log summarizing reference data, test outcomes and approval status for rolling stock vehicle;

(f) records of any derogations, concessions, or non-standard approvals, with supporting risk assessments and rationale for RIM acceptance;

(g) change records for all post-approval modifications, with dimensional or outline testing reports confirming continued compliance; and

(h) records of any out-of-gauge items per Section 7 of this document.

RIMs shall retain and manage network compatibility records, including but not limited to:

(i) specification and communication of reference rolling stock outlines and clearance limits for each route;

(j) records of reference outlines, route-specific clearances and approval criteria used for assessment and network access decisions;

(k) documentation for any derogations, concessions, or non-standard approvals, including associated risk assessments;

(l) secure storage of registers, logs and decision records for the life of the network;

(m) provisions for access to relevant outline and approval records by operators, regulators and authorized stakeholders; and

(n) updates to outline and clearance records reflecting network, standards, or rolling stock changes affecting route compatibility or risk.

All records shall be securely retained, readily auditable and made available to RIMs or regulatory authorities on request.

Records shall be maintained and updated throughout the operational life of the rolling stock unit and the corresponding infrastructure, to support traceability, audits, modifications and safety investigations.

Section 9 Maintenance

9.1 General

Rolling stock shall be maintained to ensure static dimensions and kinematic response remain within the original design configuration for the vehicle and within the requirement of this standard throughout the vehicles operational life.

9.2 Maintenance actions

The RSO shall implement routine maintenance to ensure that static dimensions and kinematic response remain within the assumed bounds. For example (but not limited to);

(a) visual checks of static outline;

(b) checking for wear or presence of limit-of-travel stops;

(c) checking spring and damper rates; and

(d) planned or on-condition replacement of suspension elements.

9.3 Non-compliance action

If verification identifies non-compliance:

(e) the rolling stock or component shall be withdrawn from service until corrective action is taken to restore compliance with the reference outline tolerance limits; and

(f) the non-compliance event and corrective action taken shall be recorded in maintenance documentation and reported according to relevant regulatory or operator protocols.

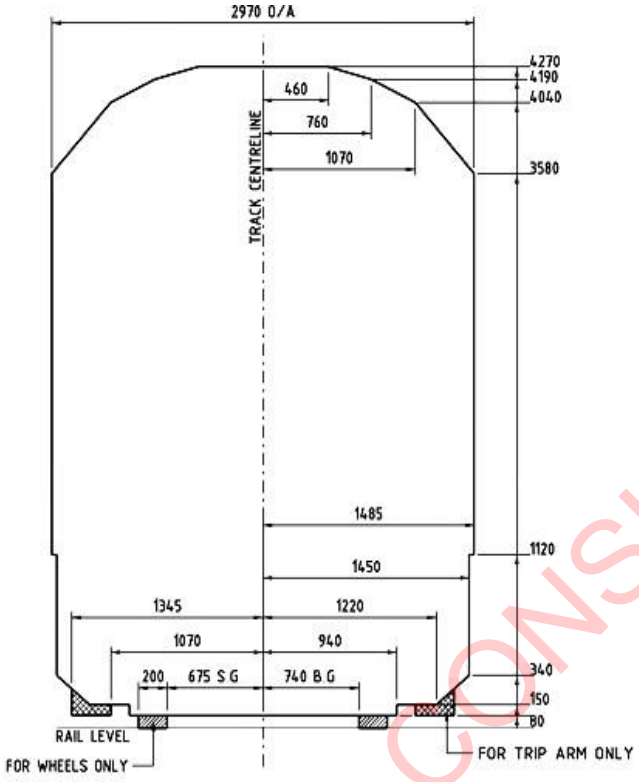
Appendix A Reference Rolling Stock Outlines (Informative)

The content of the subsequent table is current at the time of the development of this document.

Appendix Table A-1 Reference Guide for ARISO Reference Vehicles

ARISO Ref Vehicle No.	Reference Plate Name	ARISO Ref Vehicle No.	Reference Plate Name
1	Interstate Plate A	23	TfNSW Narrow Container
2	Interstate Plate B	24	TfNSW Narrow Square
3	Interstate Plate C	25	TfNSW Intersystem
4	Interstate Plate D	26	TfNSW Narrow Hopper
5	Interstate Plate E	27	TfNSW Medium Electric
6	Interstate Plate F	28	TfNSW Extended Medium
7	ARTC CY4150	29	TfNSW Wide Electric
8	ARTC CZ	30	Adelaide Broad Gauge Passenger Car
9	NSW Double Stack Container	31	WA Narrow Gauge Passenger
10	Melbourne Broad Gauge Suburban Car	32	Arc Infrastructure WA Standard Gauge General
11	Tarcoola to Darwin	33	Arc Infrastructure WA Standard Gauge Double Stack Container
12	Tasmania	34	KiwiRail
13	WA Urban Narrow Gauge Passenger	35	TasRail – All lines except Melba
14	WA Urban Narrow Gauge General	36	TasRail – Melba Line
15	WA Urban Standard & Dual Gauge General	37	Arc Infrastructure WA Narrow Gauge
16	WA Urban Standard & Dual Gauge Legacy	38	Qld Suburban lines
17	Qld Non-Electric Rolling stock	39	TfNSW Sub-Medium Electric
18	Qld Lines	40	VicTrack Single Deck Vehicles
19	Qld Electric Multiple Unit	41	Interstate Plate E1
20	Qld Central Coal Network	42	Interstate Plate F1
21	TfNSW Narrow Non- Electric	43	Interstate Plate F2
22	TfNSW Narrow Electric	44	Interstate Plate H

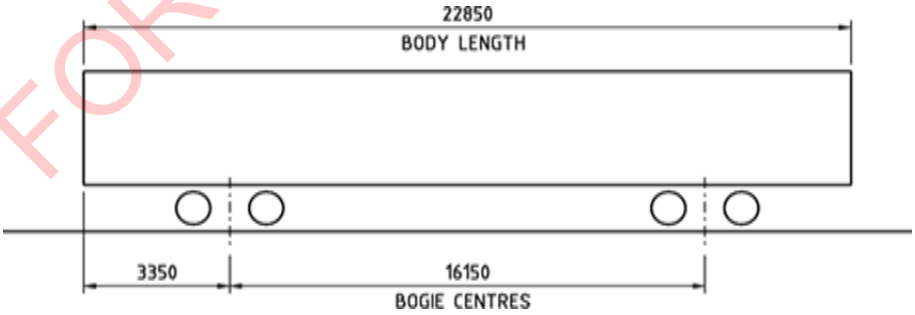
A.1 ARISO Reference Vehicle 1



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

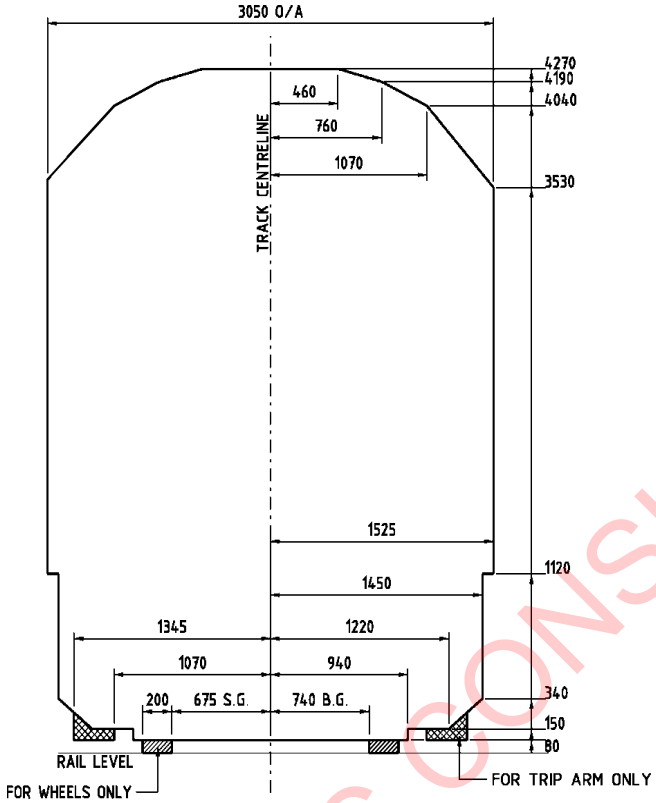
Appendix Table A.1 Kinematic Outline Translations for ARISO Reference Vehicle 1

ARISO 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 ARISO Reference Vehicle 1

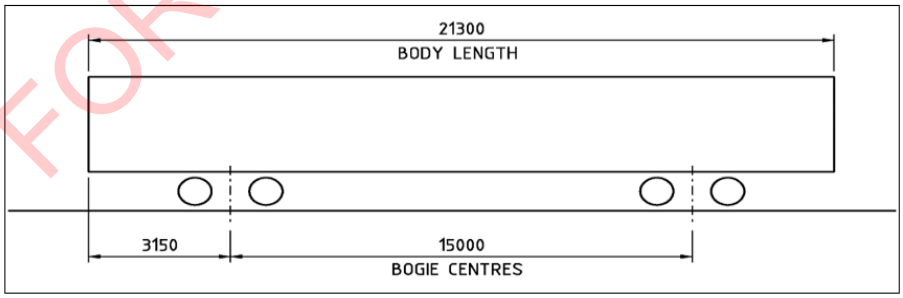
A.2 ARISO Reference Vehicle 2



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

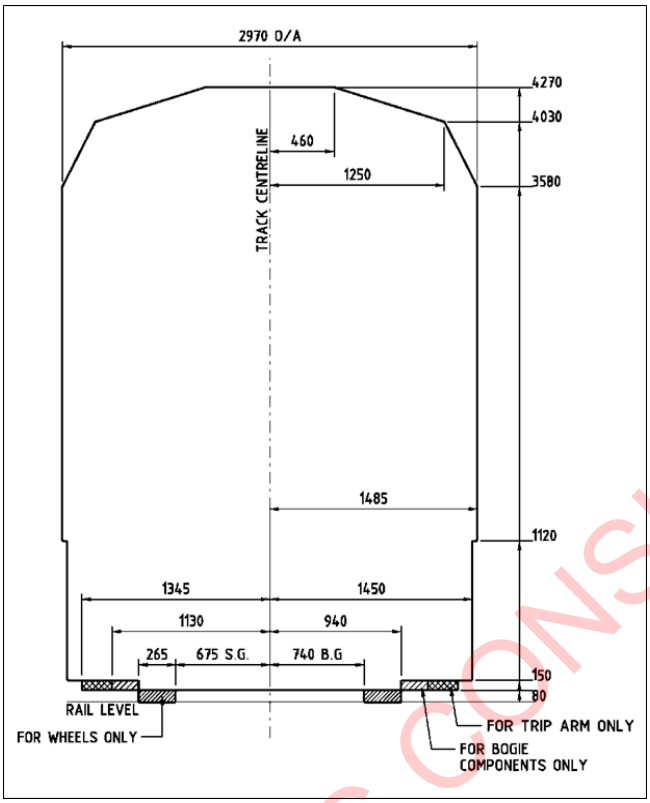
Appendix Table A.2 Kinematic Outline Translations for ARISO Reference Vehicle 2

ARISO 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 ARISO reference vehicle 2

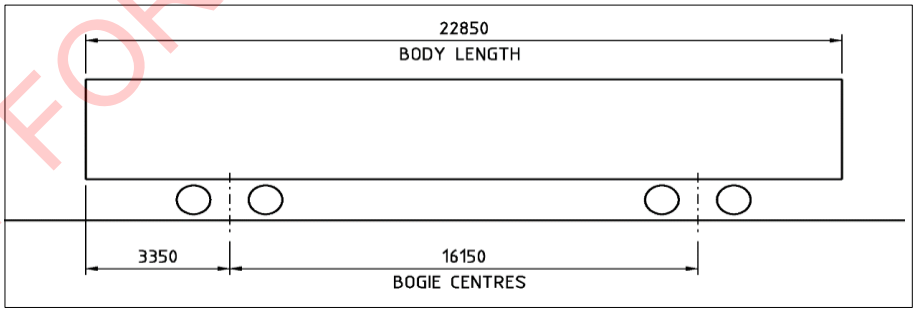
A.3 ARISO Reference Vehicle 3



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

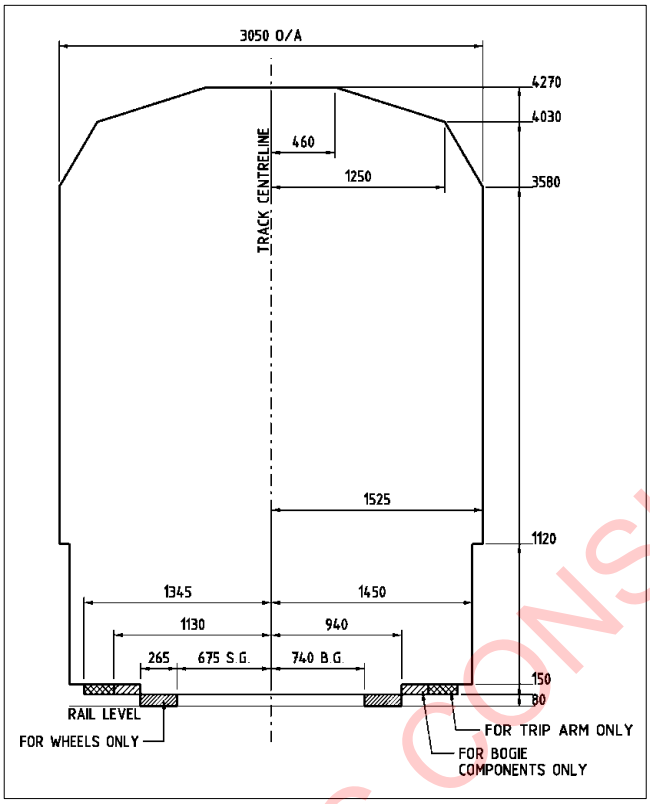
Appendix Table A.3 Kinematic Outline Translations for ARISO Reference Vehicle 3

ARISO 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 ARISO Reference Vehicle 3

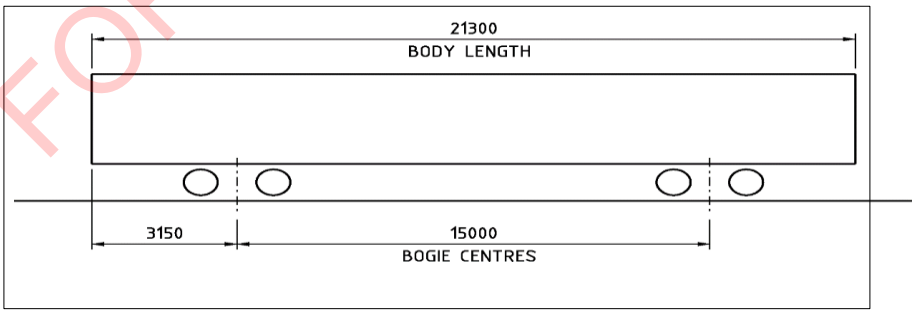
A.4 ARISO Reference Vehicle 4



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

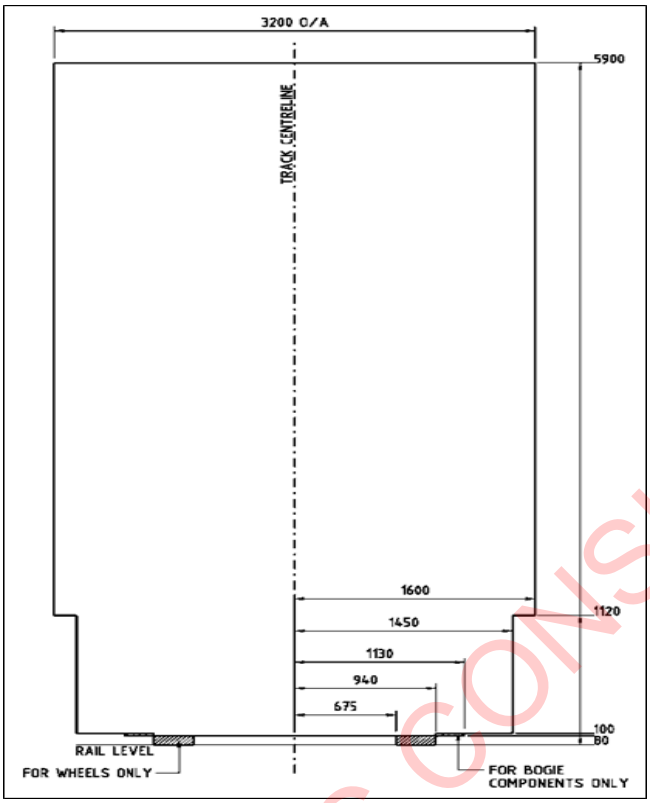
Appendix Table A.4 Kinematic Outline Translations for ARISO Reference Vehicle 4

ARISO 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 ARISO Reference Vehicle 4

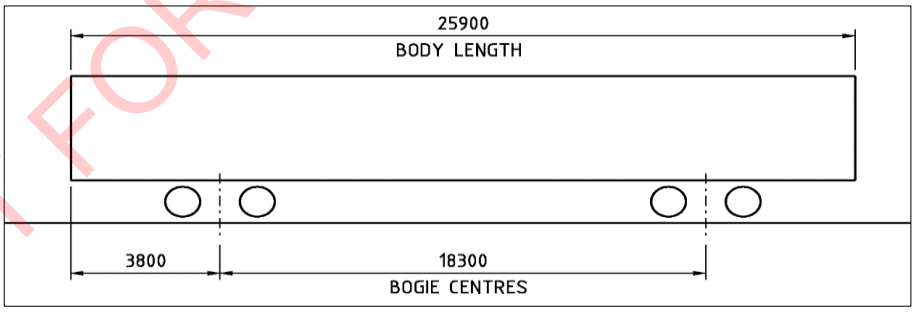
A.5 ARISO Reference Vehicle 5



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

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

ARISO 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

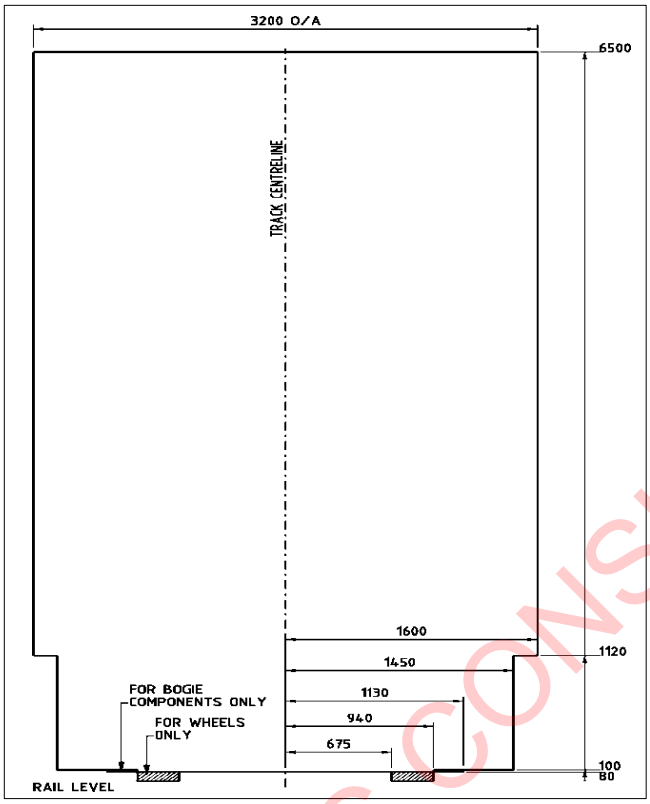


Appendix Figure A.5-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 5

Commentary *CA.5*

Reference vehicle 5, Interstate Plate E is only for existing legacy/historic vehicles.

