AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline: Engineering (Track & Civil) **Category: Code of Practice**

Clearances

Section 7

Applicability

ARTC Network wide	✓

Primary Source

Document Status

Version	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
2.4	03 Sep 12	Standards	Stakeholders	Manager Standards	General Manager Technical Standards & Environment

Amendment Record

Version	Date Reviewed	Clause	Description of Amendment
2.0	31 Jul 09		Implementation draft of network wide document which is an amalgamation of the CoP for SA/WA & Vic and NSW requirements.
2.1	18 Jun 10		Banner added regarding mandatory requirements in other documents and alternative interpretations.
2.2	01 Aug 11	Fig. 7.2-7.7	Correction of minor editorial error in relation to Rollingstock Outlines A-F showing incorrect clearance of 80mm, corrected to 75mm.
2.3	08 Nov 11		Banner added regarding elements of RISSB National CoP being incorporated
2.4	03 Sep 12	7.2.6, 7.2.7	7.1m Plate “F” required for DIRN and Inland routes. Minor editorial changes including removal of CRN applicability box from cover.

This ARTC CoP has drawn on the Rail Industry Safety and Standards Board (RISSB) National Code of Practice Volume 4, Track and Civil Infrastructure, but is not identical. The ARTC CoP has been subject to Risk Assessment as required by the various State Rail Safety Regulators. The results of these risk assessments have made it necessary to deviate from the RISSB CoP in some areas. ARTC maintains traceability of the differences.

Contents

Mandatory requirements also exist in other documents.

Where alternative interpretations occur, the Manager Standards shall be informed so the ambiguity can be removed. Pending removal of the ambiguity the interpretation with the safest outcome shall be adopted.

7 Section 7: Clearances

7.1 General

This Section applies to clearances between—

a) rollingstock and structures; and

b) rollingstock on adjacent tracks.

Structure outlines are provided for the purpose of rollingstock operation and train passage only. In addition where required, owners are to make provision for access or egress (emergency or otherwise), rollingstock clearances to people, plant or equipment, projection of parts of the body from rollingstock, risks from derailed rollingstock, other health and safety reasons, service, maintenance and future clearance upgrades..

Where a guard rail has been fitted to provide protection to a structure in the event of a derailment the structure outline shall be widened to accommodate derailed rollingstock running against the guard rail.

The minimum clearance shall not be employed in a particular situation if more clearance can be provided.

7.2 Design and Rating

7.2.1 Clearance Outlines

Clearance standards shall be determined and specified for each line section in conjunction with operators. These standards should specify the following:

a) Static rollingstock outline

The cross-sectional outline of a maximum size vehicle at rest.

b) Maximum kinematic rollingstock outline

Equivalent to the "permissible Rollingstock outline" defined in AS 4292.2 and includes the effects of vehicle centre and end throw, track tolerances and dynamic rollingstock limits described in the general procedure in Appendix A.

c) Base operating standard for structures

The outline which may be infringed only in special circumstances and subject to there being no exceedance of the appropriate track tolerances for clearance (in ARTC this may be taken as the Kinematic Envelope plus 100mm).

d) Maintenance intervention standard for structures

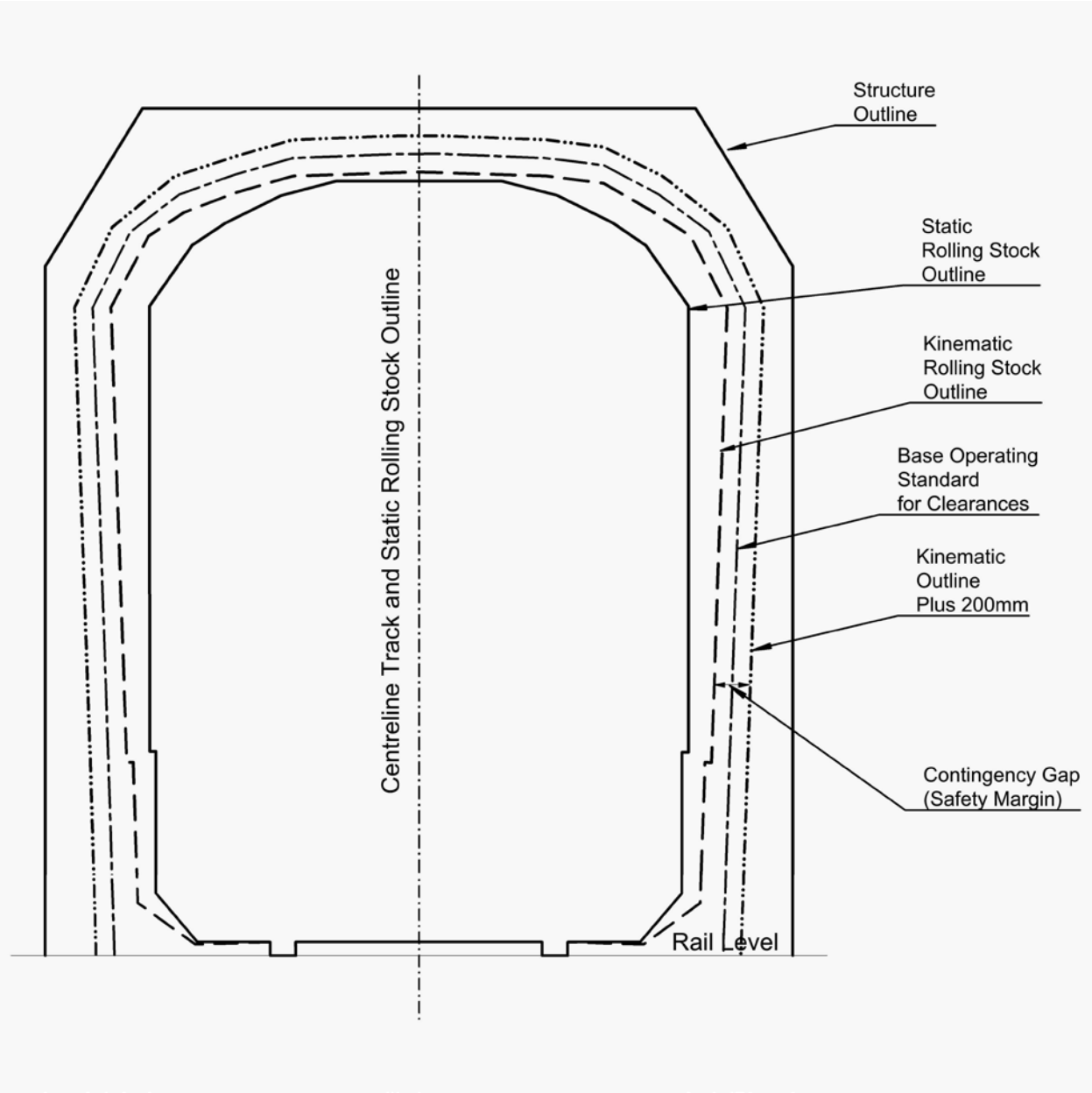
The outline that will first require maintenance actions to be taken to restore clearances to a standard such that no operating restrictions are required (in ARTC this may be taken as the Kinematic Envelope plus 200mm).

e) Structure outline

The standard that determines what structures on the line section should be included in the clearance register, i.e. because they could become subject to maintenance intervention. (in ARTC the structure outline for the purpose of clearance measurements should be 2.5m in width plus, on curves, allowances for vehicle displacement and superelevation.