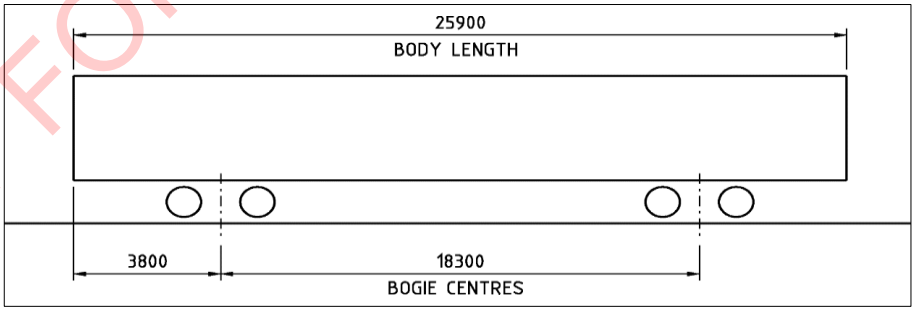
A.6 ARISO Reference Vehicle 6



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

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

ARISO 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

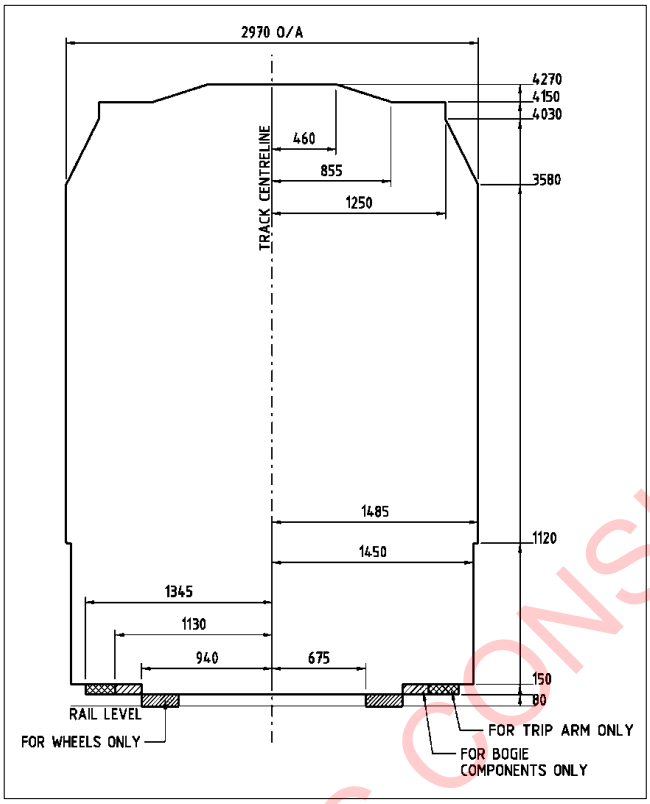


Appendix Figure A.6-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 6

Commentary *CA.6*

Reference vehicle 6, Interstate Plate F is only for existing legacy/historic vehicles.

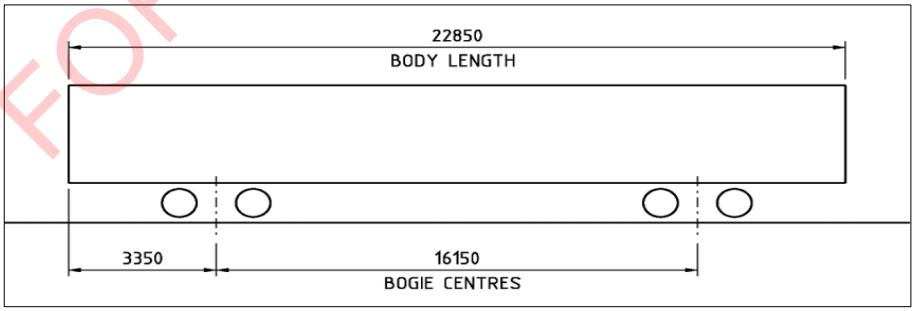
A.7 ARISO Reference Vehicle 7



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

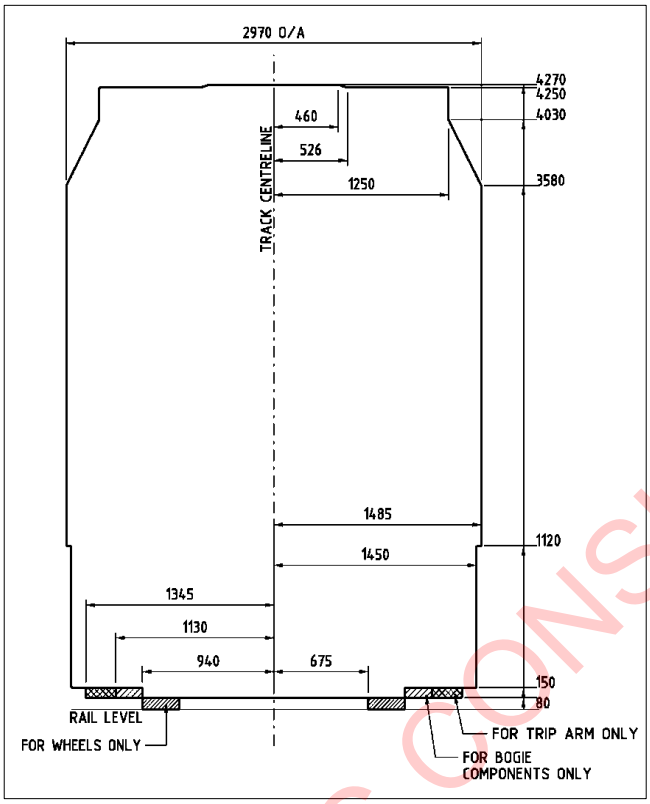
Appendix Table A.7 Kinematic Outline Translations for ARISO Reference Vehicle 7

ARISO 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 ARISO Reference Vehicle 7

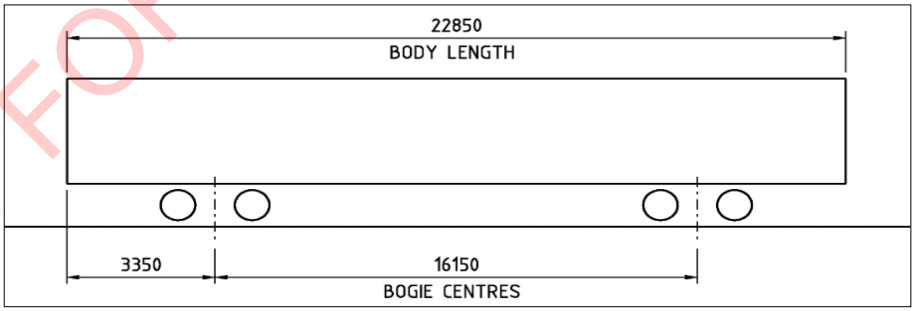
A.8 ARISO Reference Vehicle 8



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

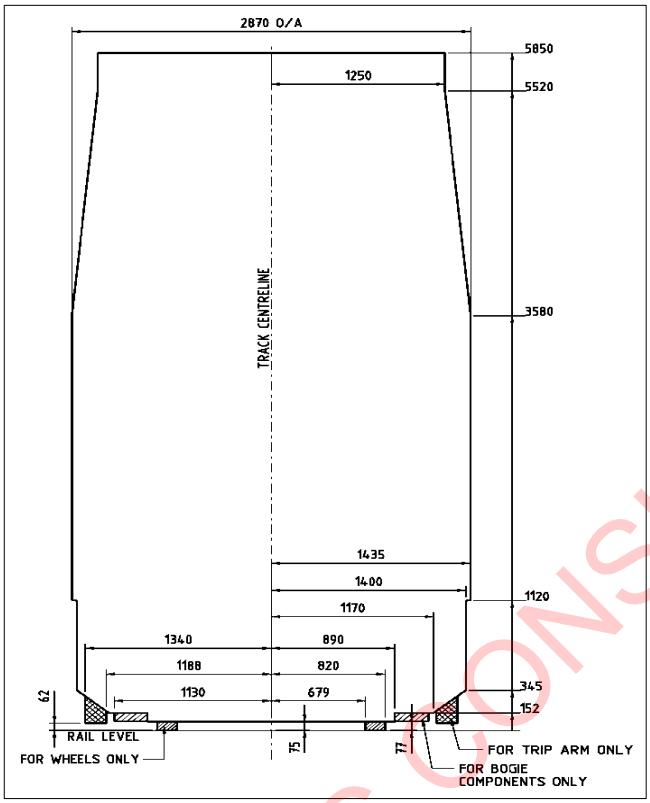
Appendix Table A.8 Kinematic Outline Translations for ARISO Reference Vehicle 8

ARISO 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 ARISO Reference Vehicle 8

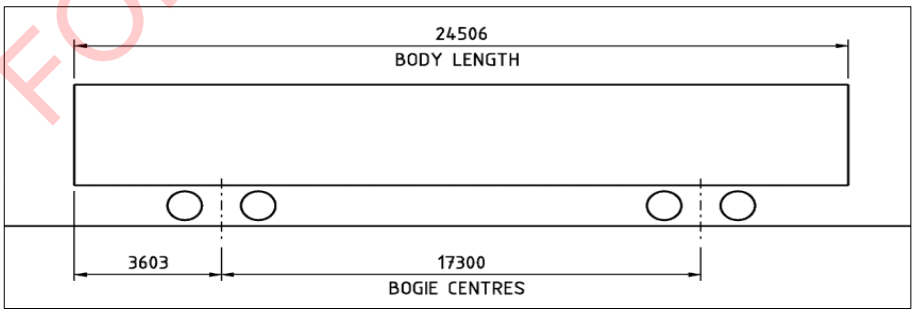
A.9 ARISO Reference Vehicle 9



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

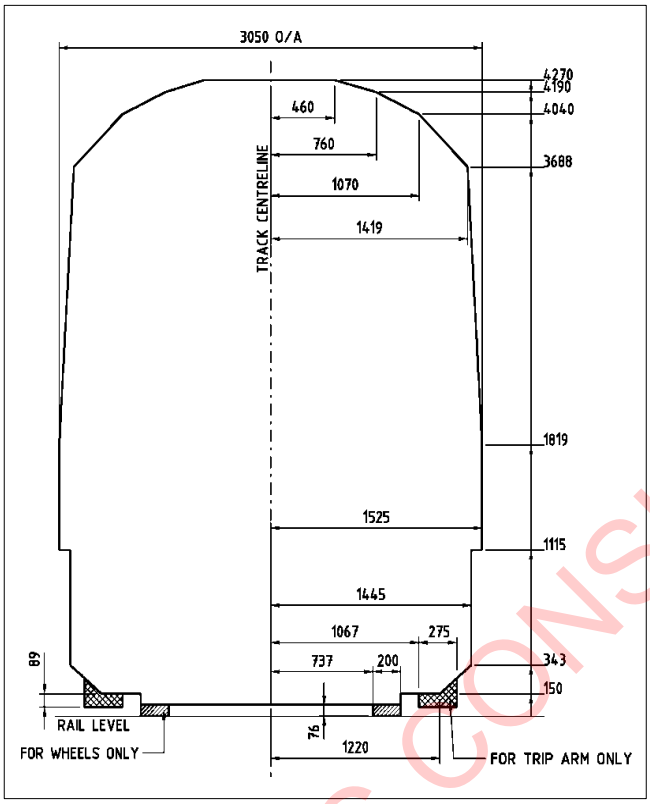
Appendix Table A.9 Kinematic Outline Translations for ARISO Reference Vehicle 9

ARISO 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 ARISO Reference Vehicle 9

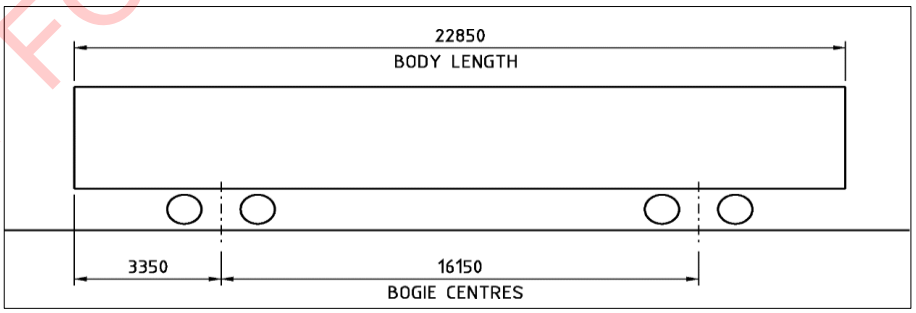
A.10 ARISO Reference Vehicle 10



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

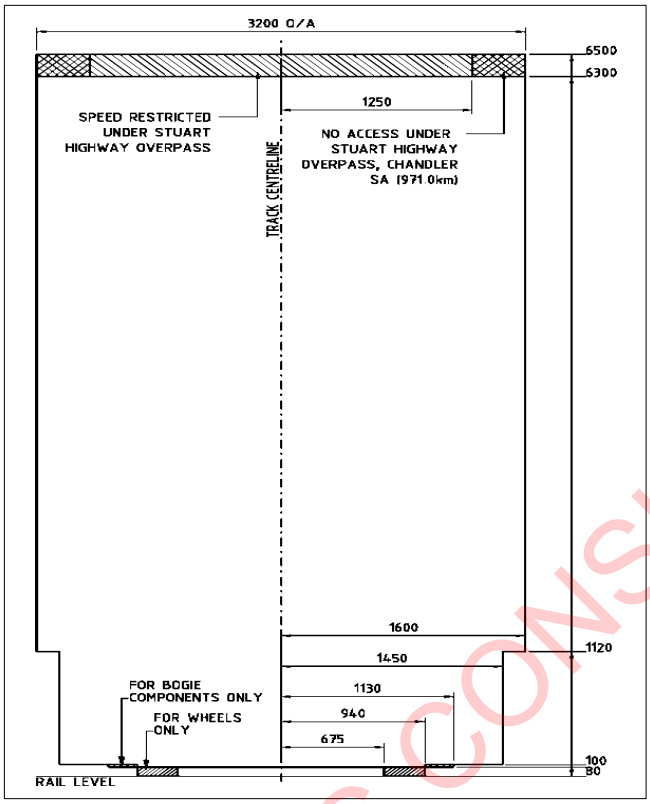
Appendix Table A.10 Kinematic Outline Translations for ARISO Reference Vehicle 10

ARISO 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 ARISO Reference Vehicle 10

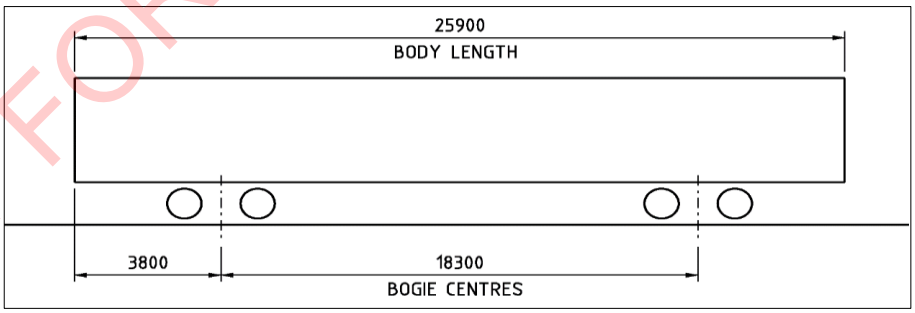
A.11 ARISO Reference Vehicle 11



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

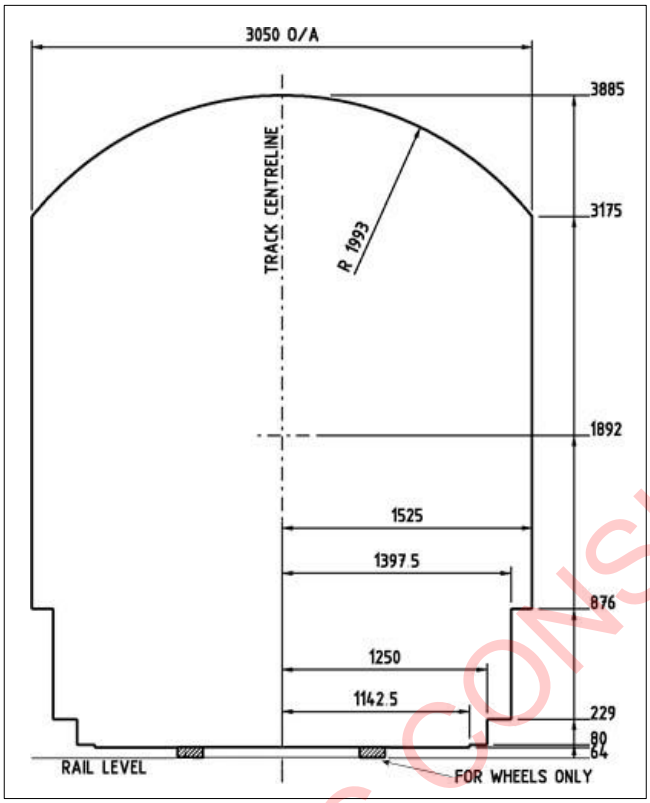
Appendix Table A.11 Kinematic Outline Translations for ARISO Reference Vehicle 11

ARISO 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 ARISO Reference Vehicle 11

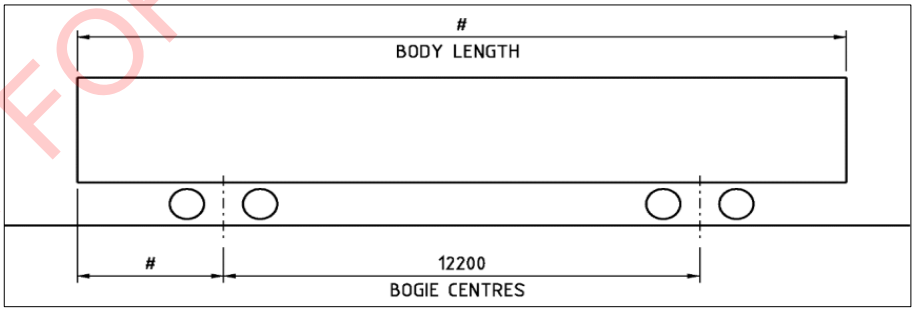
A.12 ARISO Reference Vehicle 12



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

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

ARISO 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	(?)

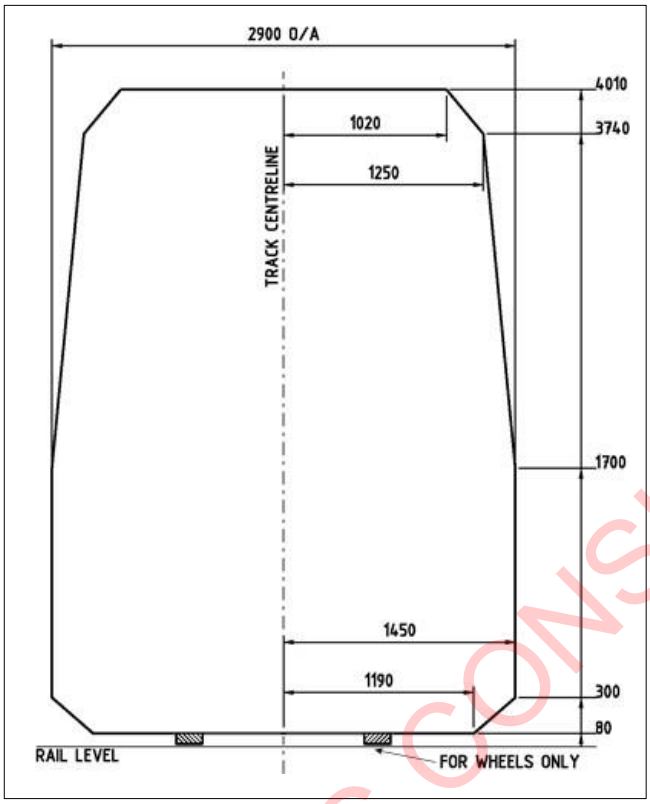


Appendix Figure A.12-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 12

Commentary *CA.12*

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

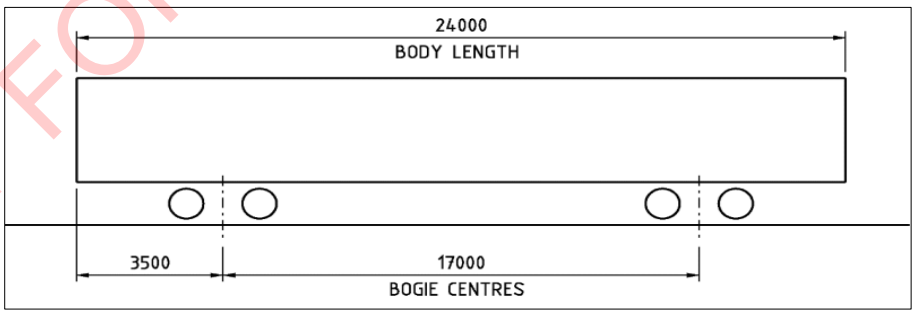
A.13 ARISO Reference Vehicle 13



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

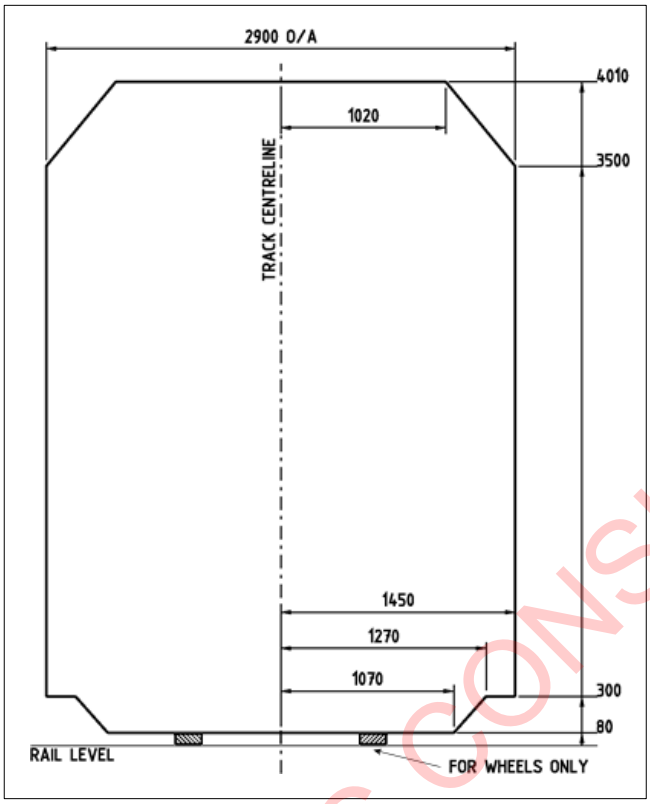
Appendix Table A.13 Kinematic Outline Translations for ARISO Reference Vehicle 13

ARISO Reference Vehicle 13	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
WA Urban Narrow Gauge Passenger	60	3.5	1,000	50	15



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

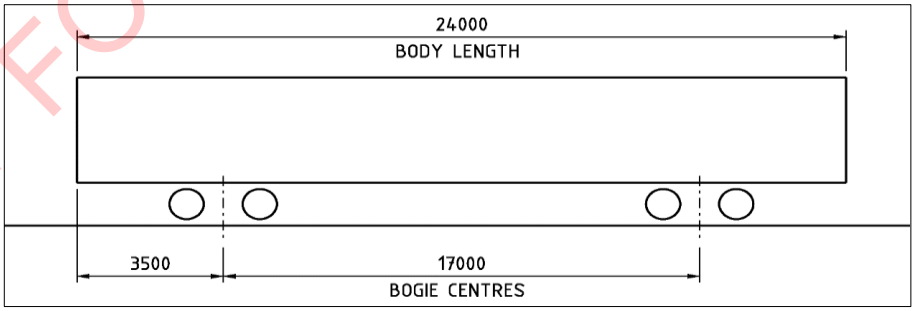
A.14 ARISO Reference Vehicle 14



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

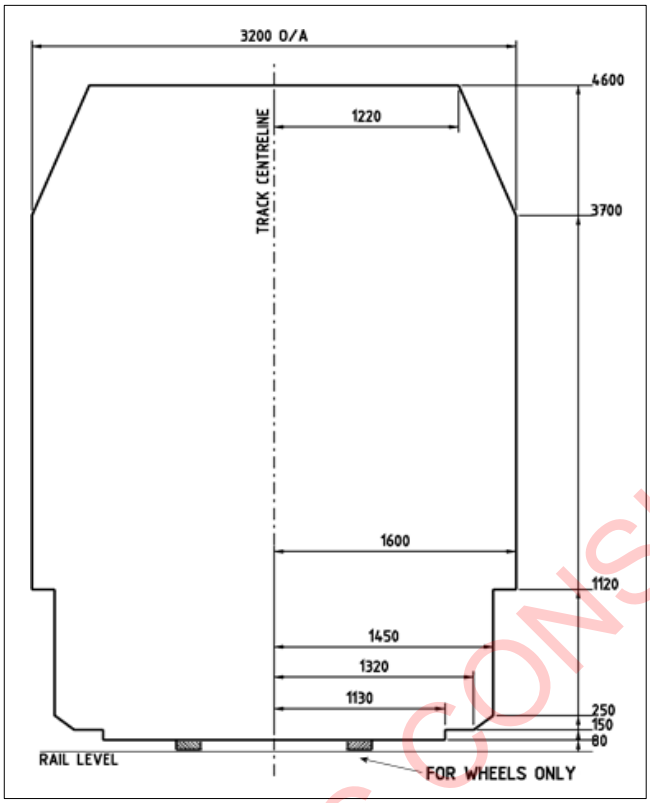
Appendix Table A.14 Kinematic outline translations for ARISO Reference Vehicle 14

ARISO Reference Vehicle 14	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
WA Urban Narrow Gauge General	20	1.0	610	25	20



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

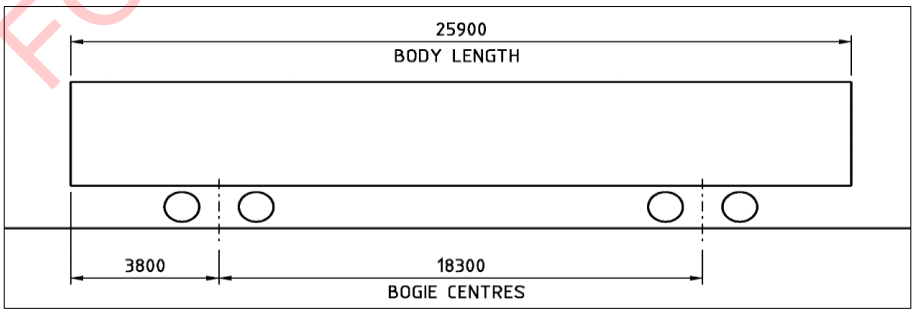
A.15 ARISO Reference Vehicle 15



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

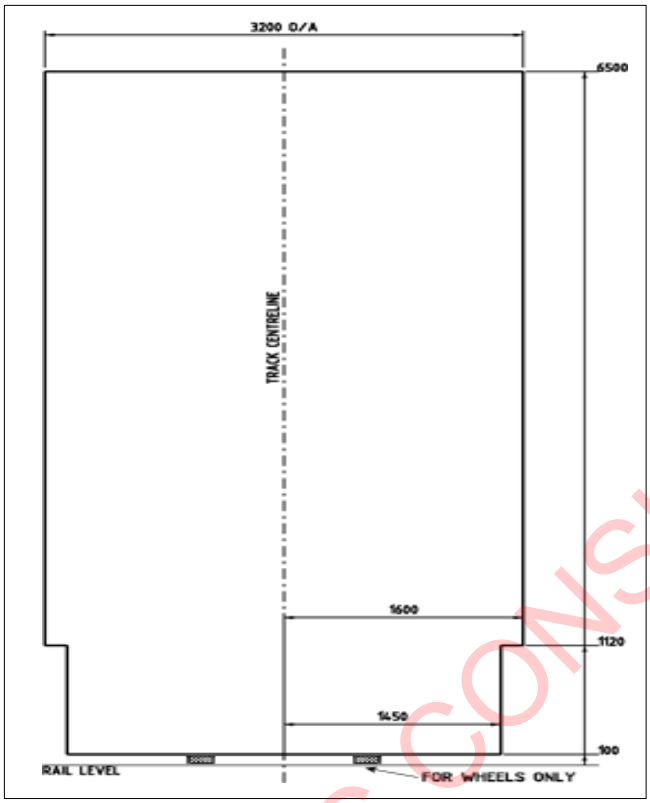
Appendix Table A.15 Kinematic Outline Translations for ARISO Reference Vehicle 15

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



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

A.16 ARISO Reference Vehicle 16



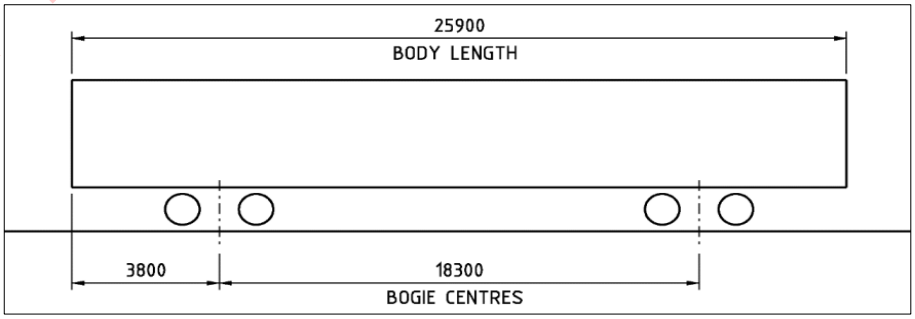
Appendix Figure A.16-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 16

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

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

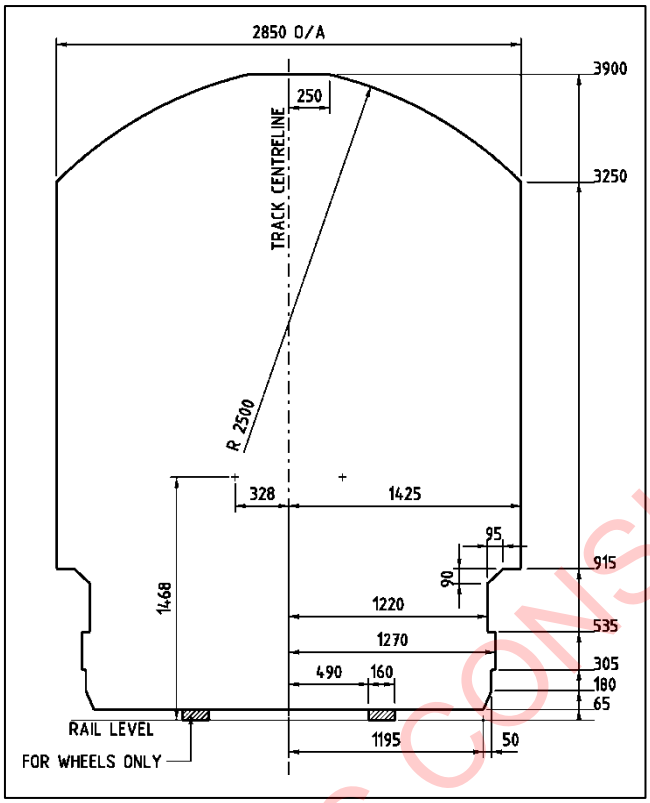
Commentary *CA.16*

This Reference Vehicle is no longer in use and is provided for legacy purposes.



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

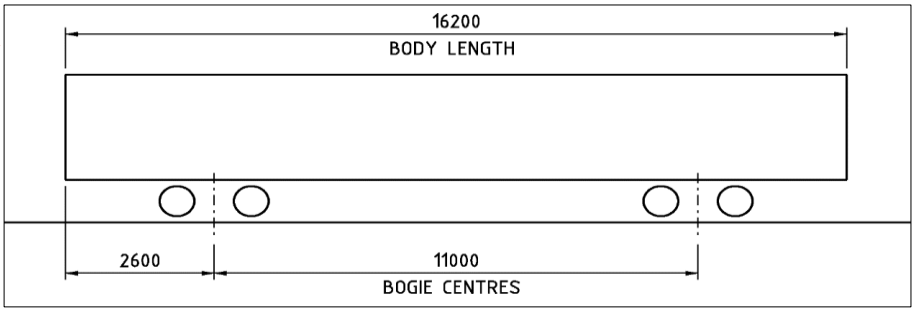
A.17 ARISO Reference Vehicle 17



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

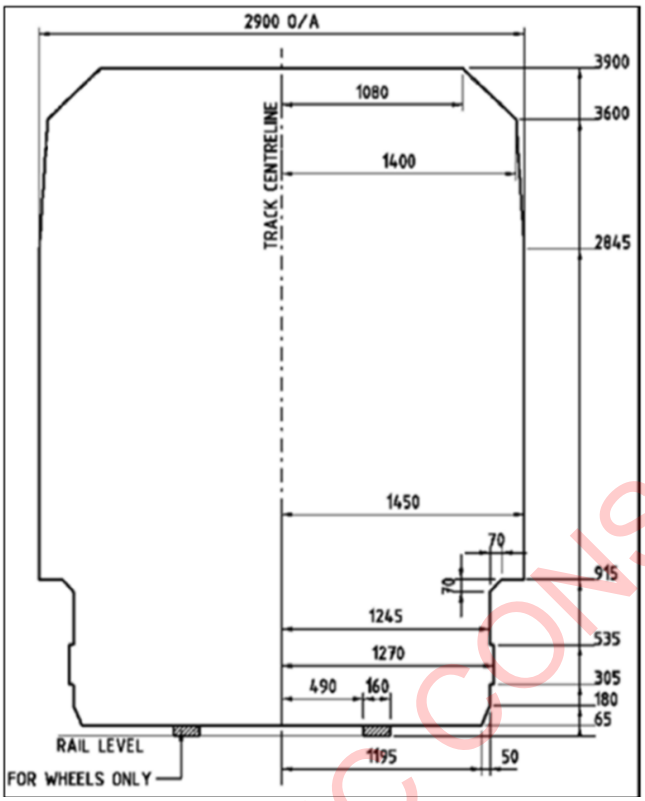
Appendix Table A.17 Kinematic Outline Translations for ARISO Reference Vehicle 17

ARISO 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	1.25	1,100	50/25	11
Commentary *CA.17* +/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only. 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 ARISO Reference Vehicle 17

A.18 ARISO Reference Vehicle 18



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

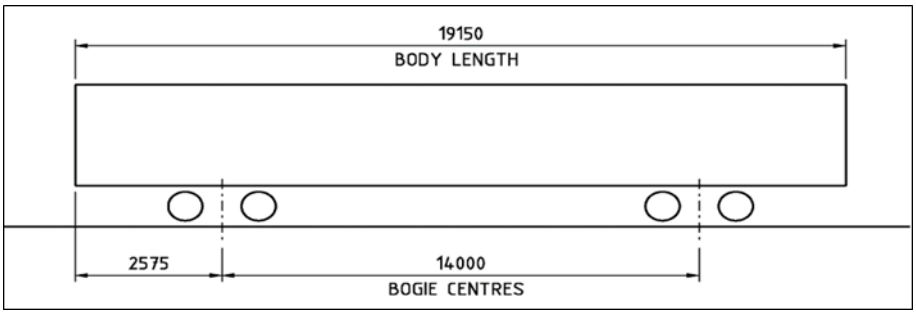
Appendix Table A.18 Kinematic Outline Translations for ARISO Reference Vehicle 18

ARISO Reference Vehicle 18	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Lines	**43**	**1.25**	**1,100**	**50/25**	**11**

Commentary *C.A.18*

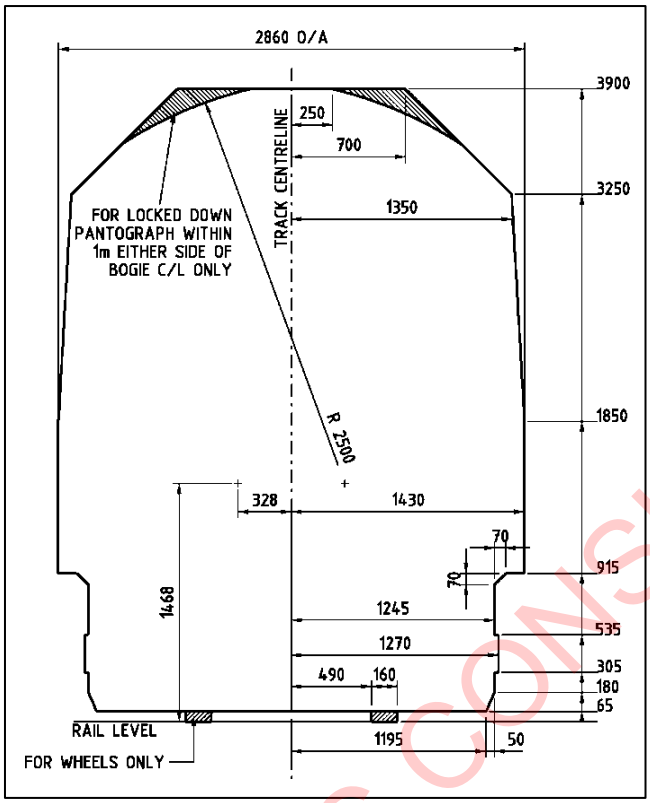
+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

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



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

A.19 ARISO Reference Vehicle 19



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

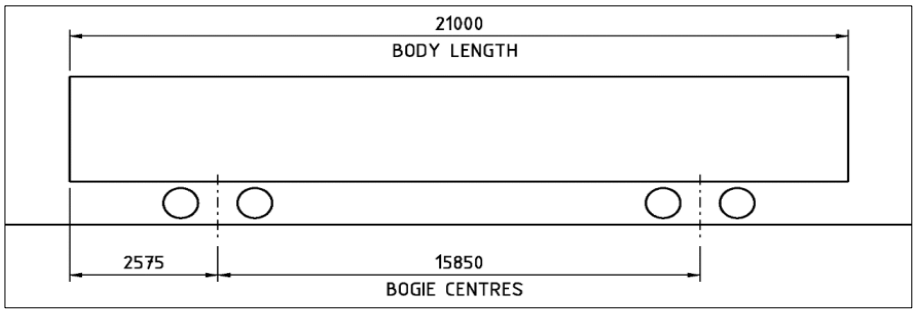
Appendix Table A.19 Kinematic Outline Translations for ARISO Reference Vehicle 19

ARISO 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*

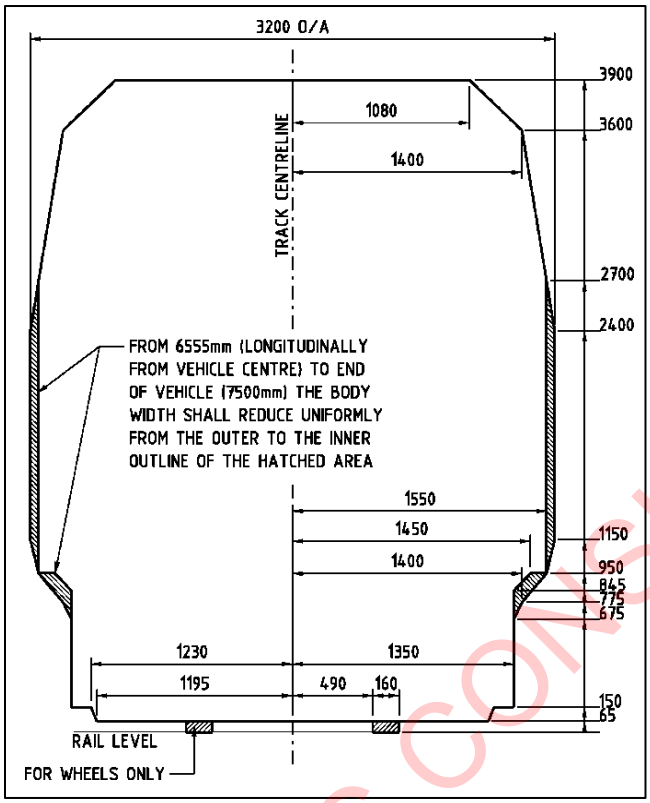
+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