These outlines are illustrated in Figure 7.1.

Figure 7.1 – Schematic of Clearance Outlines



7.2.2 Determination of clearance standards

Appendix A outlines a method that may be used to determine clearance standards. These procedures may be used for the specification of clearance standards listed in Clause 7.2.1 when considering both new and existing combinations of structures and rollingstock. The standards determined should represent the worst-case combination of structure and rollingstock for the track section under consideration.

Appendix A uses the static rollingstock outline as the starting point for determining the remaining clearance outlines listed in Clause 7.2.1.

When determining the clearance standards the following clearance management practices shall be taken into consideration:

a) Infringement of the maximum kinematic rollingstock outline shall not be permitted in normal operations and shall be treated as a track obstruction.

b) Infringement of the base operating standard for structures shall result in action being taken prior to the passage of the next train.

c) Infringement of the maintenance intervention standard for structures shall result in action being taken to restore clearances. Consideration should be given to increased monitoring for further deterioration until the clearances are restored.

d) Permanent infringements of the maintenance intervention standard shall be subject to increased rates of scheduled inspection in accordance with Clause 7.3.1.

e) Where a permanent infringement of the structure outline occurs the structure shall be placed on a clearance register and subject to scheduled inspection in accordance with Clause 7.2.8.

7.2.3 Exceedences and infringements of adopted standards

Design and rating methods based on the guidelines given in Clause 7.2.2 may be used to determine whether to approve the following exceedences and infringements of the specified clearance standards:

a) Exceedance of static rollingstock outline including out-of-gauge loads.

b) Exceedance of dynamic rollingstock limits or track tolerances used to determine the maximum kinematic rollingstock outline.

c) Infringement of structure outlines.

d) Infringement of base operating standards for structures.

e) Infringement of maintenance intervention standards for structures.

Approval by the owner may be subject to conditions such as speed restriction or tightened track tolerances.

7.2.4 Infringements of the base operating standard

No structure should be designed, or have a change in configuration, which will result in a safety margin less than 200mm.

The safety margin between the maximum kinematic rollingstock outlines on adjacent tracks shall not be less than 200mm.

For a limited period the clearance, other than at platforms or where the track position is fixed, may be reduced down to the Base Operating Standard of 100mm without restricting operating conditions. However, inspection and maintenance systems should be reviewed and modified where specified by ARTC. In accordance with clause 7.2.2 (c).

The permanent infringement of the base operating standard for clearances should be subject to approval by the owner and only be permitted in special circumstances, such as at platforms.

Notes:

[1] Normal practice is to locate platforms as close as possible to the train for passenger safety. This may be achieved by allowing the platform to be built to the kinematic envelope of the largest swept path envelope of rollingstock using the route. The track may need higher inspection or maintenance levels than for open track.

[2] The Infrastructure owners (track and platform) should determine with the passenger train operators tolerances for the furthest position of the track from the platform.

7.2.5 New structures or new rollingstock - general

Where new structures or new types of rollingstock are being considered, the requirements to be specified should be determined in accordance with one or other of the following:

a) The dynamic rollingstock limits and track tolerances used should be appropriate to the actual rollingstock and infrastructure combination being considered.

b) Designs should include the dynamic rollingstock limits in Table 7.1 and track tolerances in Table 7.2 and should be appropriate to the actual rollingstock and infrastructure combination being considered.

c) Existing clearance standards where the maximum kinematic rollingstock outline should be appropriate to the dynamic rollingstock limits and track tolerances of the actual rollingstock and infrastructure combination being considered.

7.2.6 New Structures on the Defined Interstate Rail Network (DIRN) and the Inland Route

a) Unless otherwise formally approved by appropriate ARTC Executive General Manager, all new structures over mainlines and passing loops/sidings shall be constructed to give full plate "F" (See Figures 7.17, 7.18 and 7.19 below) i.e. this will give 7.1m clearance above rail.

b) Some of the conditions under which exceptions to the above may be approved include:

- Some structures are specifically covered by provisions in ARTC's NSW lease and this allows for the Rail Infrastructure Corporation (RIC) to replace existing structures at existing heights.
- Where an approved business case justifies approval of a structure that is designed to be lifted to give 7.1m in future.

7.2.7 New Structures on other Corridors

For any other Corridors, any variations to the above must be approved by the appropriate ARTC Executive General Manager.

7.2.8 Existing structures and existing rollingstock

Where existing structures and existing types of rollingstock, see Note 1, are being considered the permissible rollingstock outlines may be determined from clearance standards for the relevant line section.

Note [1] Refers to rollingstock that meets the ROA Manual of Engineering Standards and Practices and was built and in-service prior to the publication of this Code.

7.2.9 Rollingstock and structure outline standards

For the static rollingstock outlines in Figures 7.2 to 7.7 the corresponding structure outlines in Figures 7.8 to 7.19 may be adopted. These structure outlines have been derived from the corresponding static rollingstock outlines by applying the following:

a) Dynamic rollingstock limits from Table 7.1.

b) Track tolerances from Table 7.2.

c) 150 mm and 0 mm cant elevation to provide for clearances on the inside and outside rail respectively of curved track.

d) For curves of 300 m radius or greater, centre and end throws based on 300 m radius.

e) For curves of radius 100 m and greater but less than 300 m radius, centre and end throws based on 100 m radius.

f) 200 mm air gap, see Note 1.

Table 7.1 – Dynamic Rollingstock Limits

FACTOR	ASSUMED LIMITS
Lateral translation, see Note 1	± 40 mm
Body roll, see Note 2:	
Rollingstock outlines (not double stack containers)	±2°about a roll centre 610 mm above rail level
Rollingstock outlines (for double stack containers).	±2.5° about a roll centre 440 mm above rail level
Bounce, see Note 3	+50 mm
Wheel clearance (worn wheel to new rail), see Note 1	±20 mm (refer to Figure 7.2)

Notes:

[1] ± means linear displacement parallel to the plane of the top of the rails to each side of rollingstock centreline.

[2] ± means angular displacement clockwise and anti-clockwise about the roll centre on the rollingstock centreline.

[3] + means upward linear displacement normal to the plane of the top of the rails.