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 ARISO Reference Vehicle 19

A.20 ARISO Reference Vehicle 20



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

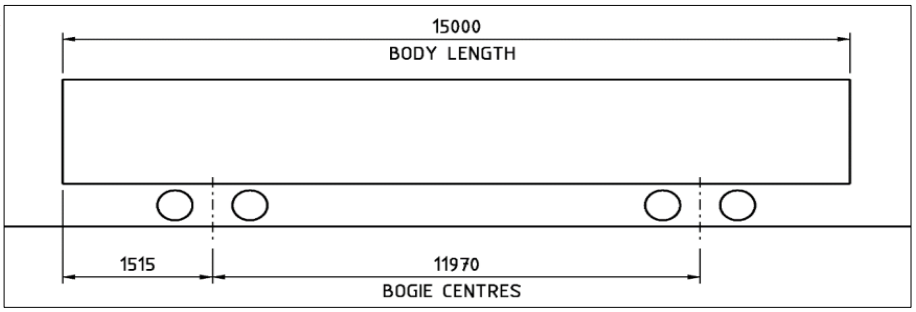
Appendix Table A.20 Kinematic Outline Translations for ARISO Reference Vehicle 20

ARISO 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	2.0	610	50/25	11

Commentary *C.A.20*

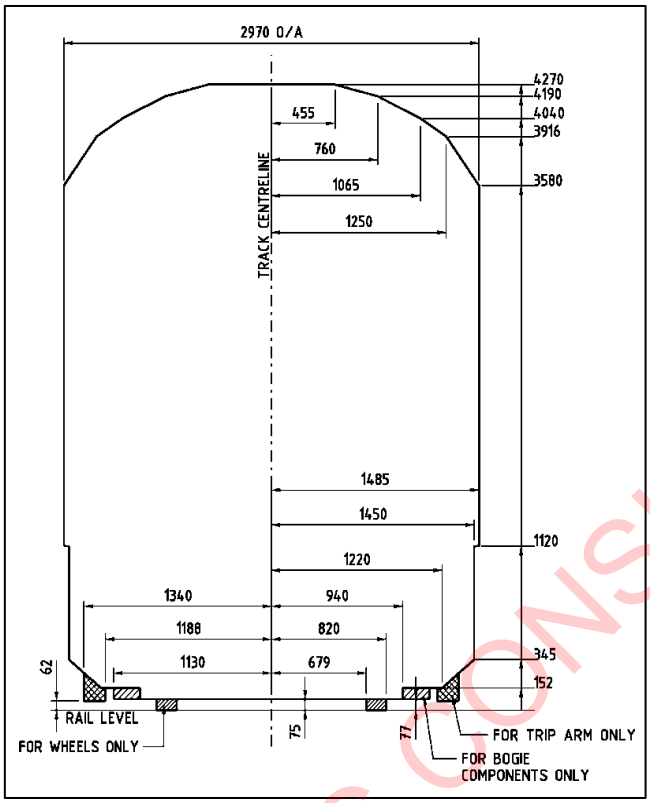
+/-2.0^{o} of body roll displacement is applied to all points above the point of rotation only.

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 ARISO Reference Vehicle 20

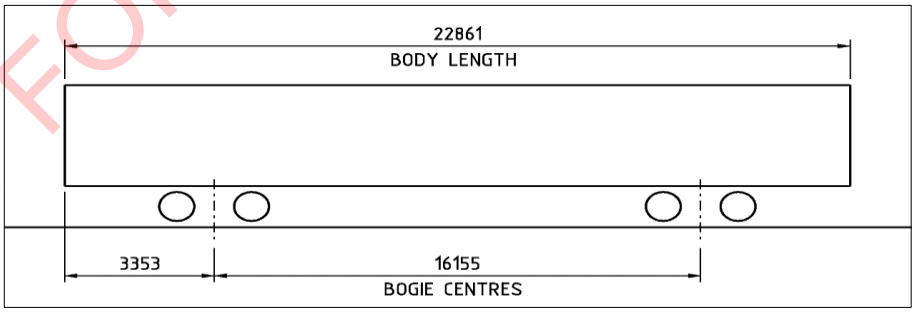
A.21 ARISO Reference Vehicle 21



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

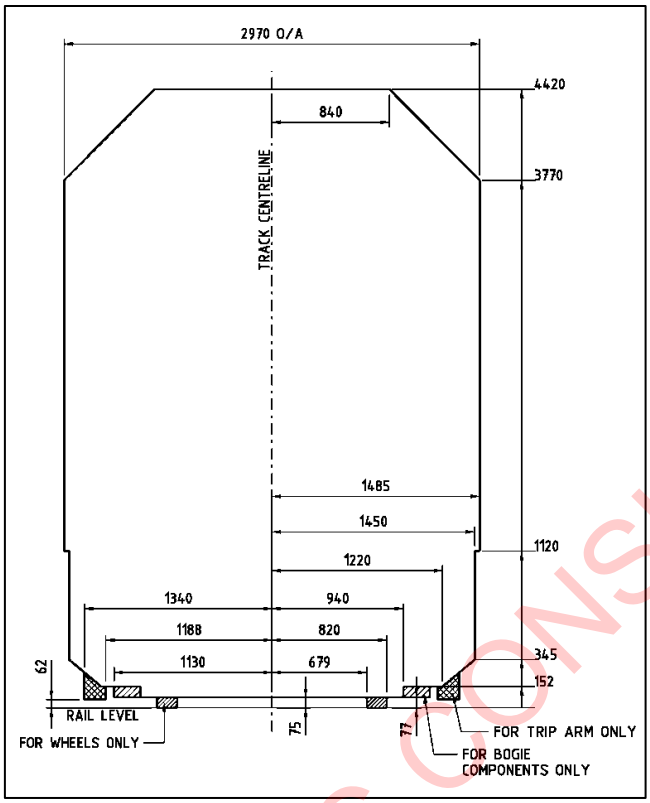
Appendix Table A.21 Kinematic Outline Translations for ARISO Reference Vehicle 21

ARISO 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 ARISO Reference Vehicle 21

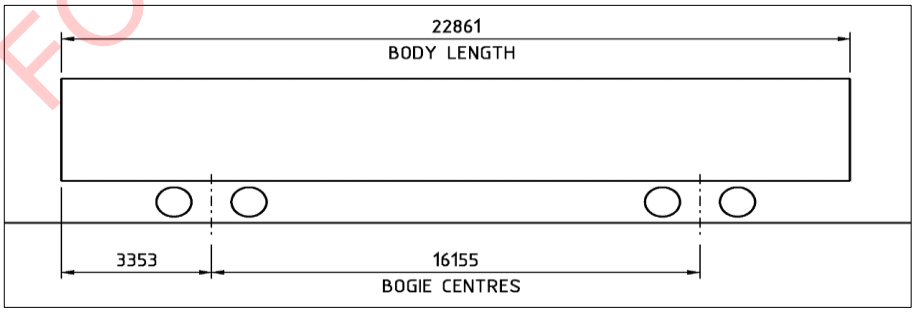
A.22 ARISO Reference Vehicle 22



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

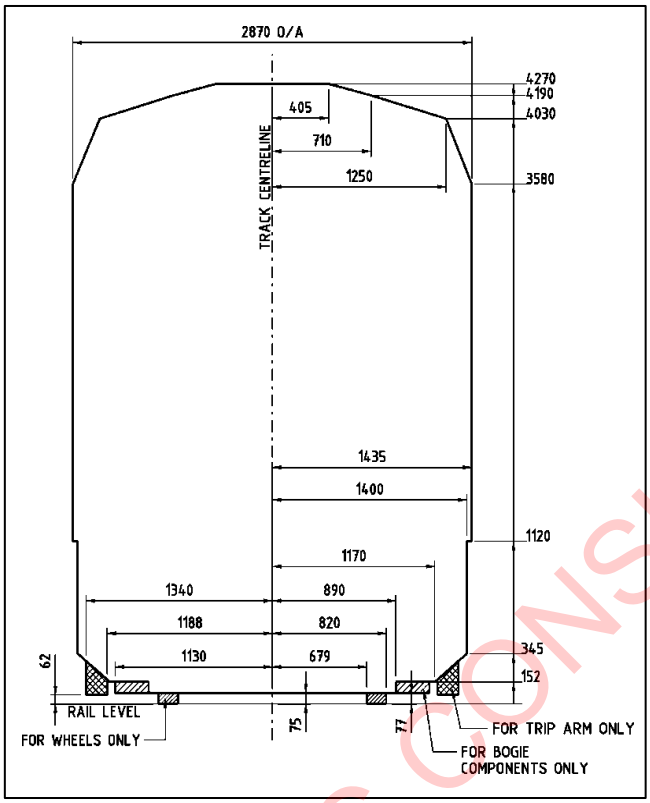
Appendix Table A.22 Kinematic Outline Translations for ARISO Reference Vehicle 22

ARISO 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 ARISO Reference Vehicle 22

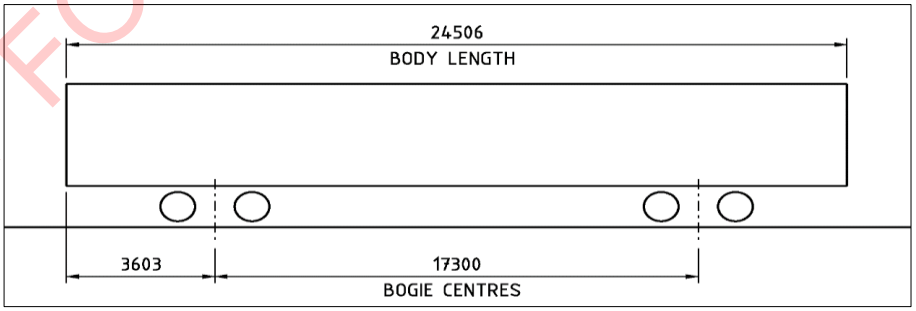
A.23 ARISO Reference Vehicle 23



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

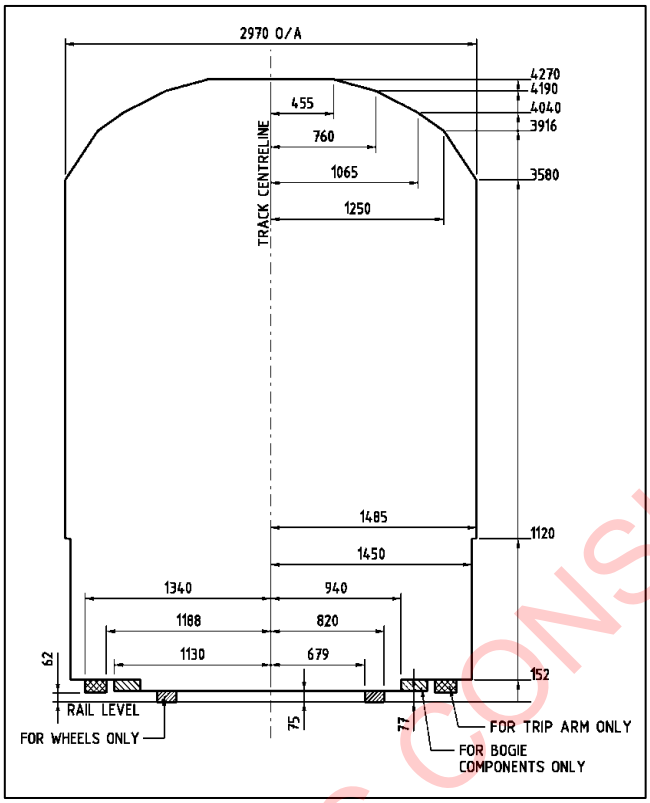
Appendix Table A.23 Kinematic Outline Translations for ARISO Reference Vehicle 23

ARISO 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 ARISO Reference Vehicle 23

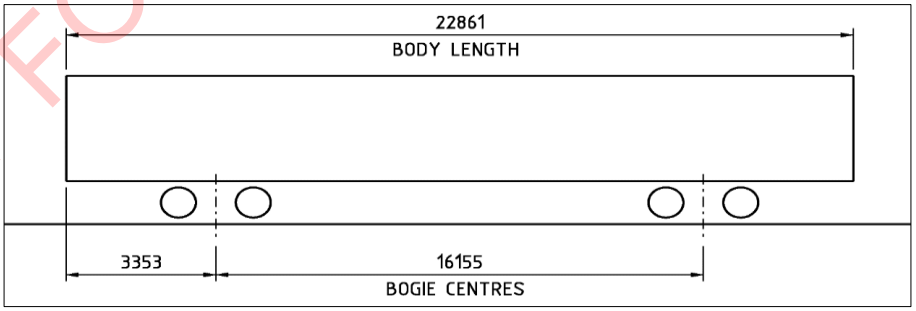
A.24 ARISO Reference Vehicle 24



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

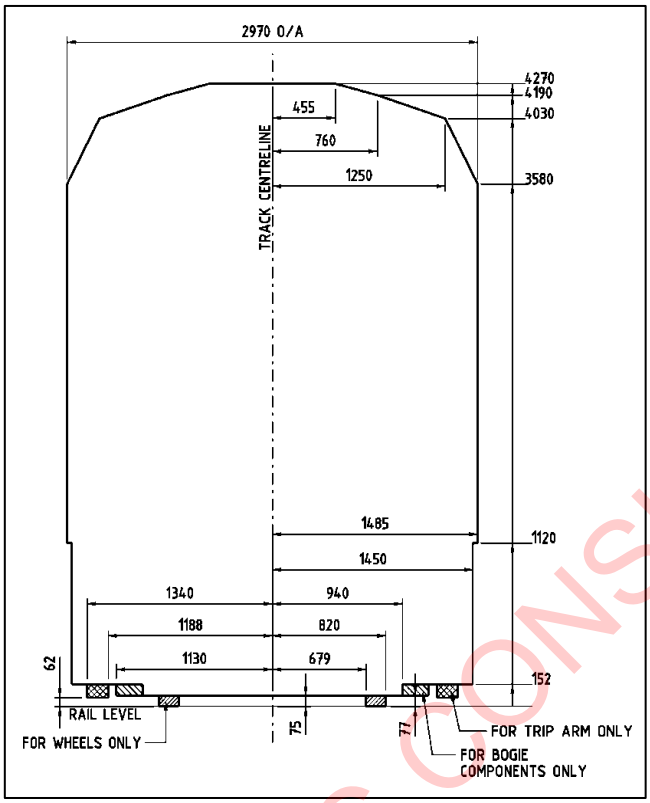
Appendix Table A.24 Kinematic Outline Translations for ARISO Reference Vehicle 24

ARISO 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 ARISO Reference Vehicle 24

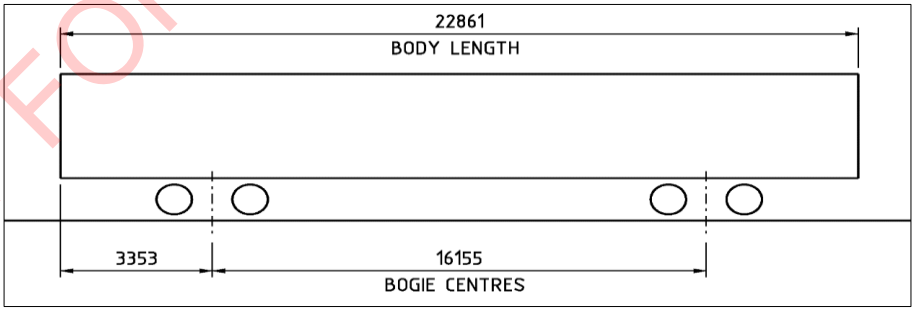
A.25 ARISO Reference Vehicle 25



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

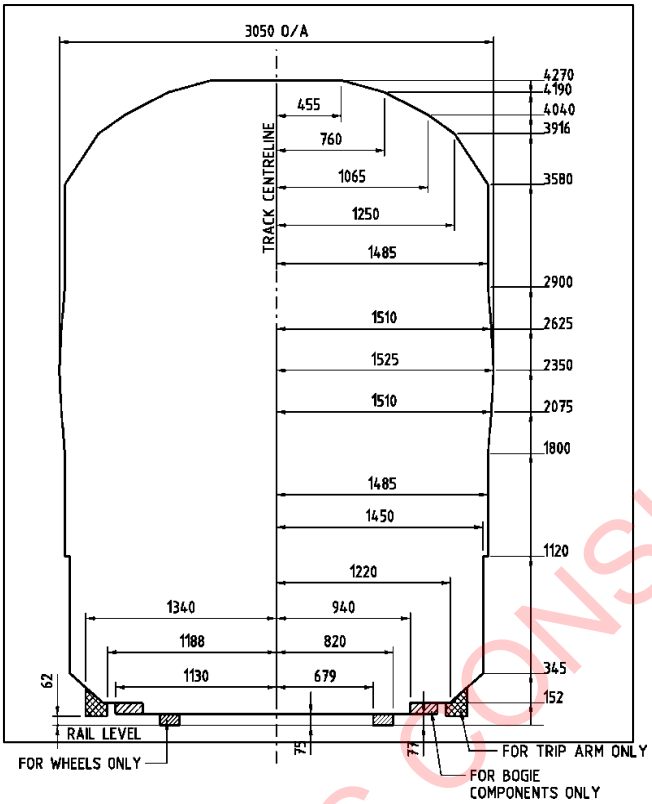
Appendix Table A.25 Kinematic Outline Translations for ARISO Reference Vehicle 25

ARISO 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 ARISO Reference Vehicle 25

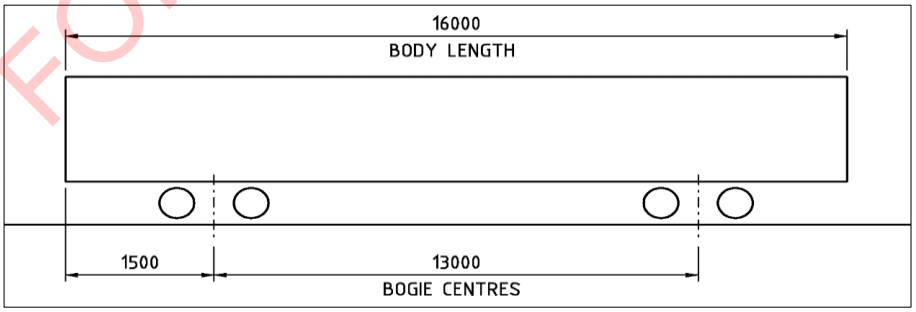
A.26 ARISO Reference Vehicle 26



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

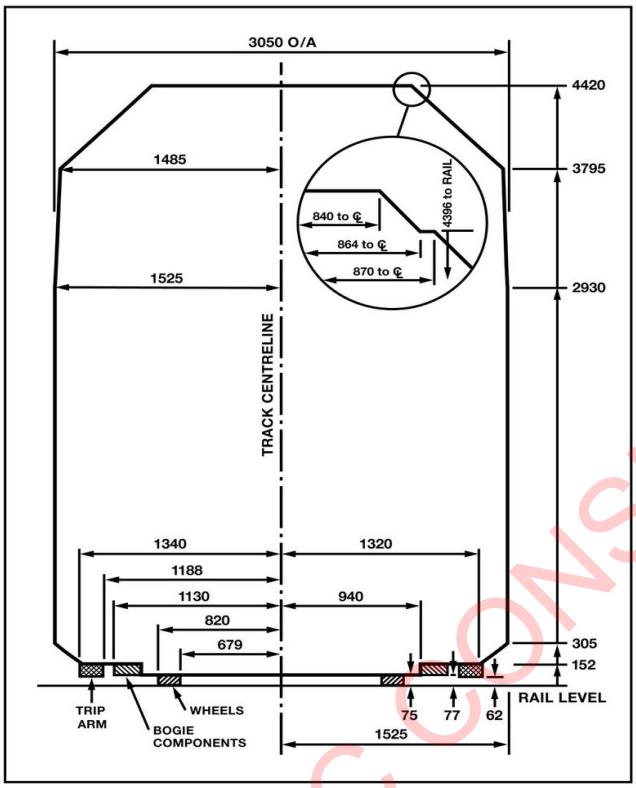
Appendix Table A.26 Kinematic Outline Translations for ARISO Reference Vehicle 26

ARISO 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 ARISO Reference Vehicle 26

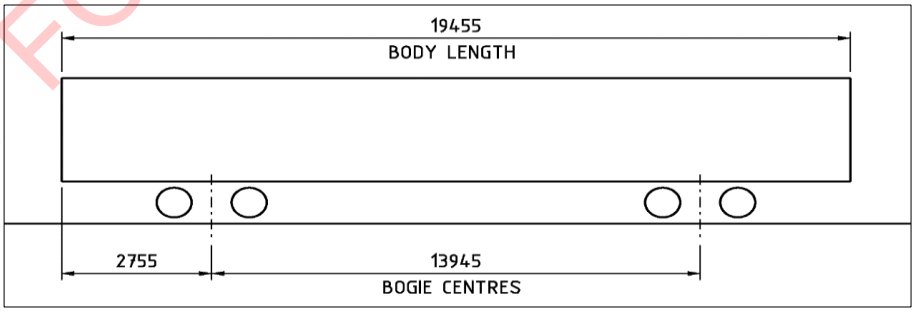
A.27 ARISO Reference Vehicle 27



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

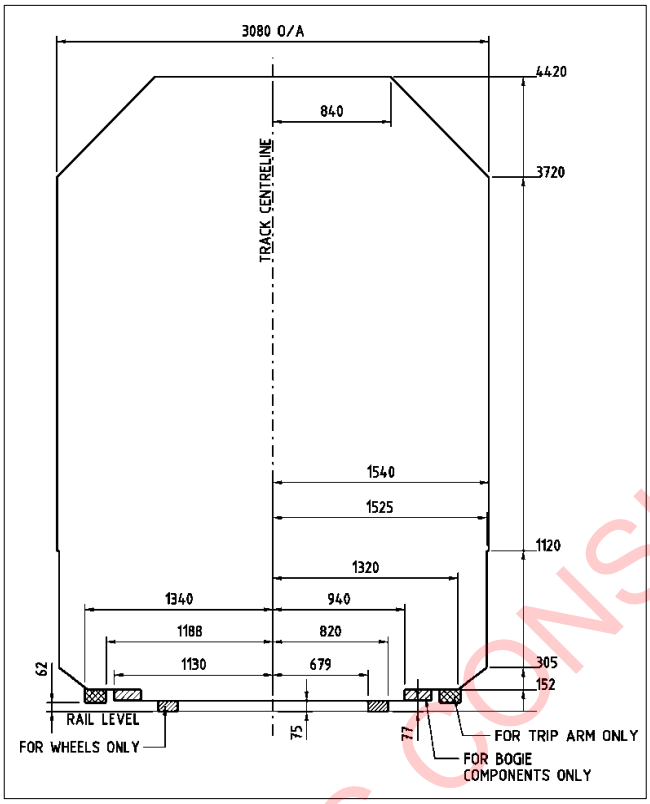
Appendix Table A.27 Kinematic Outline Translation ARISO Reference Vehicle 27

ARISO 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 ARISO Reference Vehicle 27

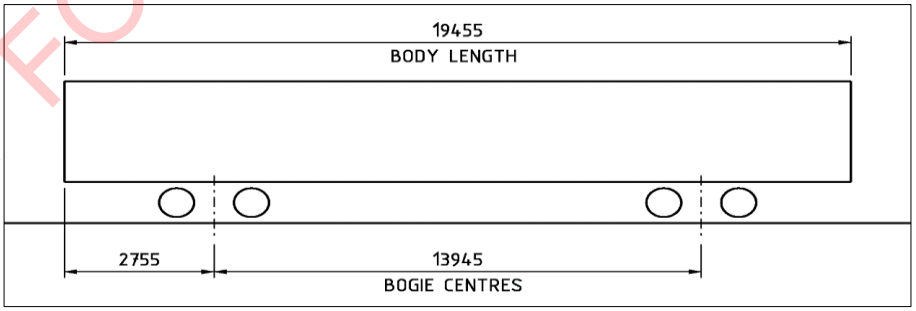
A.28 ARISO Reference Vehicle 28



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

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

ARISO 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

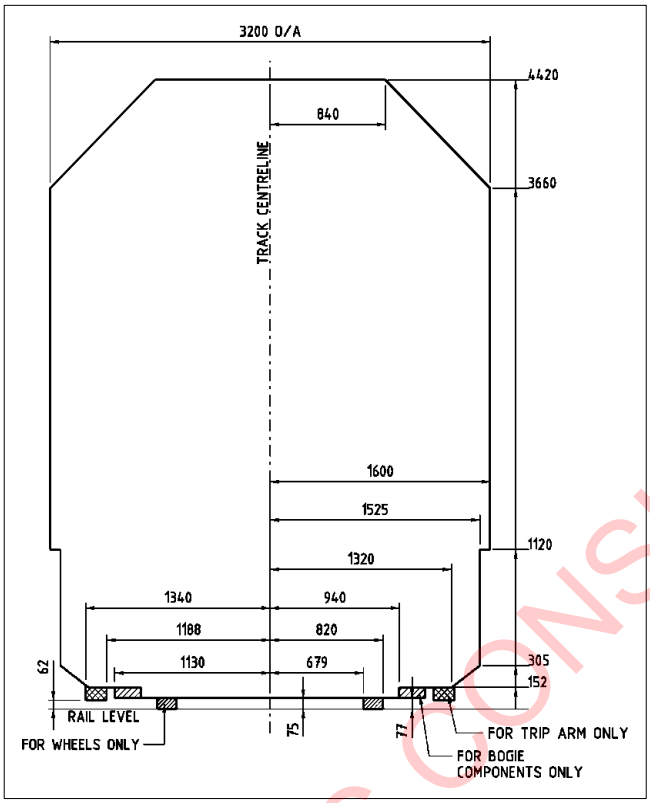


Appendix Figure A.28-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 28

Commentary *CA.28*

Reference Vehicle 28, NSW Extended Medium is only for existing legacy/historic vehicles.

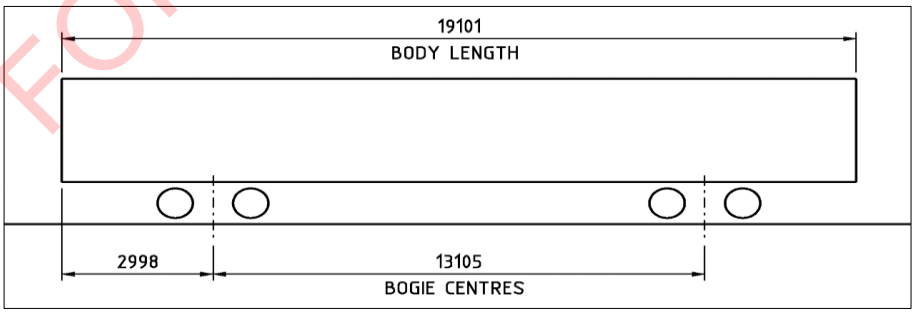
A.29 ARISO Reference Vehicle 29



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

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

ARISO 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

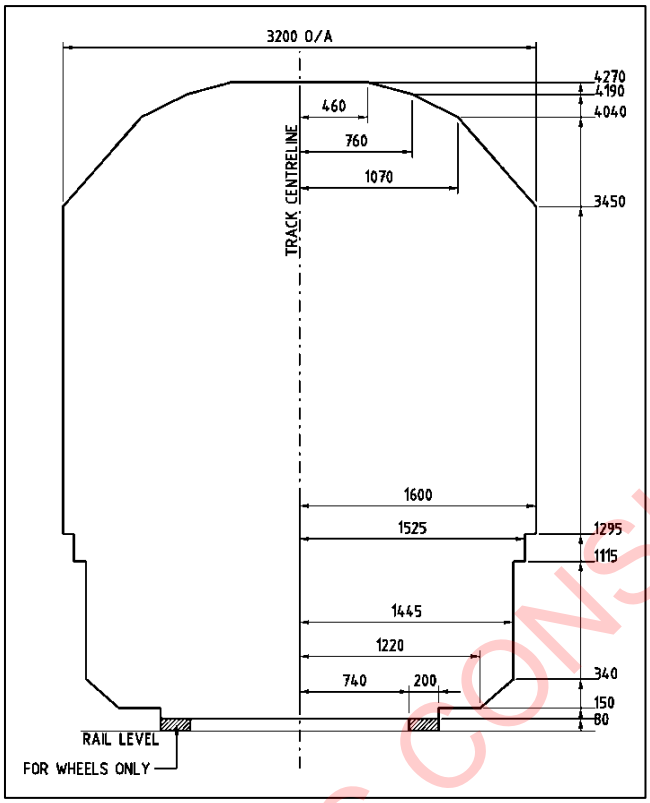


Appendix Figure A.29-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 29

Commentary *CA.29*

Reference Vehicle 29, NSW Extended Medium is only for existing legacy/historic vehicles.

A.30 ARISO Reference Vehicle 30



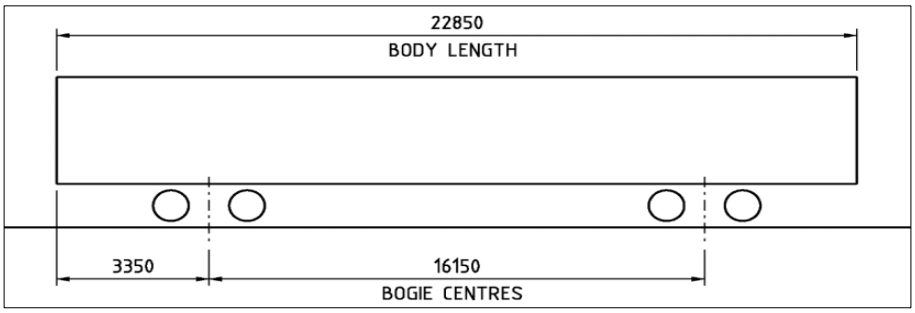
Appendix Figure A.30-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 30

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

ARISO 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

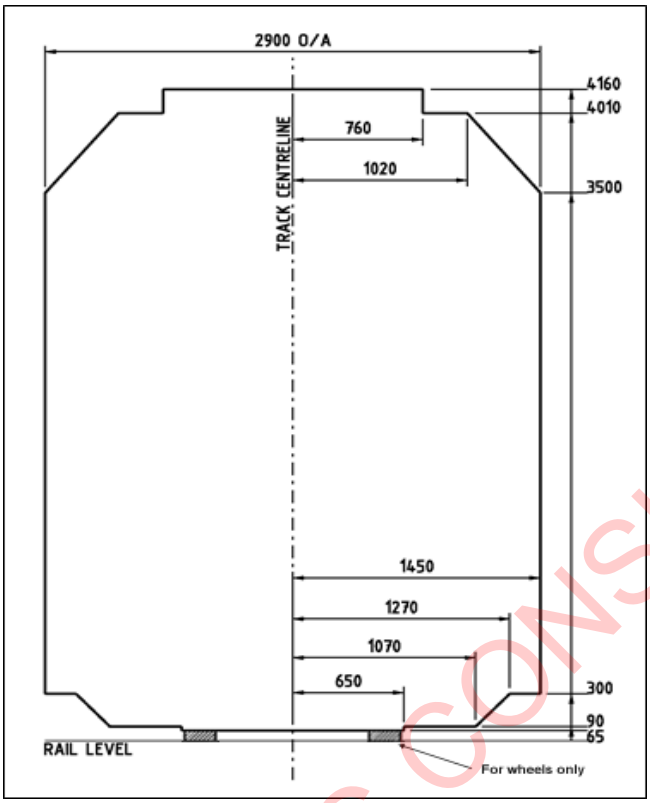
Commentary *C.A.30*

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 ARISO Reference Vehicle 30

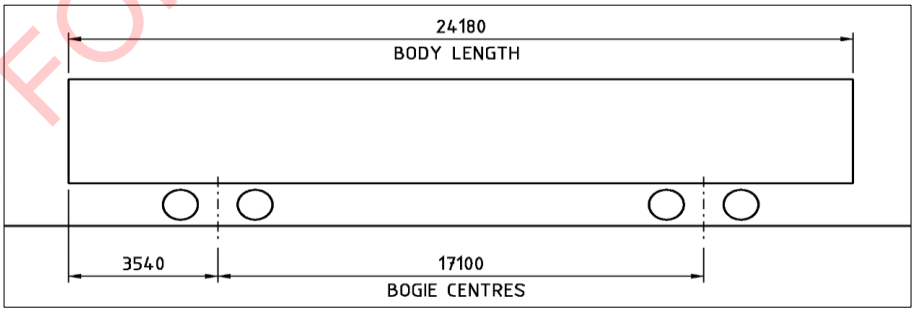
A.31 ARISO Reference Vehicle 31



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

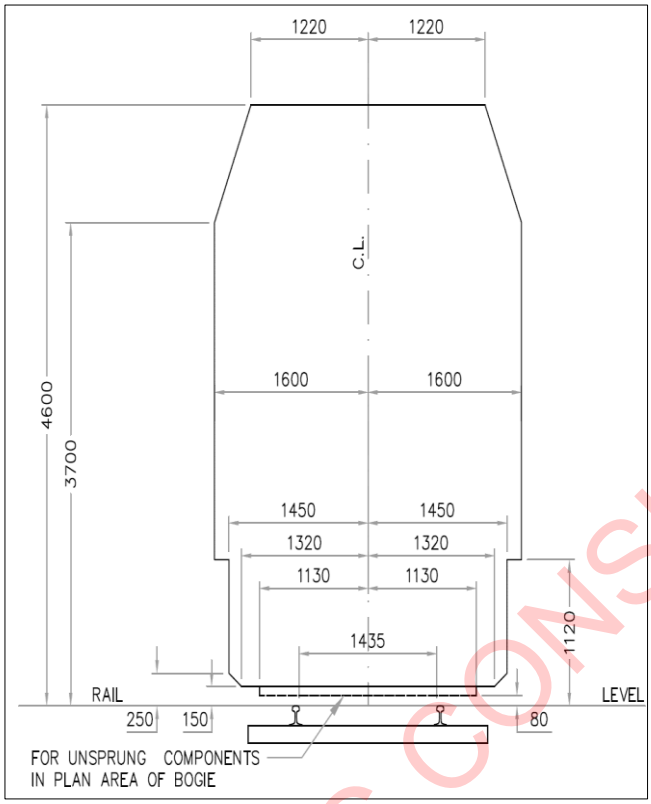
Appendix Table A.31 Kinematic outline translations for ARISO Reference Vehicle 31

ARISO 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 ARISO Reference Vehicle 31

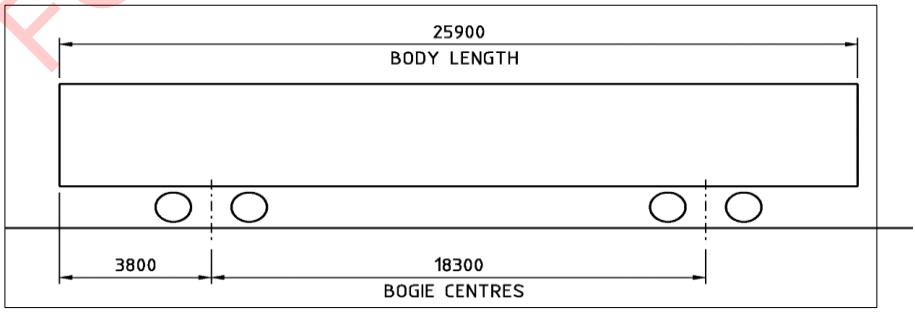
A.32 ARISO Reference Vehicle 32



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

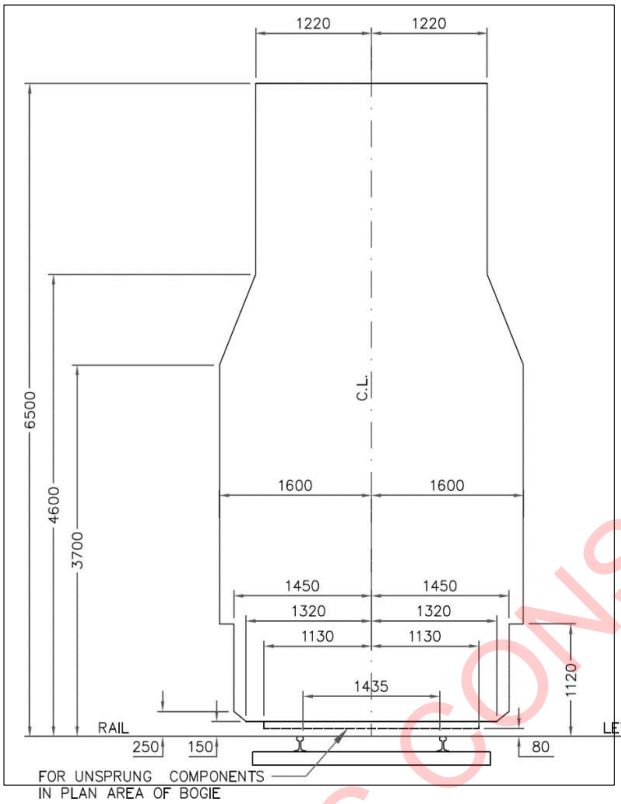
Appendix Table A.32 Kinematic outline translations for ARISO Reference Vehicle 32

ARISO Reference Vehicle 32	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Arc Infrastructure WA Standard Gauge General	40	2.0	610	50	20



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

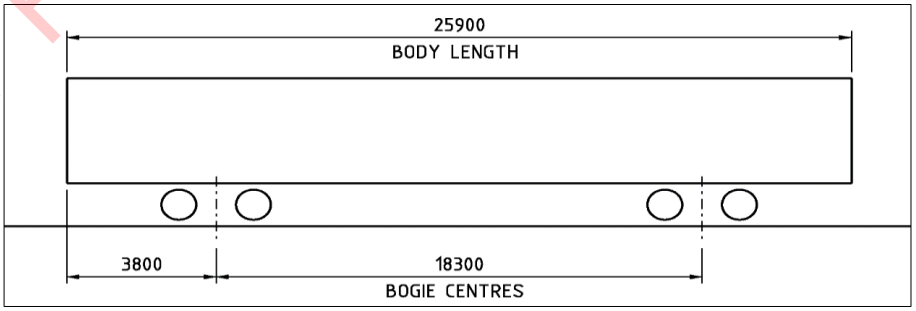
A.33 ARISO Reference Vehicle 33



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

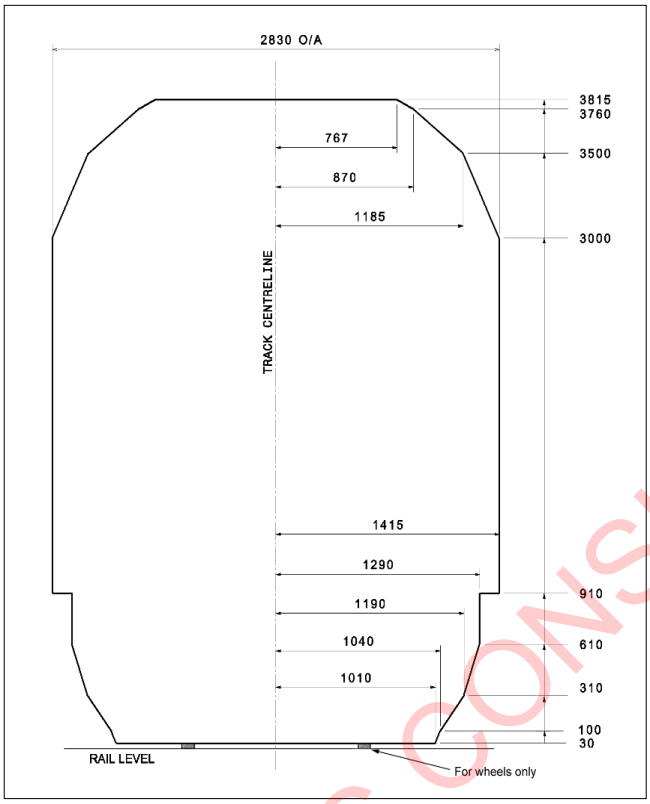
Appendix Table A.33 Kinematic Outline Translations for ARISO Reference Vehicle 33