Table 7.2 – Track Tolerances

Factor	Assumed tolerances, see Note 1, (mm)		
	Straight Track	> 300 m Radius	<300 m Radius
Rail side wear, see Note 2	± 5	+ 25, - 5	+ 25, -5
Gauge widening, see Note 2	± 0	± 0	+0, -15
Gauge (from 1435 mm), see Note 2	± 20	± 20	± 25
Track alignment (from design), see Note 3	± 50	± 50	± 75
Cross-level (from design), see Note 4	± 30	± 30	± 30
Rail Level, see Note 5	± 100	± 100	± 100

Notes:

[1] These geometry tolerances are intended for the purpose of calculating clearances only.

[2] On straight track ± means linear displacement parallel to the plane of the top of the rails to each side of the design centreline of the track.

On curved track, + means linear displacement to the outside of the curve and - means linear displacement to the inside of the curve parallel to the plane of the top of the rails.

[3] On straight track ± means horizontal linear displacement each side of the design centreline of the track.

On curved track, + means horizontal linear displacement to the outside of the curve and - means horizontal linear displacement to the inside of the curve.

[4] ± means vertical displacement of the left and right rails respectively resulting in a clockwise and anti-clockwise rotation of the track in the vertical plane normal to the track.

[5] ± means vertical linear displacement above (+) and below (-) design rail level.

7.2.10 Documentation

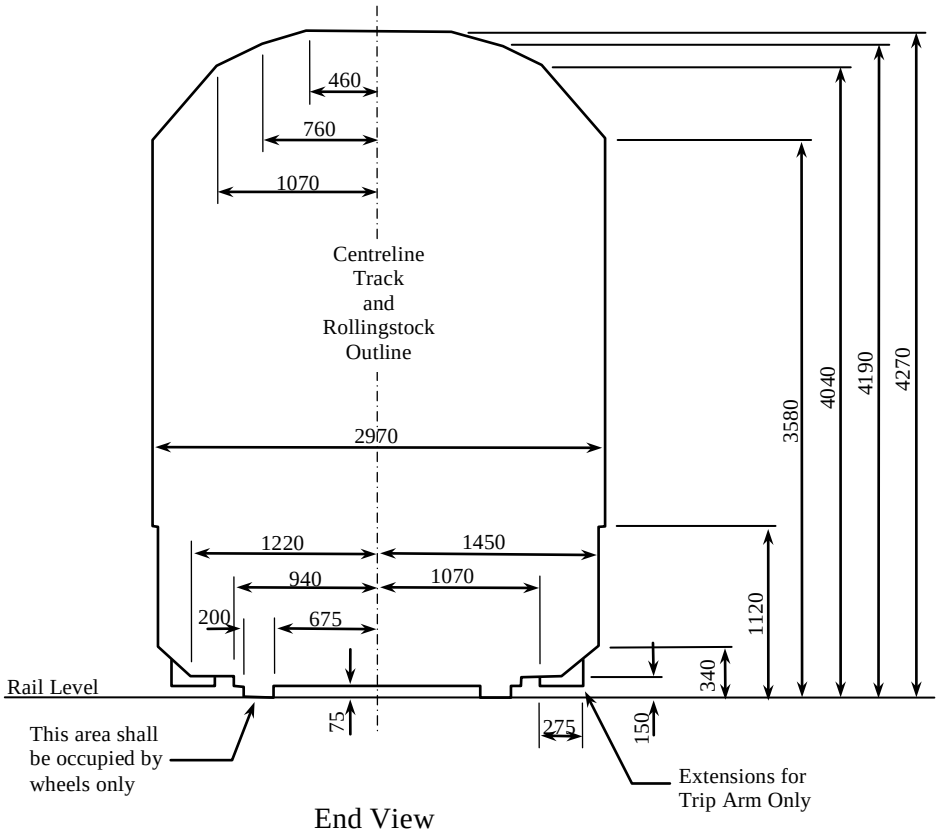
A register providing information on all clearance locations inside the adopted structure outline of 2.5 m plus an allowance for curves and superelevation shall be established and maintained. General inspections should be carried out with reference to this register.

Documentation should include clearance classification of each track section in terms of the standards adopted.

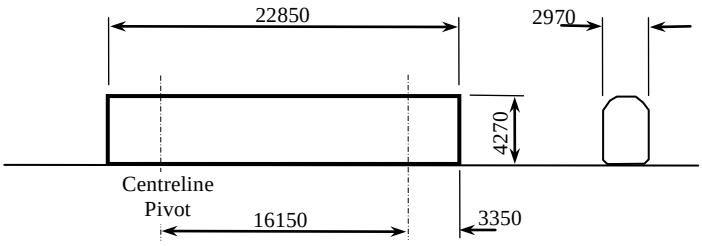
All locations on a track section where structures (or the maximum kinematic rollingstock outline on adjacent track) infringe on the adopted structure outline shall be placed on a clearance register.

For a given line section the maximum kinematic rollingstock outline on an adjacent track may be treated in a similar way to a structure over or adjacent the line.

Figure 7.2 – Rollingstock Outline A



End View



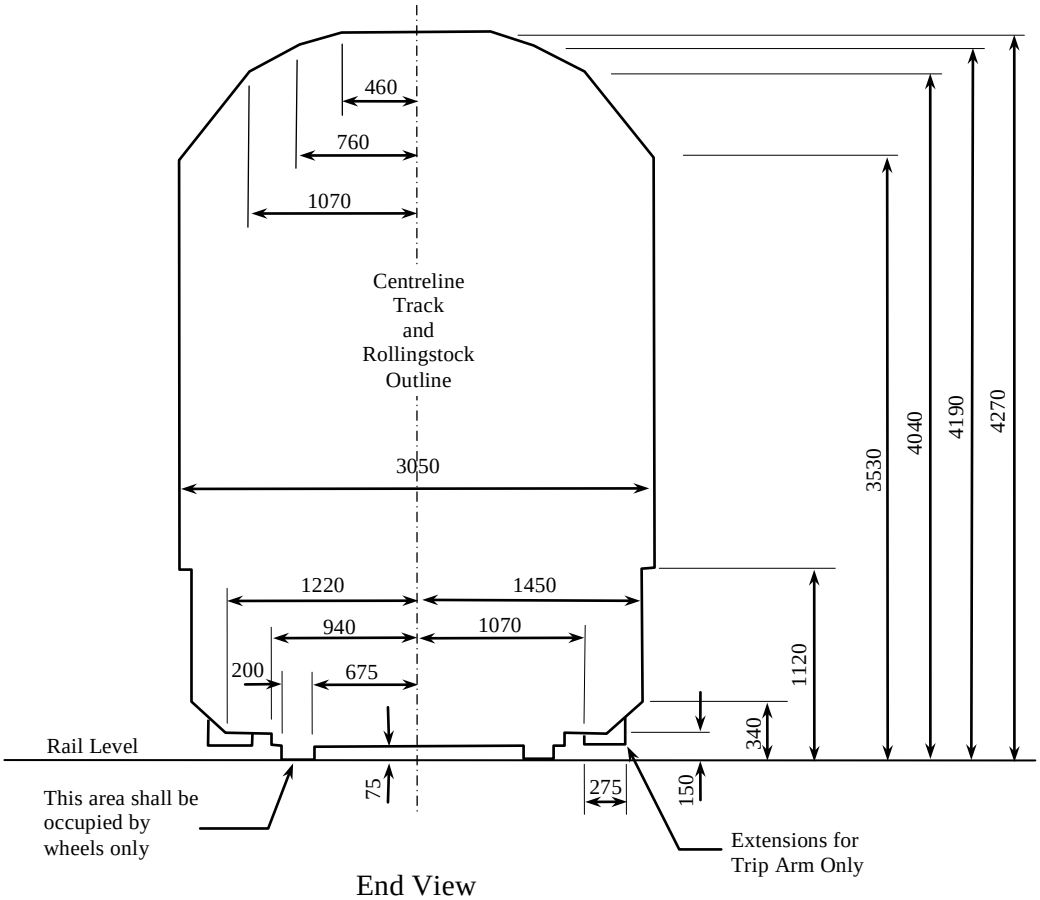
Design Vehicle Configuration

Notes:

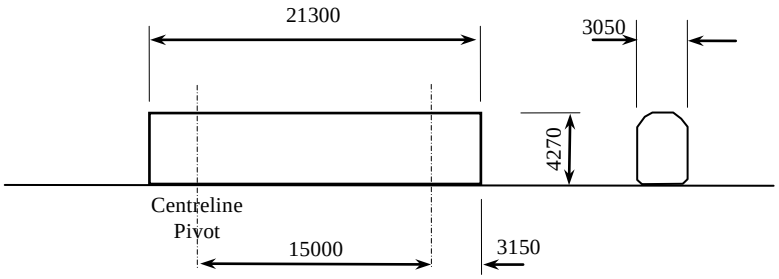
[1] The dimensions between bogie pivots and from bogie pivot to end of body should not be increased unless allowance is made by a reduction in width to compensate for increased centre and end throw on a curve of 100 m radius.

[2] The clearances above rail should be preserved under all conditions of operation, loading and maintenance of a vehicle on level track.

Figure 7.3 – Rollingstock Outline B



End View



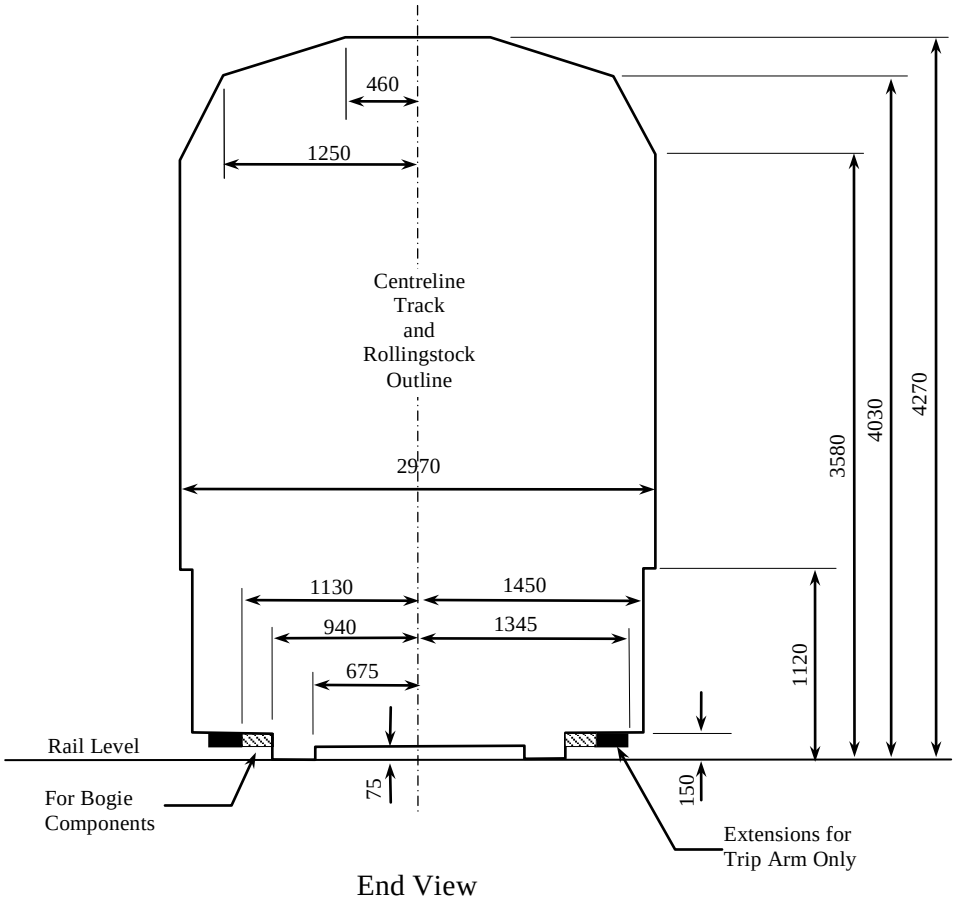
Design Vehicle Configuration

Notes:

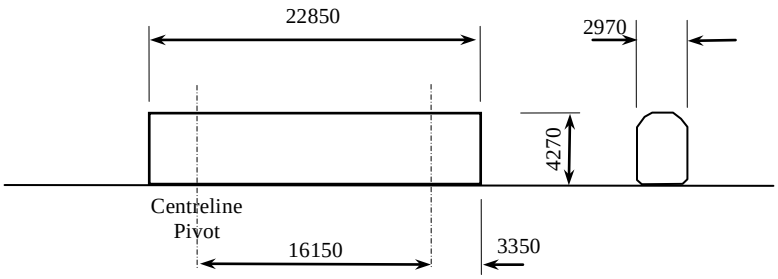
[1] The dimensions between bogie pivots and from bogie pivot to end of body should not be increased unless allowance is made by a reduction in width to compensate for increased centre and end throw on a curve of 100 m radius.

[2] The clearances above rail should be preserved under all conditions of operation, loading and maintenance of a vehicle on level track.