ARISO Reference Vehicle 33	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Arc Infrastructure WA Standard Gauge Double Stack Container	40	2.5	440	50	20



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

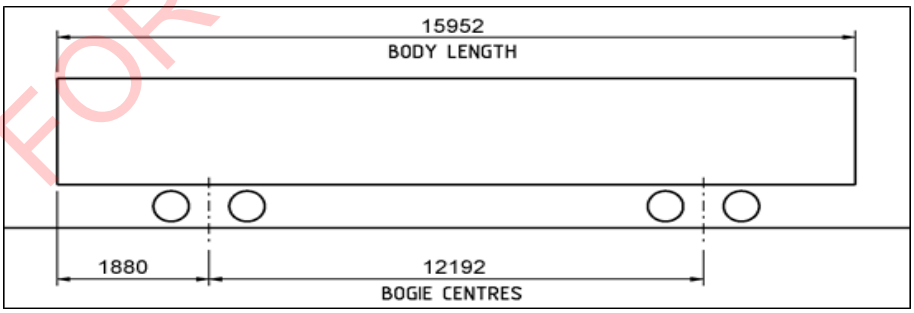
A.34 ARISO Reference Vehicle 34



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

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

ARISO Reference Vehicle 34	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				



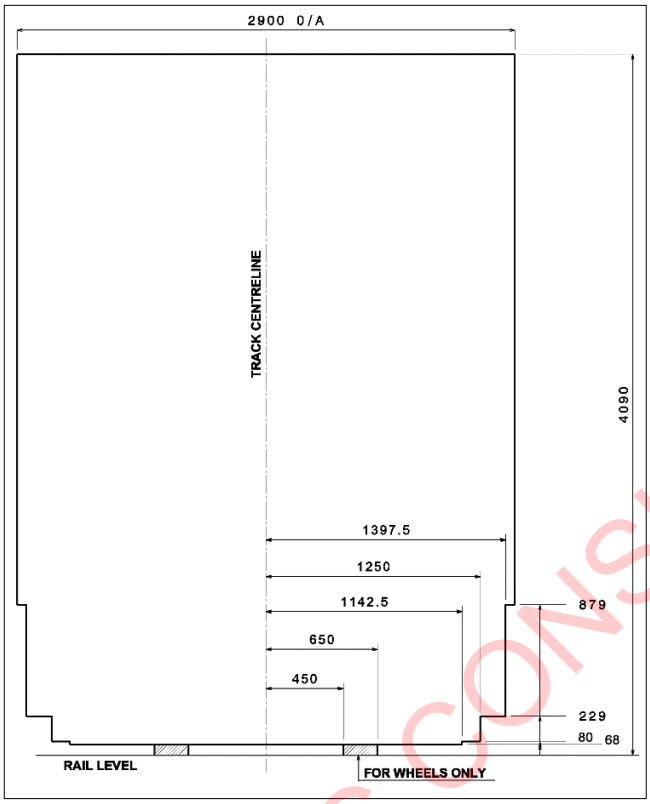
Appendix Figure A.34-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 34

Commentary *CA.34*

This is a universal KiwiRail outline, larger outlines exist for specific routes.

KiwiRail do not currently have a universal kinematic outline.

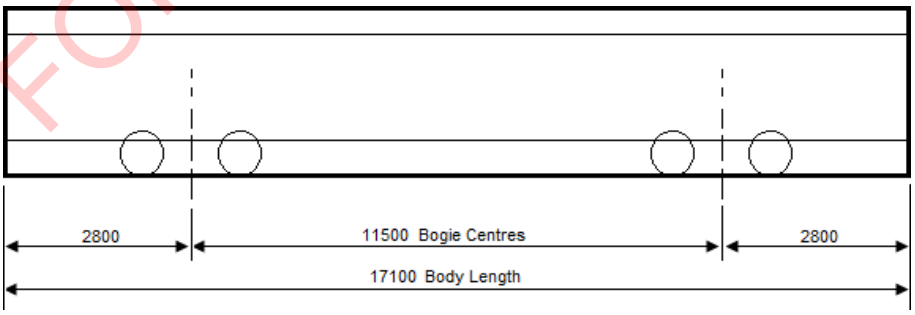
A.35 ARISO Reference Vehicle 35



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

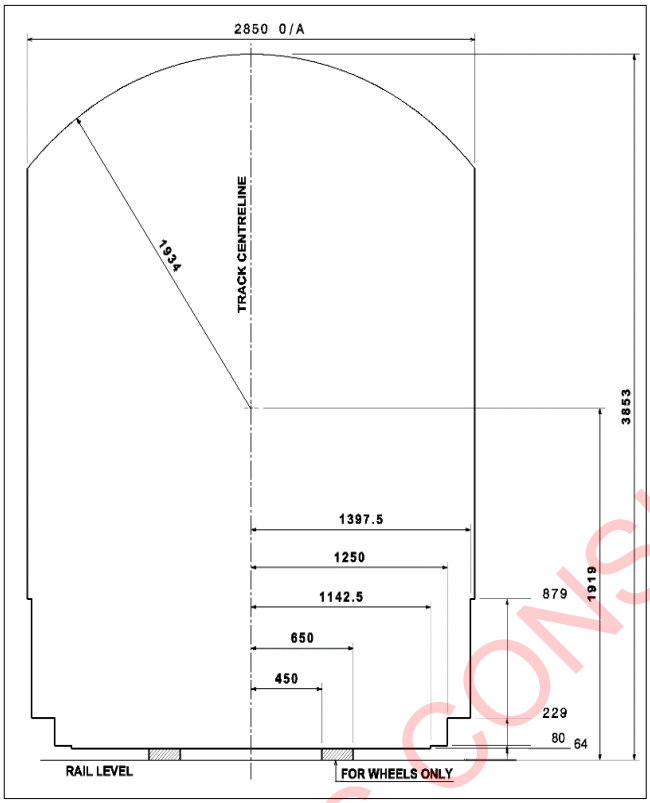
Appendix Table A.35 Kinematic Outline Translations for ARISO Reference Vehicle 35

ARISO Reference Vehicle 35	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 ARISO Reference Vehicle 35

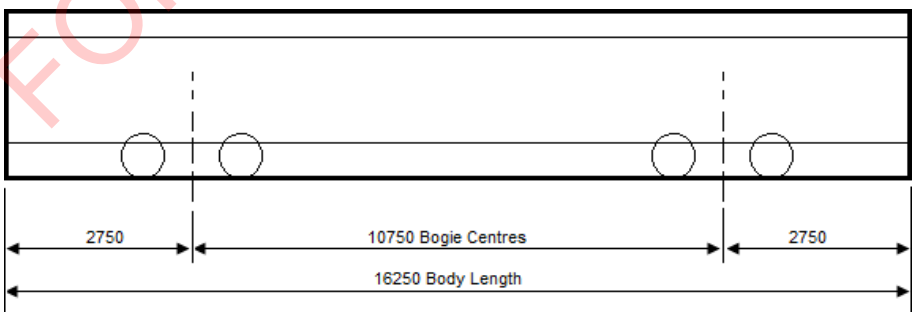
A.36 ARISO Reference Vehicle 36



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

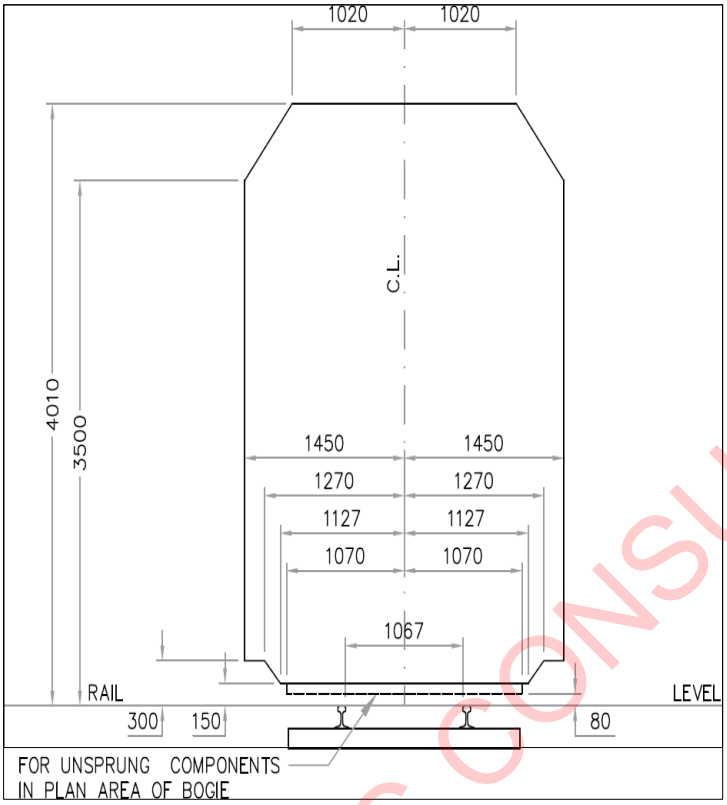
Appendix Table A.36 Kinematic Outline Translations for ARISO Reference Vehicle 36

ARISO 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 ARISO Reference Vehicle 36

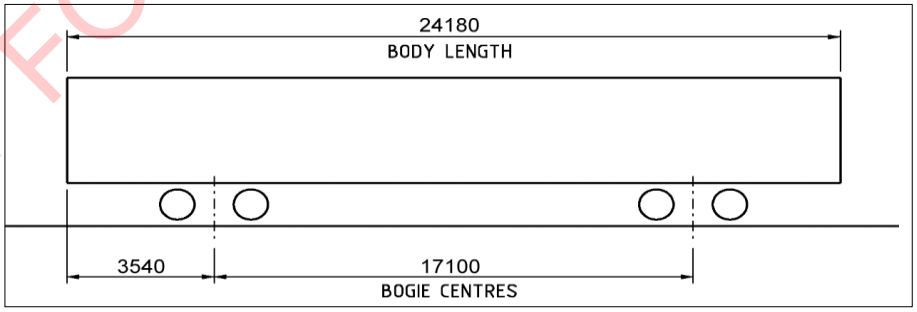
A.37 ARISO Reference Vehicle 37



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

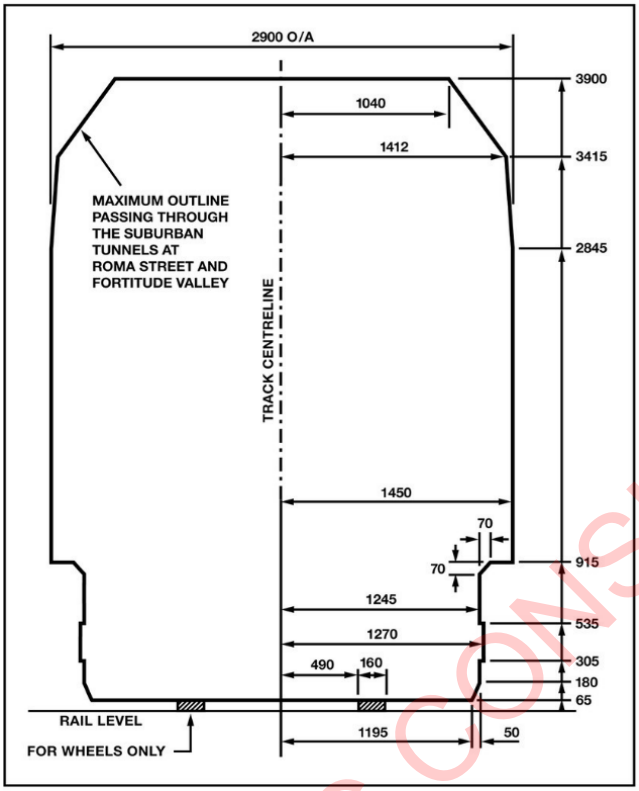
Appendix Table A.37 Static Rolling Stock Outline Dimensions for ARISO Reference Vehicle 37

ARISO Reference Vehicle 37	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Arc Infrastructure WA Narrow Gauge	40	2.0	610	50	20



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

A.38 ARISO Reference Vehicle 38



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

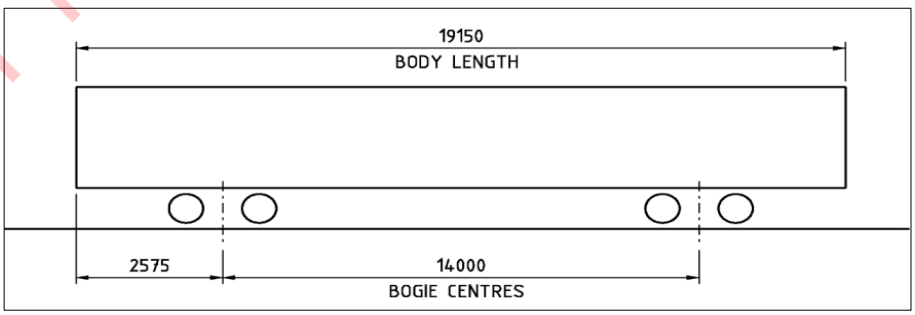
Appendix Table A.38 Kinematic Outline Translations for ARISO Reference Vehicle 38

ARISO Reference Vehicle 38	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Qld Suburban lines	43	1.25	1,100	50/25	11

Commentary *C.A.38-1*

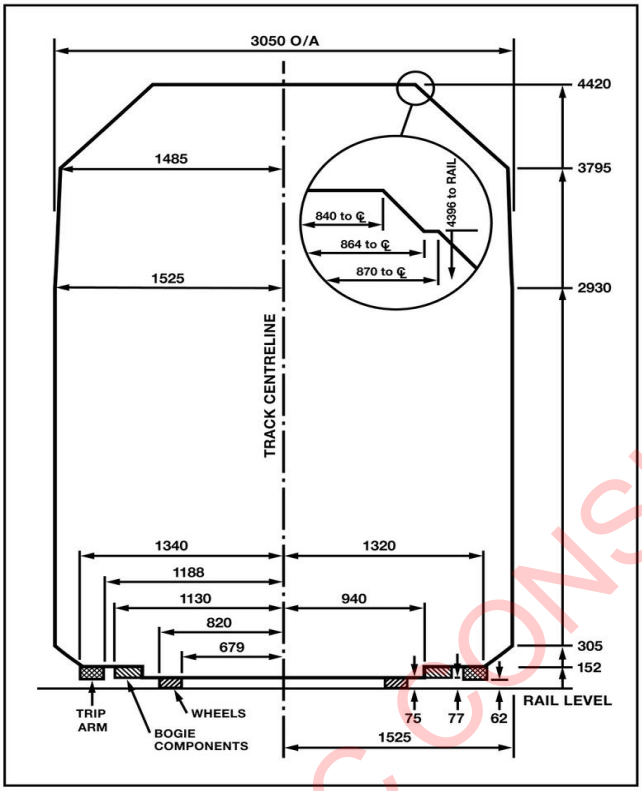
+/-1.25^{o} of body roll displacement is applied to all points above the point of rotation only.

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 ARISO Reference Vehicle 38

A.39 ARISO Reference Vehicle 39



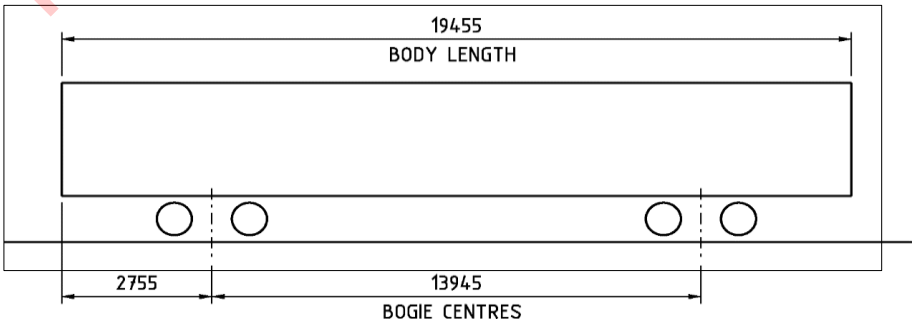
Appendix Figure A.39-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 39

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

ARISO Reference Vehicle 39	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
NSW Sub-Medium Electric	*50/60	*1.3/2.0	610	*40/50	

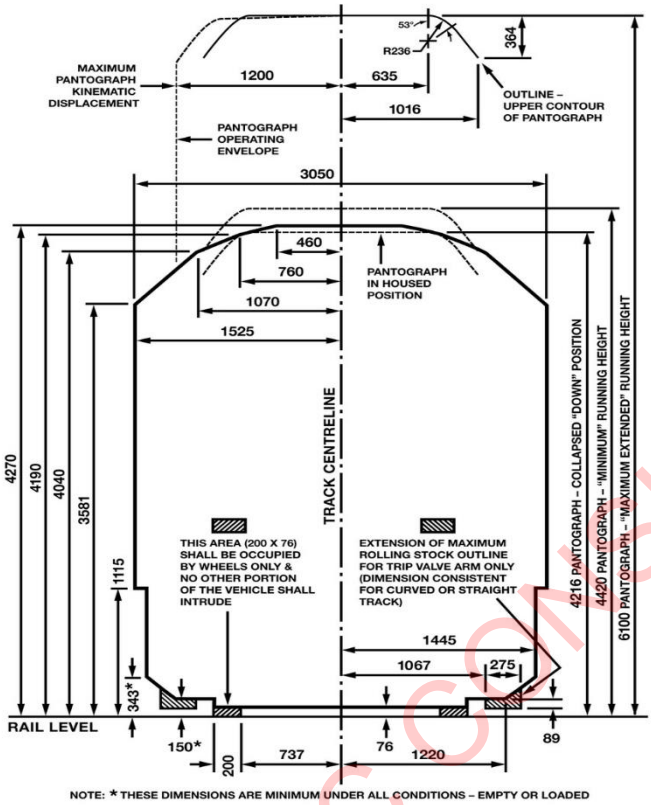
Commentary *CA.39*

Refer to RIM for applicable conditions and areas of operation for the kinematic details marked (*).