Figure 7.4 – Rollingstock Outline C



End View



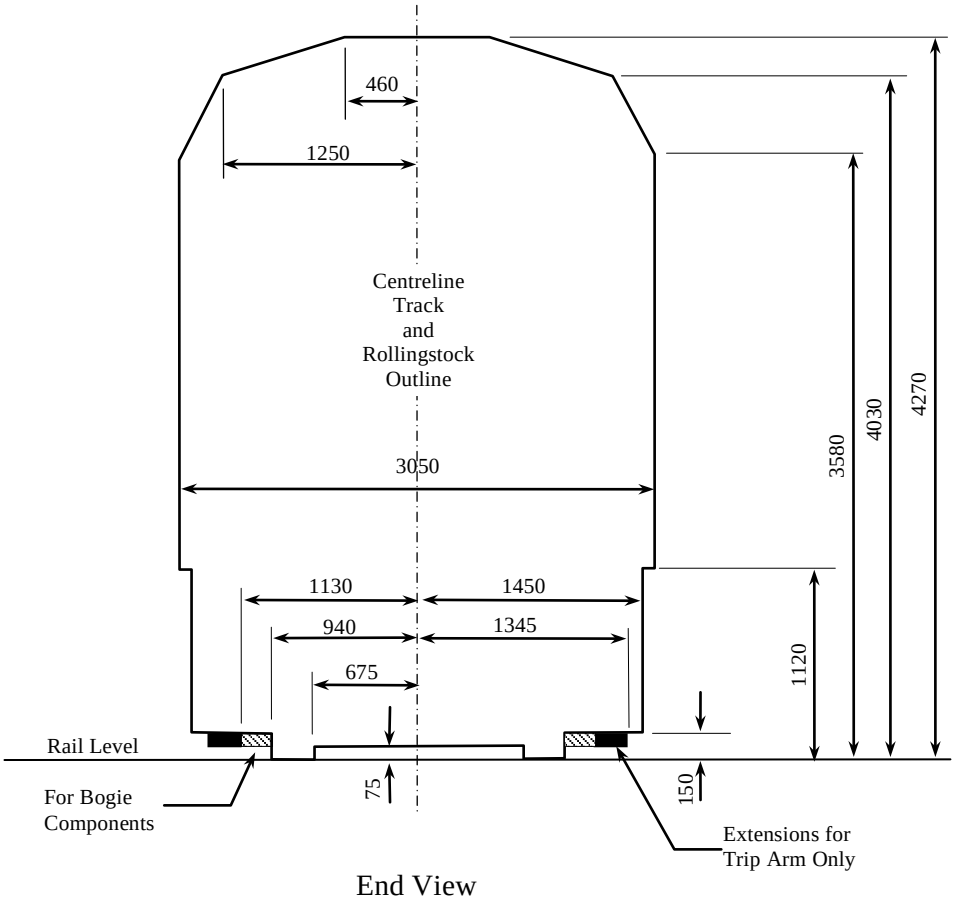
Design Vehicle Configuration

Notes:

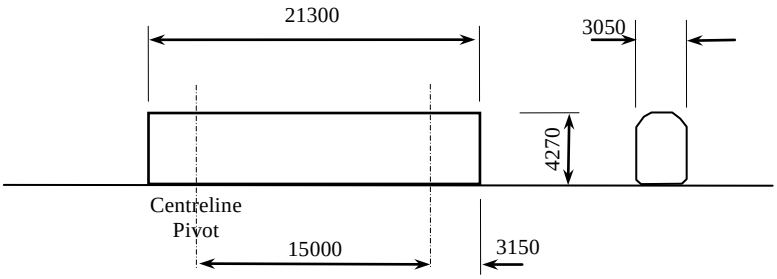
[1] The dimensions between bogie pivots and from bogie pivot to end of body should not be increased unless allowance is made by a reduction in width to compensate for increased centre and end throw on a curve of 100 m radius.

[2] The clearances above rail should be preserved under all conditions of operation, loading and maintenance of a vehicle on level track.

Figure 7.5 – Rollingstock Outline D



End View



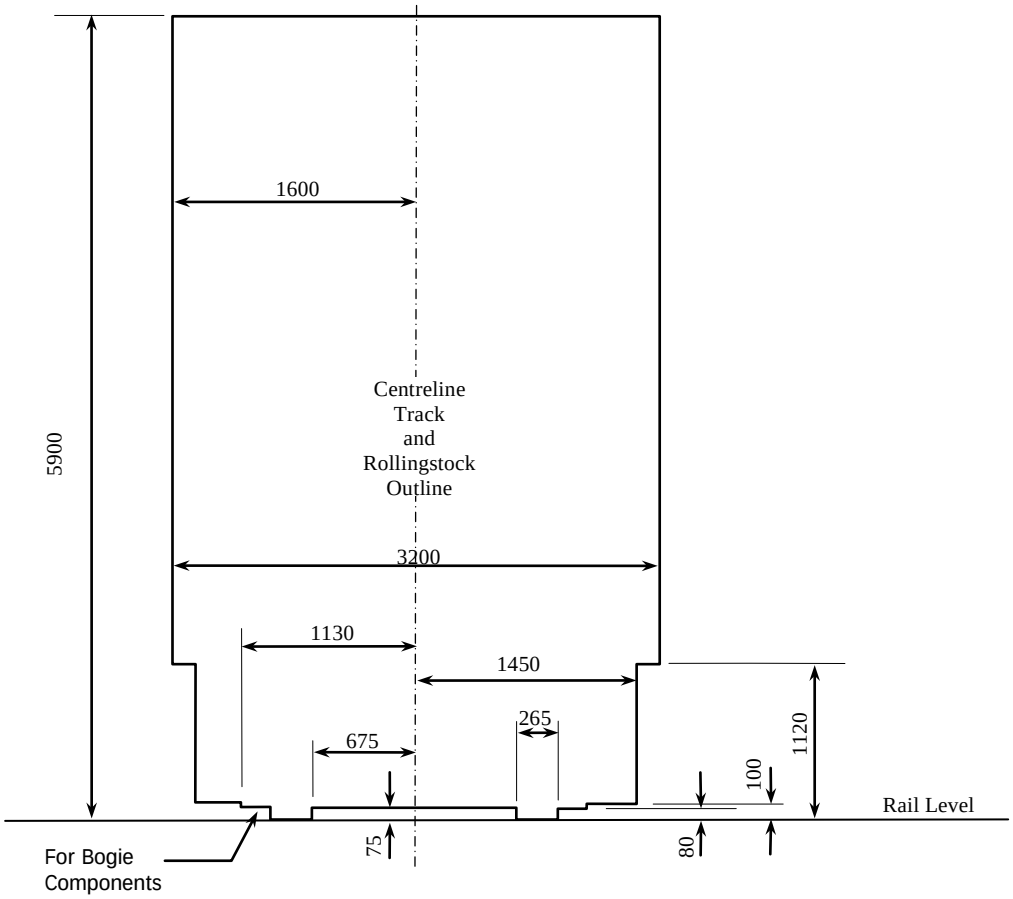
Design Vehicle Configuration

Notes:

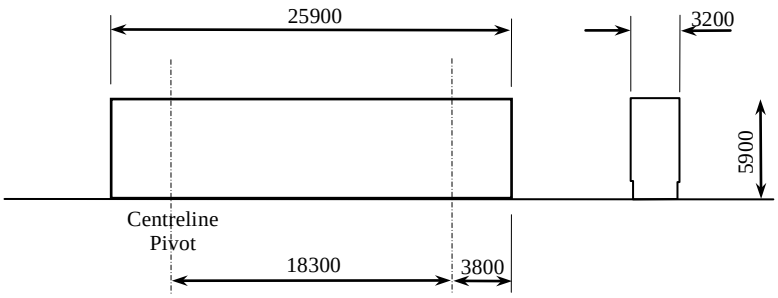
[1] The dimensions between bogie pivots and from bogie pivot to end of body should not be increased unless allowance is made by a reduction in width to compensate for increased centre and end throw on a curve of 100 m radius.

[2] The clearances above rail should be preserved under all conditions of operation, loading and maintenance of a vehicle on level track.

Figure 7.6 – Rollingstock Outline E



End View



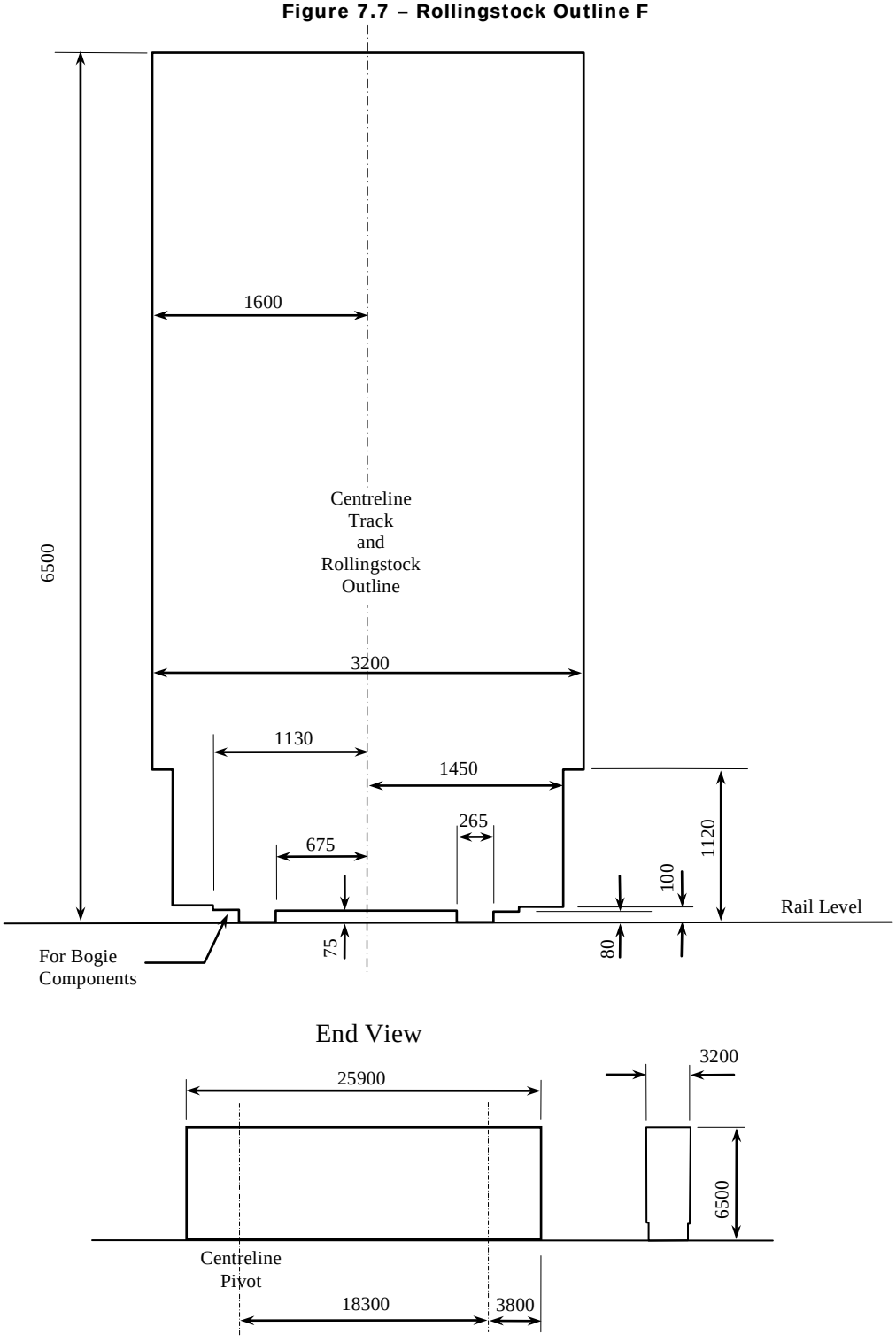
Design Vehicle Configuration

Notes:

[1] The dimensions between bogie pivots and from bogie pivot to end of body should not be increased unless allowance is made by a reduction in width to compensate for increased centre and end throw on a curve of 100 m radius.

[2] The clearances above rail should be preserved under all conditions of operation, loading and maintenance of a vehicle on level track.