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

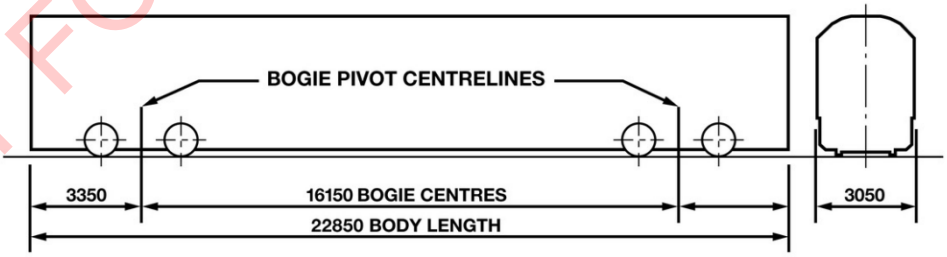
A.40 ARISO Reference Vehicle 40



Appendix Figure A.40-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 40

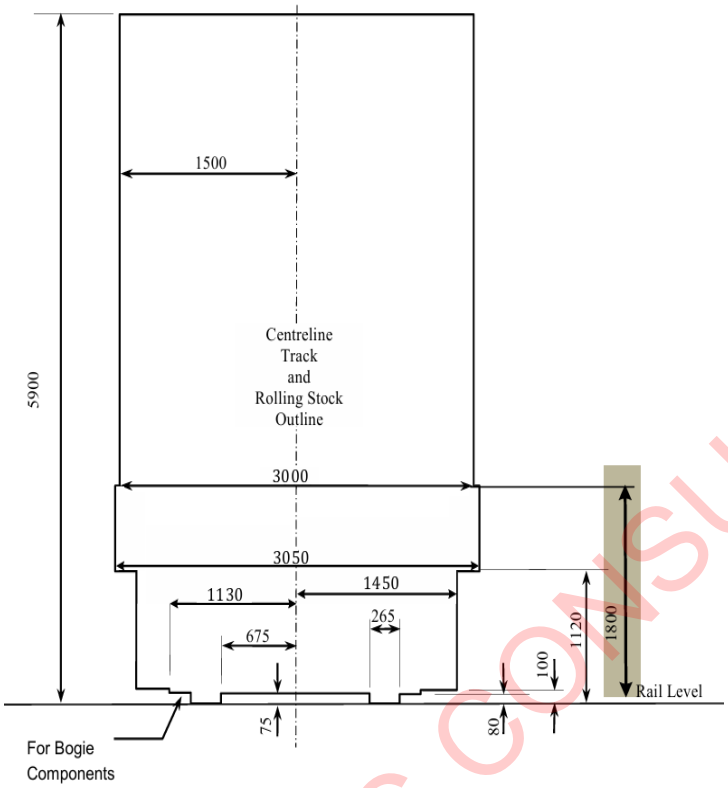
Appendix Table A.40 Swept Outline Vehicle Dimensions for ARISO Reference Vehicle 40

ARISO Reference Vehicle 40	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
VicTrack Single Deck Vehicles	50/60	1.3/2	610	40/50	20.5



Appendix Figure A.40-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 40

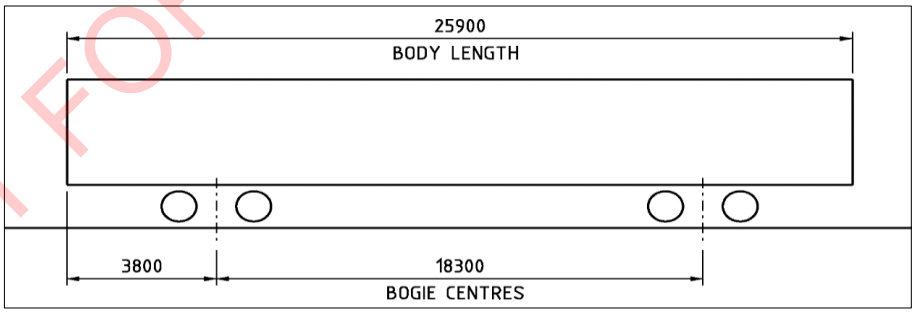
A.41 ARISO Reference Vehicle 41



Appendix Figure A.41-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 41

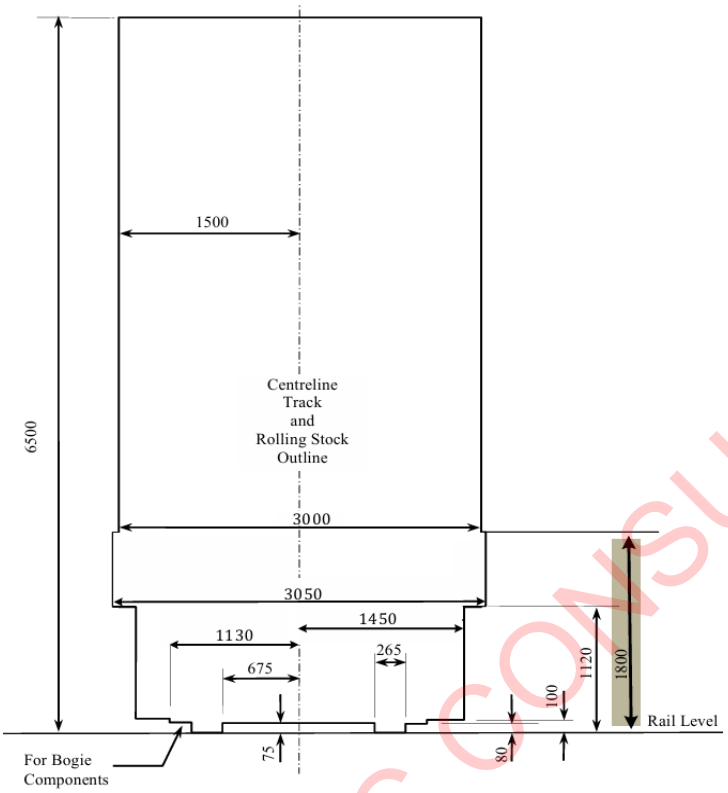
Appendix Table A.41 Swept Outline Vehicle Dimensions for ARISO Reference Vehicle 41

ARISO Reference Vehicle 41	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate E1	40	2.5	440	50	20



Appendix Figure A.41-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 41

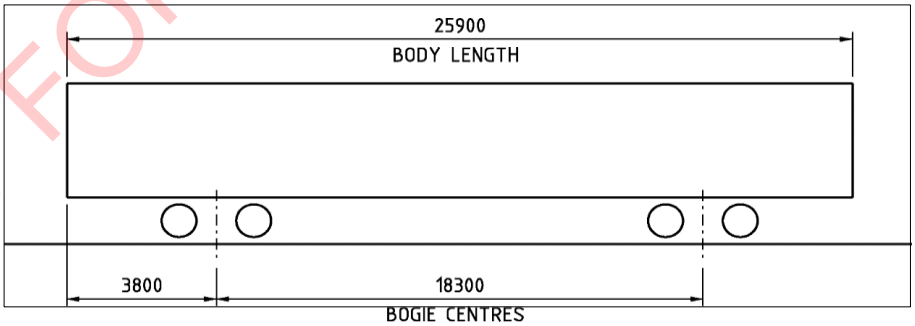
A.42 ARISO Reference Vehicle 42



Appendix Figure A.42-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 42

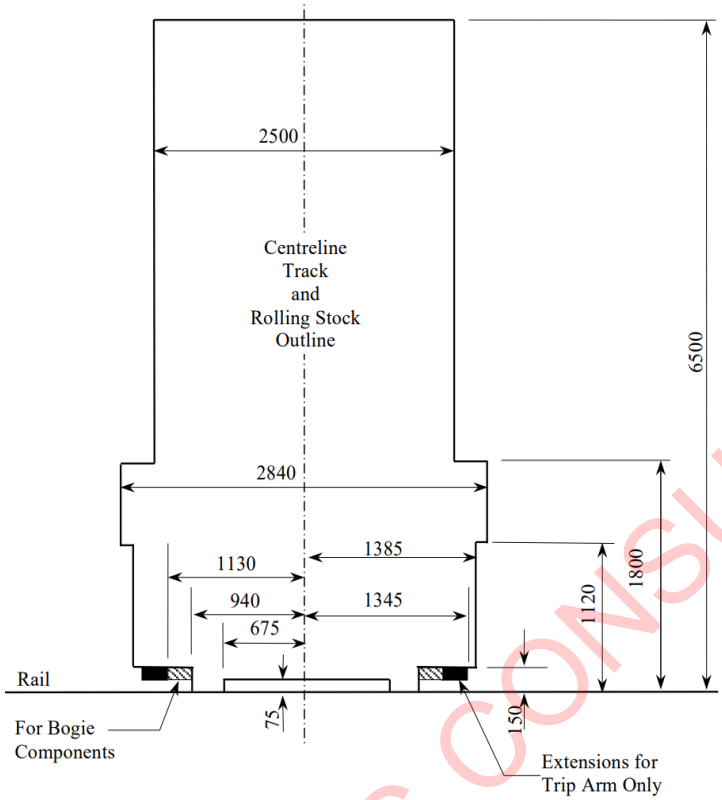
Appendix Table A.42 Swept Outline Vehicle Dimensions for ARISO Reference Vehicle 42

ARISO Reference Vehicle 42	Body Roll			Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
	Lateral Translation +/- (mm)	Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate F1	40	2.5	440	50	20



Appendix Figure A.42-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 42

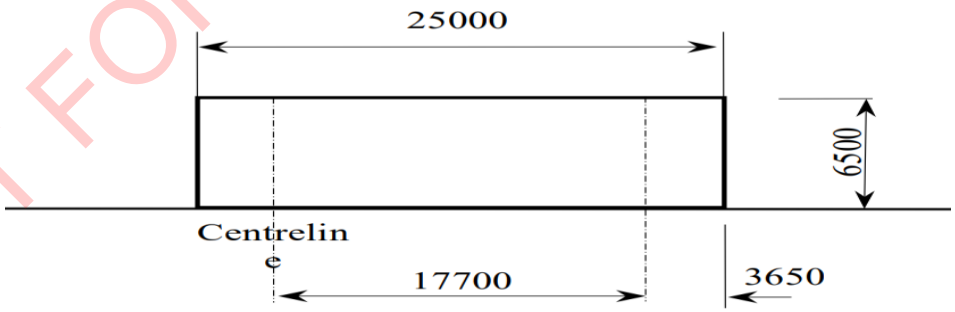
A.43 ARISO Reference Vehicle 43



Appendix Figure A.43-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 43

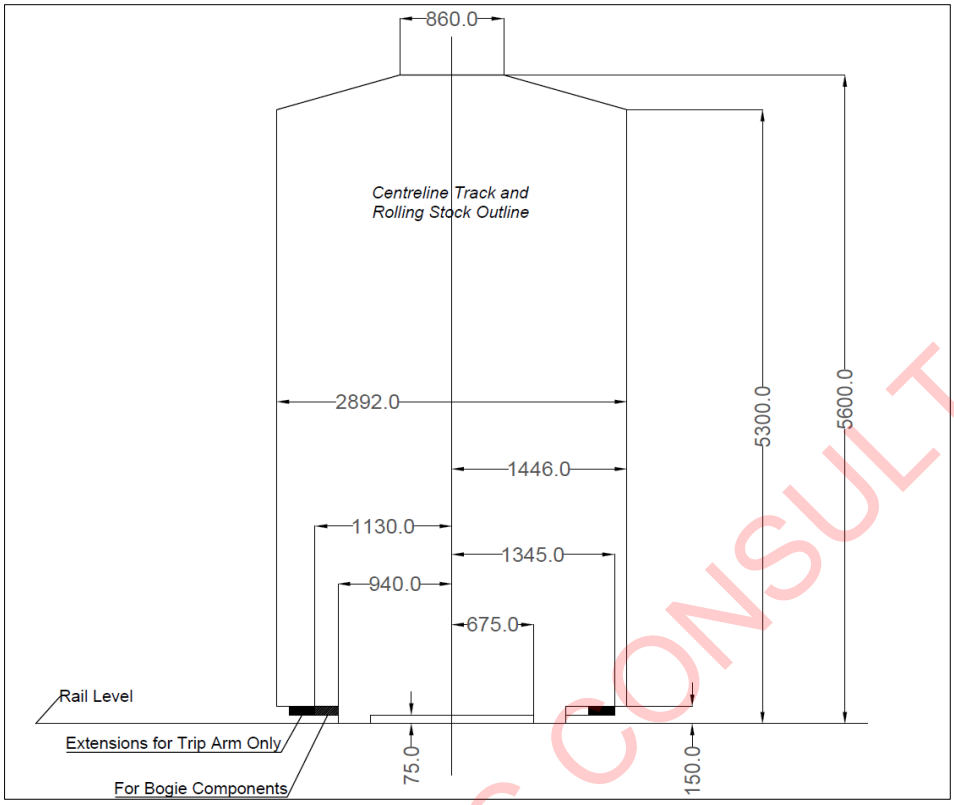
Appendix Table A.43 Swept Outline Vehicle Dimensions for ARISO Reference Vehicle 43

ARISO Reference Vehicle 43	Lateral Translation +/- (mm)	Body Roll		Bounce upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate F2	40	2.5	440	50	20



Appendix Figure A.43-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 43

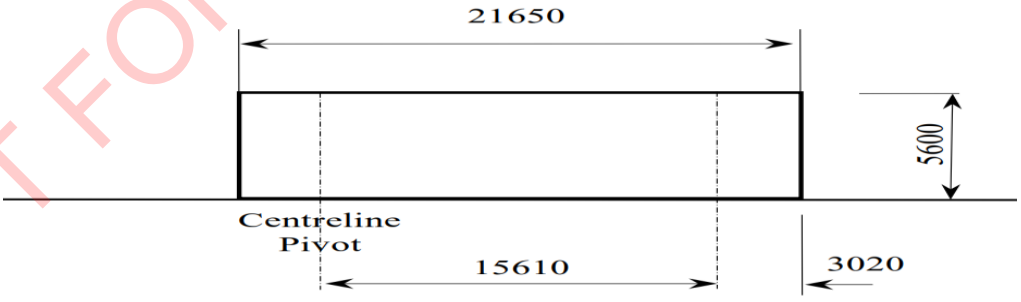
A.44 ARISO Reference Vehicle 44



Appendix Figure A.44-1 Static rolling stock outline dimensions for ARISO Reference Vehicle 44

Appendix Table A.44 Swept Outline Vehicle Dimensions for ARISO Reference Vehicle 44

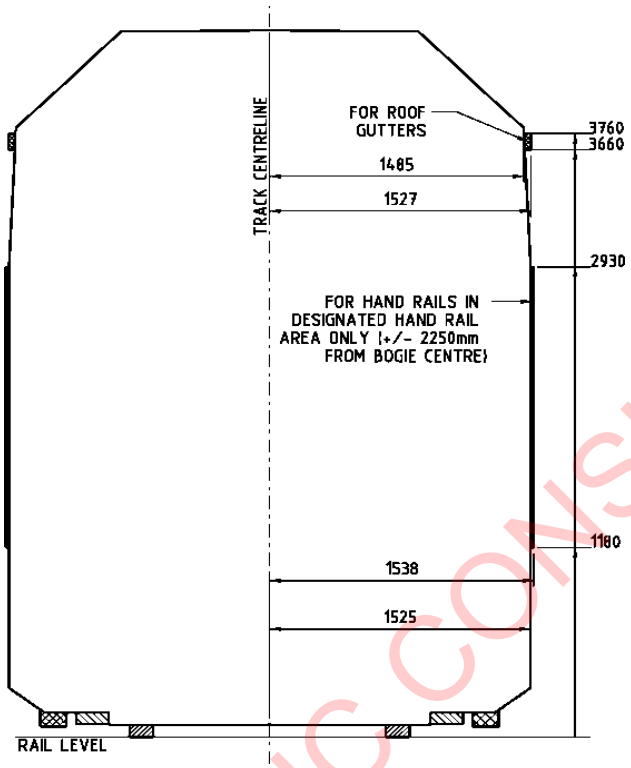
ARISO Reference Vehicle 44	Lateral Translation +/- (mm)	Body Roll		Bounce (upwards only) (mm)	Wheel Clearance +/- (mm)
		Angle +/- (degrees)	Point of Rotation ARL (mm)		
Interstate Plate H	40	2.0	610	50	20



Appendix Figure A.44-2 Swept outline vehicle dimensions for ARISO Reference Vehicle 44

Appendix B Specific Items (Informative)

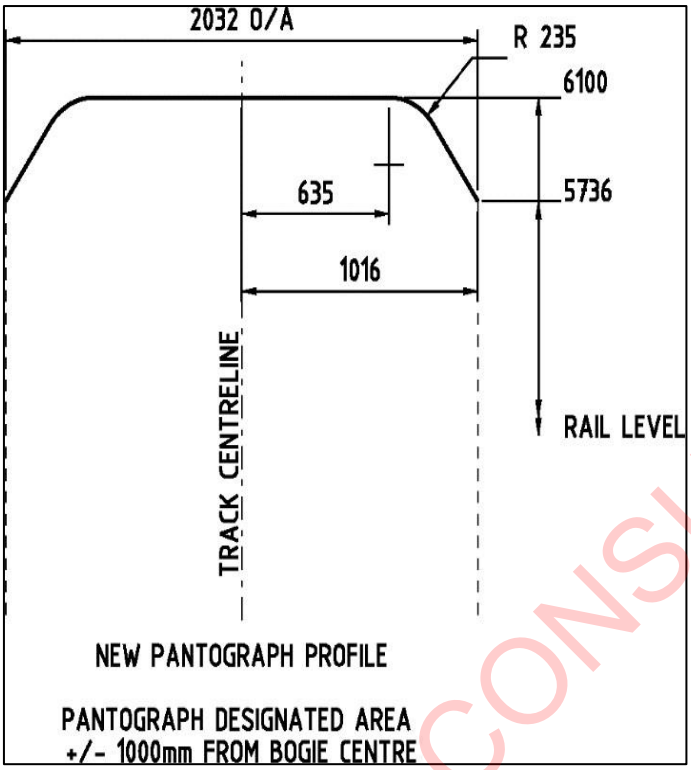
B.1 Expendable items



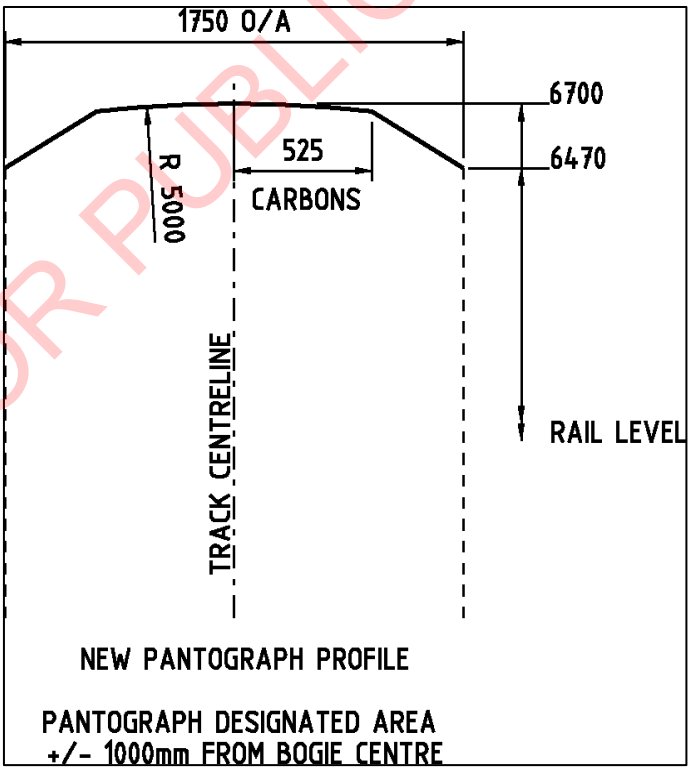
Appendix Figure B.1-1 Expendable items for ARISO Reference Vehicle 27