Figure 7.7 – Rollingstock Outline F

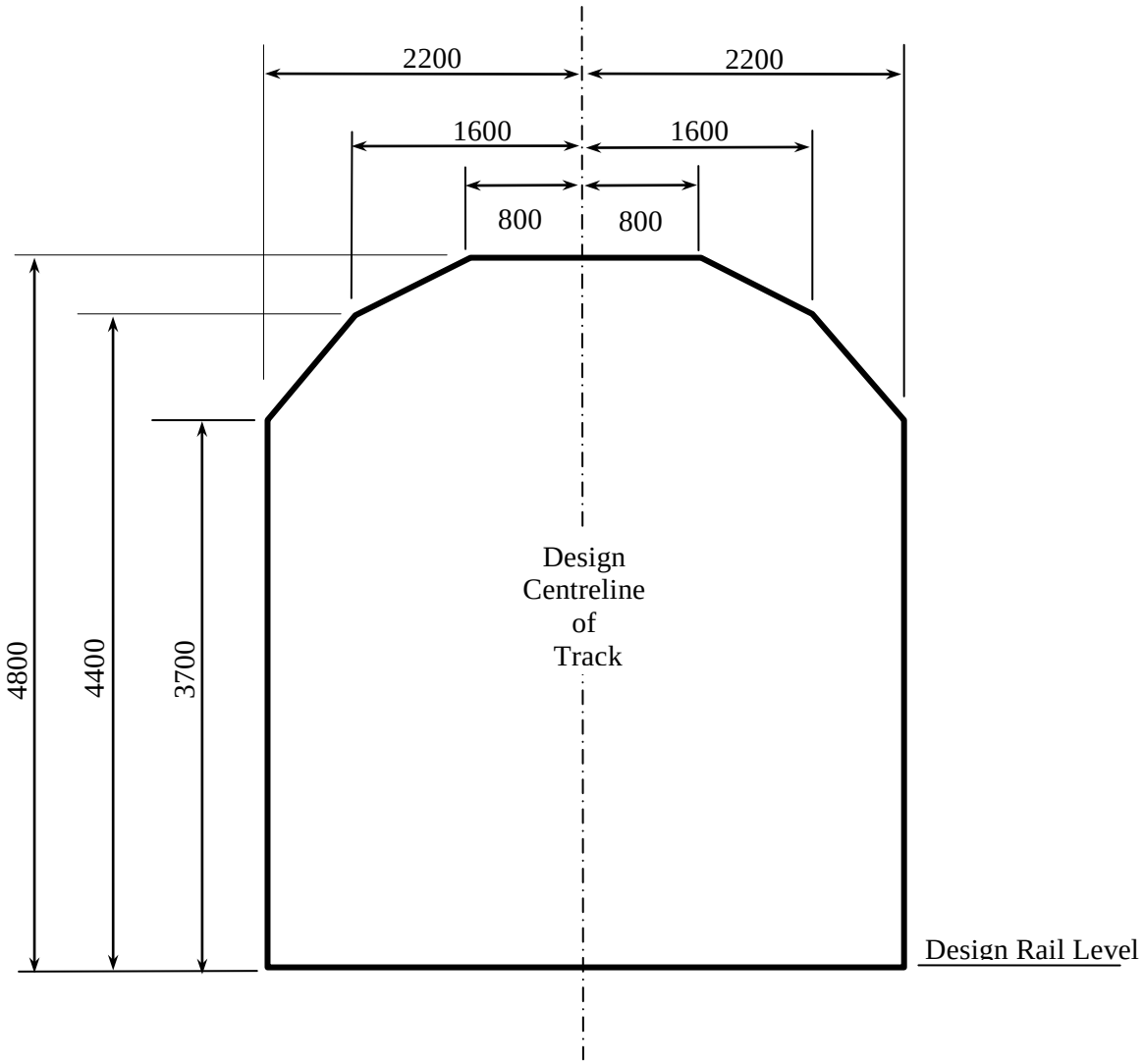


Notes:

[1] The dimensions between bogie pivots and from bogie pivot to end of body should not be increased unless allowance is made by a reduction in width to compensate for increased centre and end throw on a curve of 100 m radius.

[2] The clearances above rail should be preserved under all conditions of operation, loading and maintenance of a vehicle on level track.

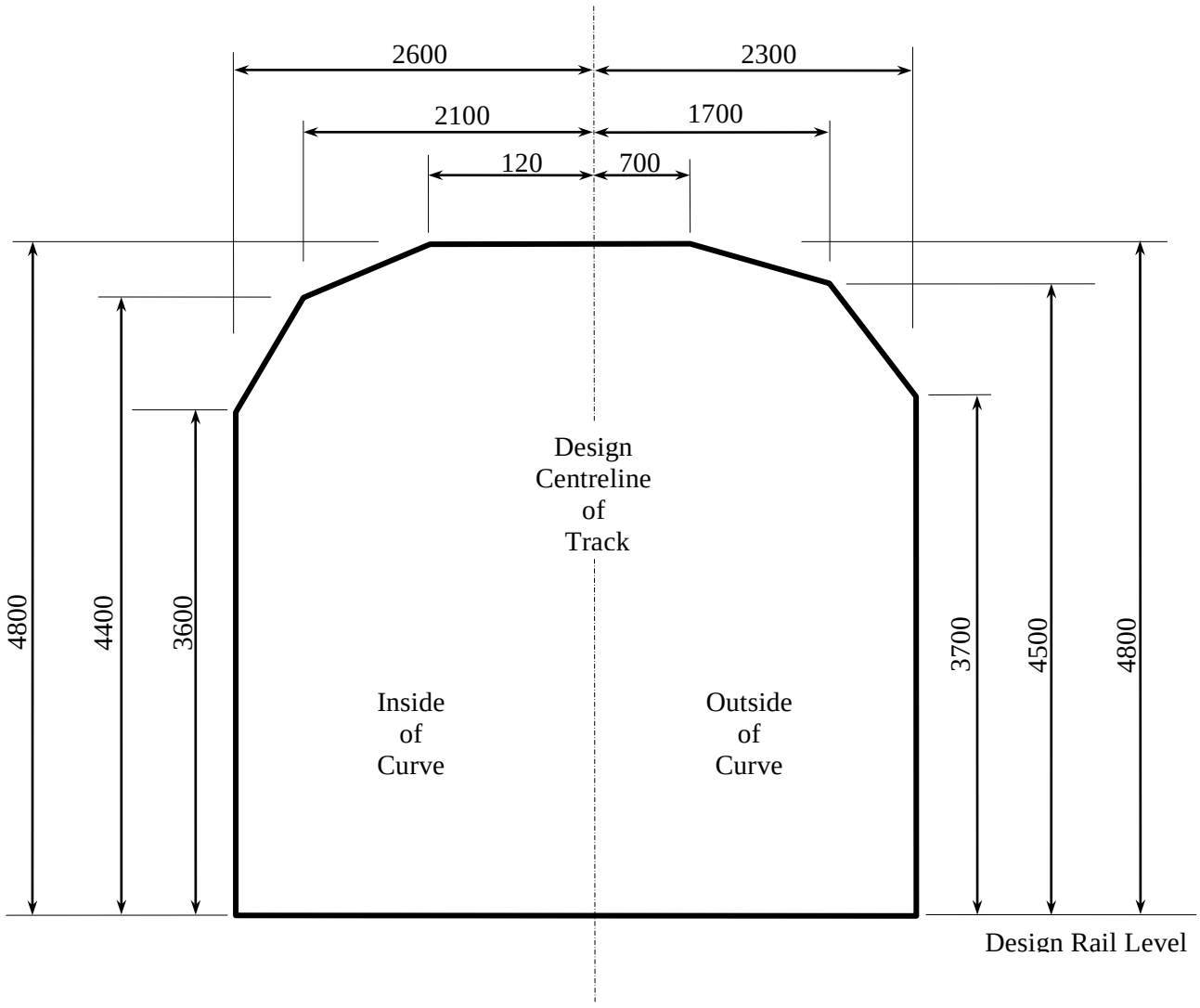
**Figure 7.8 – Structure Outline
Straight Track
Used for Rollingstock Outlines A and B**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