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

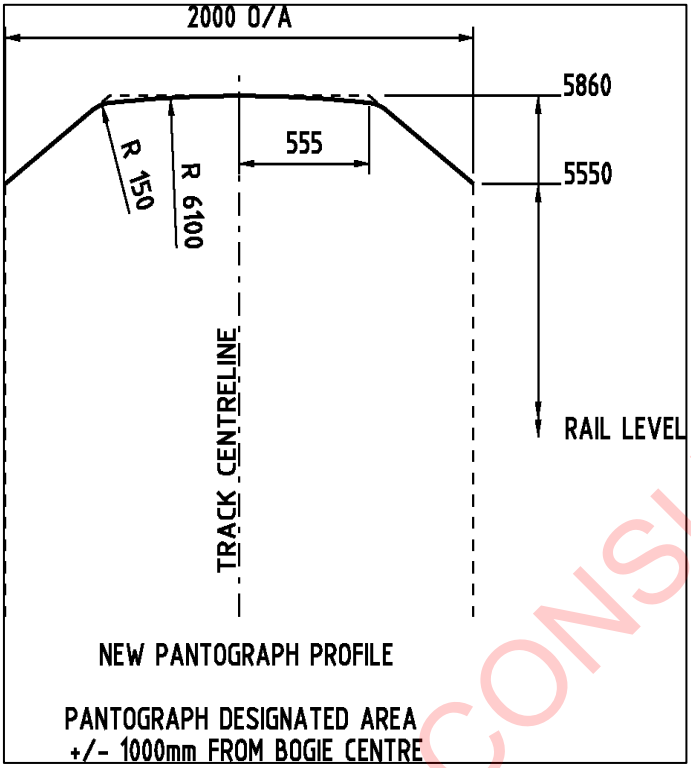
B.2 Pantographs



Appendix Figure B.1-2 ARISO pantograph outline 1

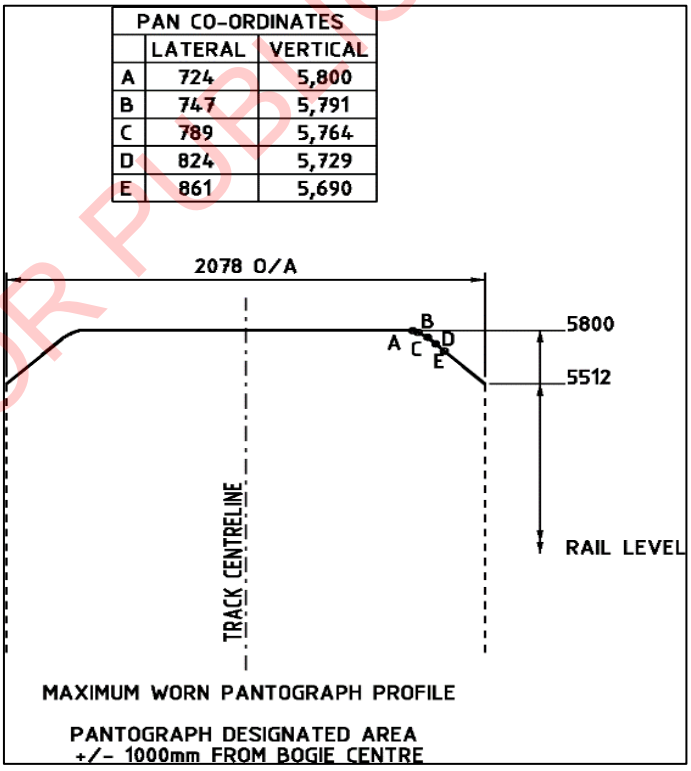


Appendix Figure B.2-2 ARISO pantograph outline 2



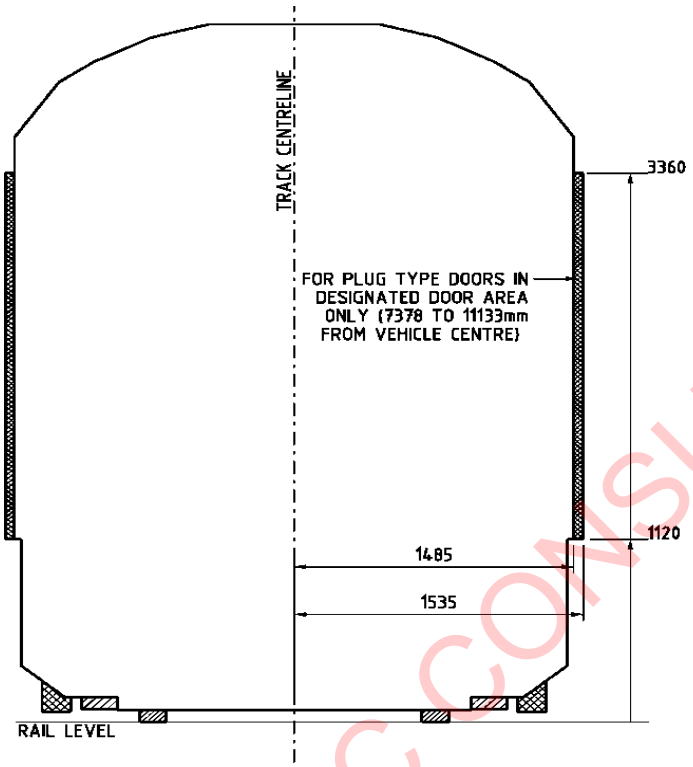
Appendix Figure B.2-3 ARISO pantograph outline 3

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

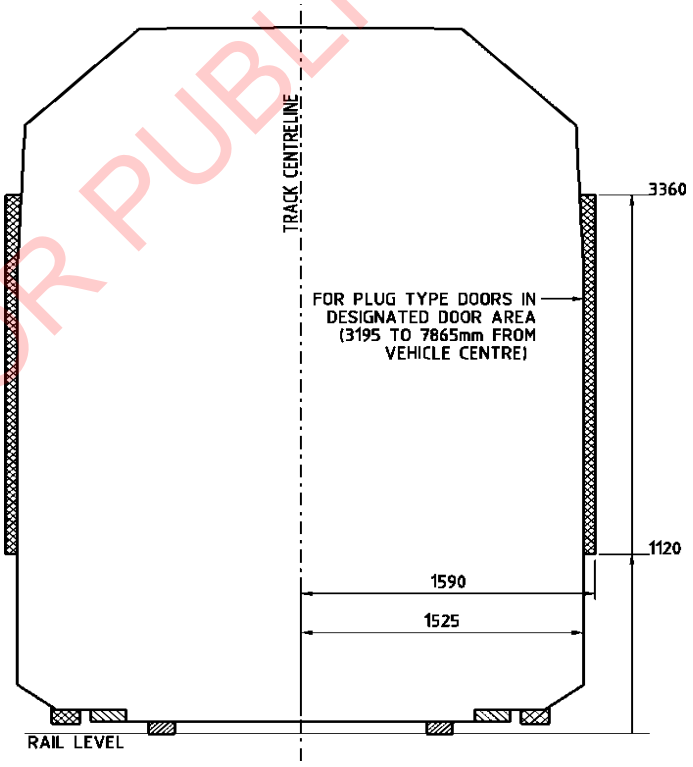


Appendix Figure B.2-4 ARISO pantograph outline 4

B.3 Doors



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



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

Appendix C Static Kinematic Test (Informative)

C.1 Static kinematic test

A static kinematic outline test is conducted 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 reference kinematic 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.

Chocks to prevent the vehicle from moving.

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.

The use of measurement tools including but not limited to, stringline and plumb bob, tape measure and steel rule., inclinometer, laser tracking, photogrammetry and Inertial Measurement Unit (IMU) systems.

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

C.4.1 Roll assessment

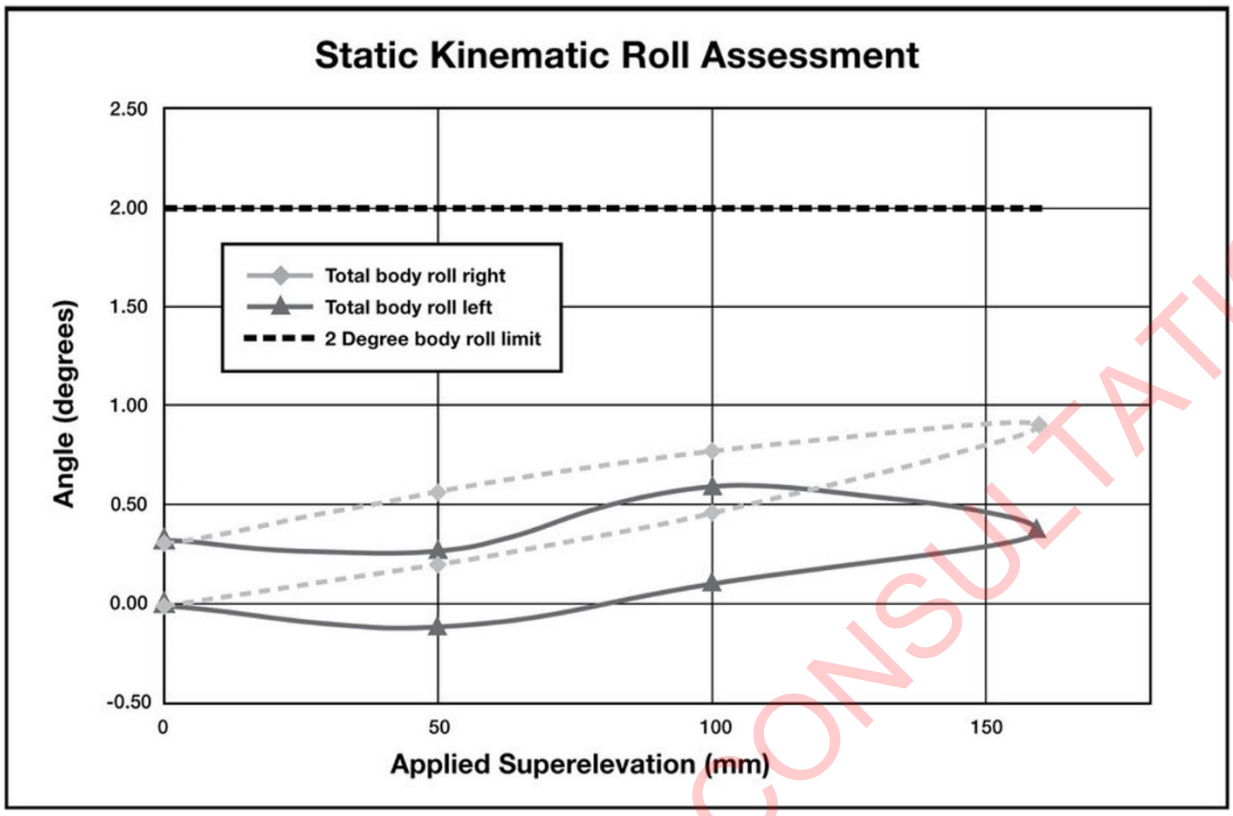
Appendix Table C-1 Roll (Right) Measurements

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

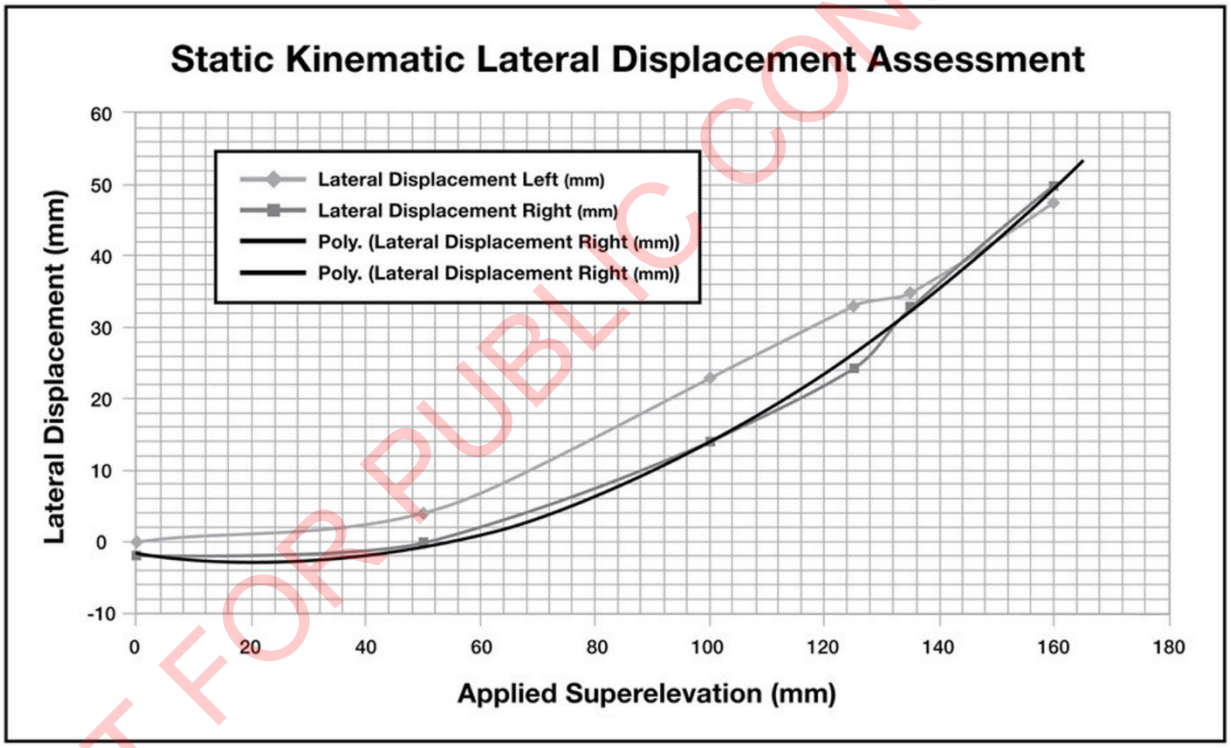
C.4.2 Lateral displacement assessment

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	

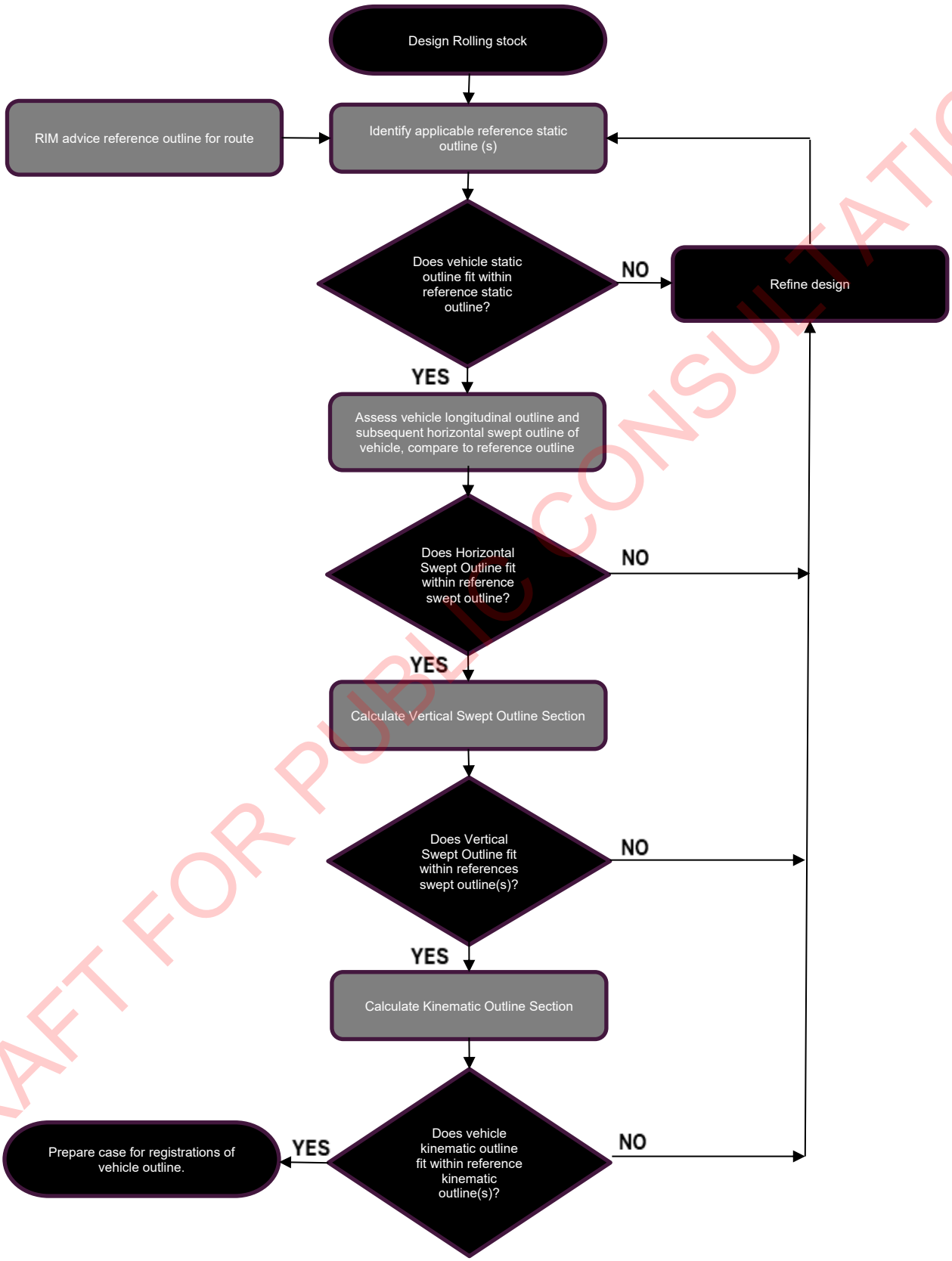
Appendix Table C-4 Lateral Displacement (Left) Measurements

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)



D.1 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 possibly 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 *CD.1-1*
Item C: Surveys or laser measurements might be considered as acceptable alternates, with prior approval of the RIM.

Commentary *CD.1-2*
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:

Appendix Equation D.1-A

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

Appendix Equation D.1-B

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

Appendix Equation D.1-C

$$BR_T = AR_T - A_C$$

Appendix Equation D.1-D

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

Appendix Equation D.1-E

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

Appendix Equation D.1-F

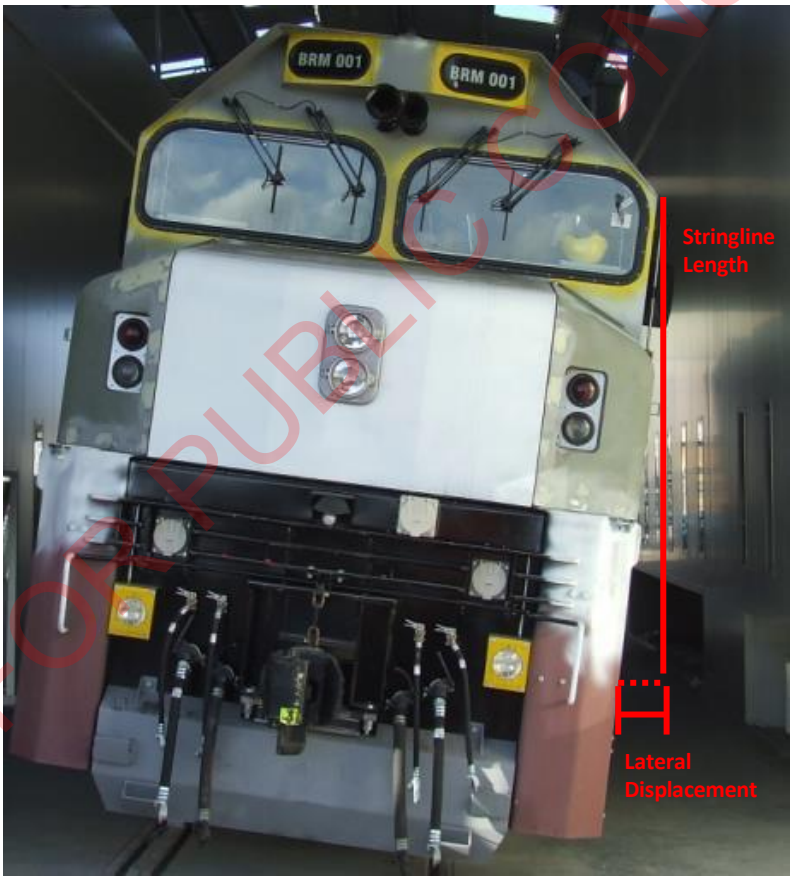
$$LD_{E\,Left} = LD + D_a$$

Appendix Equation D.1-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

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
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)

Bibliography

The documents listed below are for informative purposes.

- AS 7635:2023, *Track Geometry*
- *RISSB Code of Practice – Loading of Rail Freight*