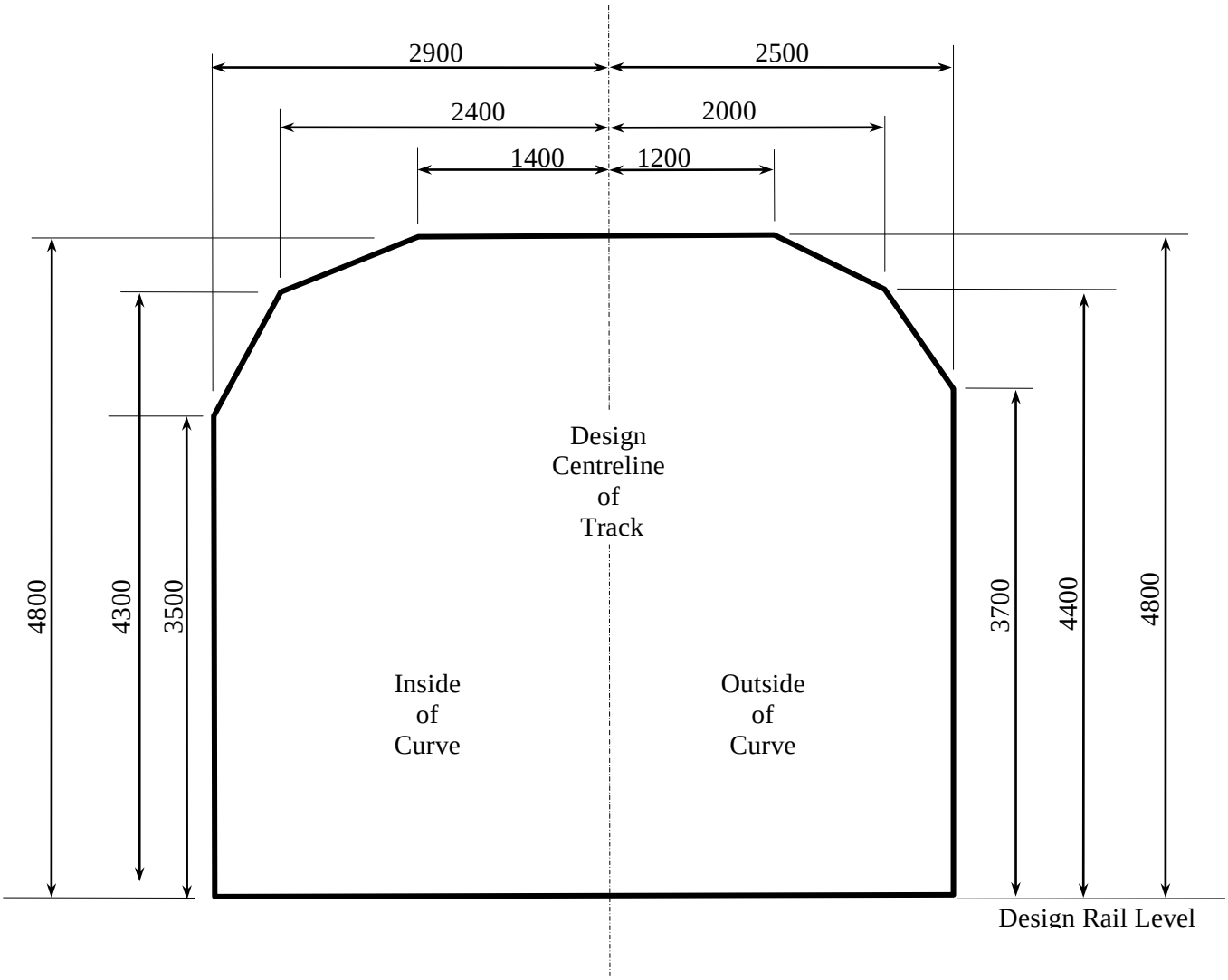
Figure 7.9 – Structure Outline
Curved Track ≥ 300 M Radius
Used for Rollingstock Outlines A and B



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2

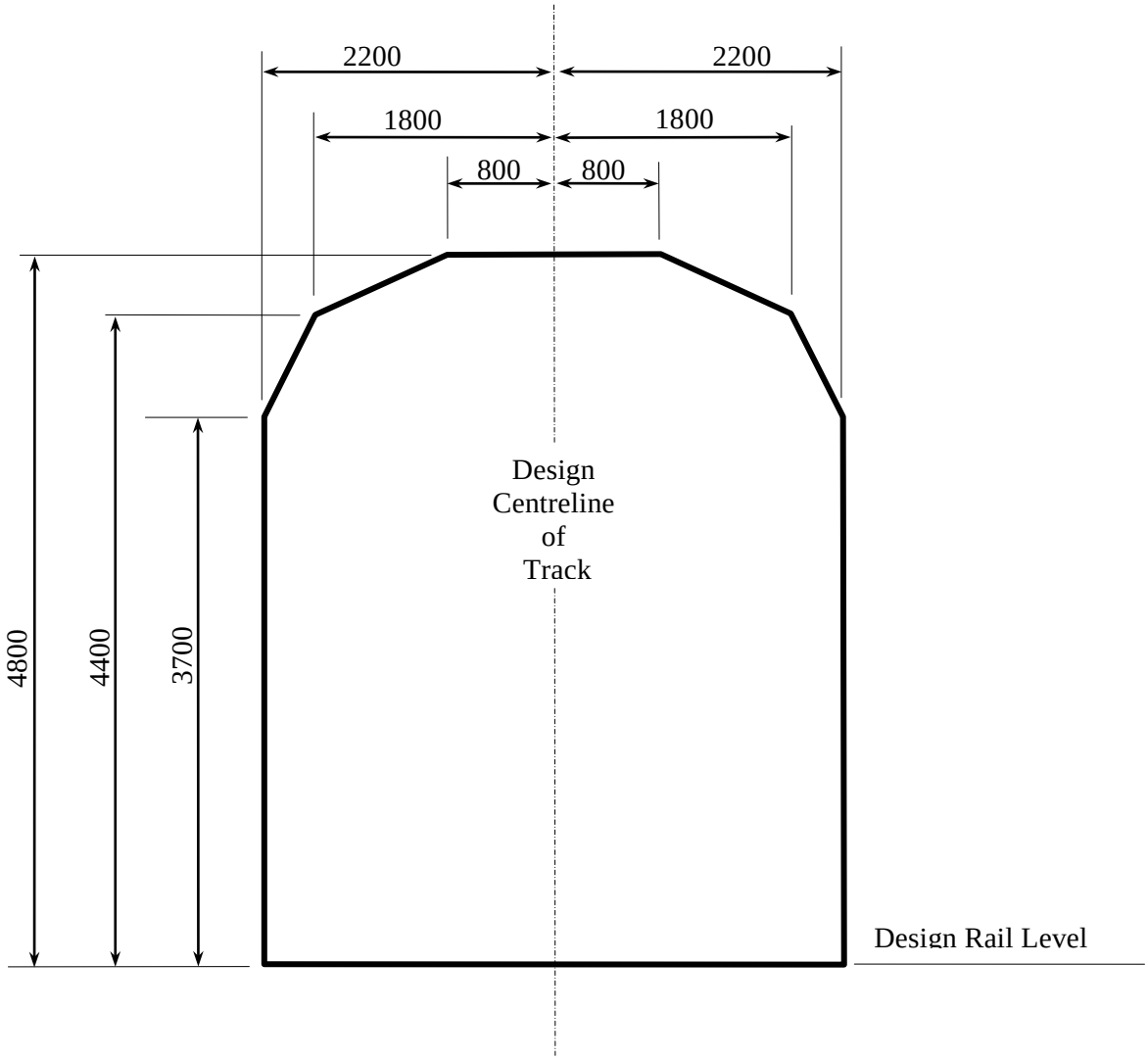
Figure 7.10 – Structure Outline
Curved Track ≥100 M and <300 M Radius
Used for Rollingstock Outlines A and B



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

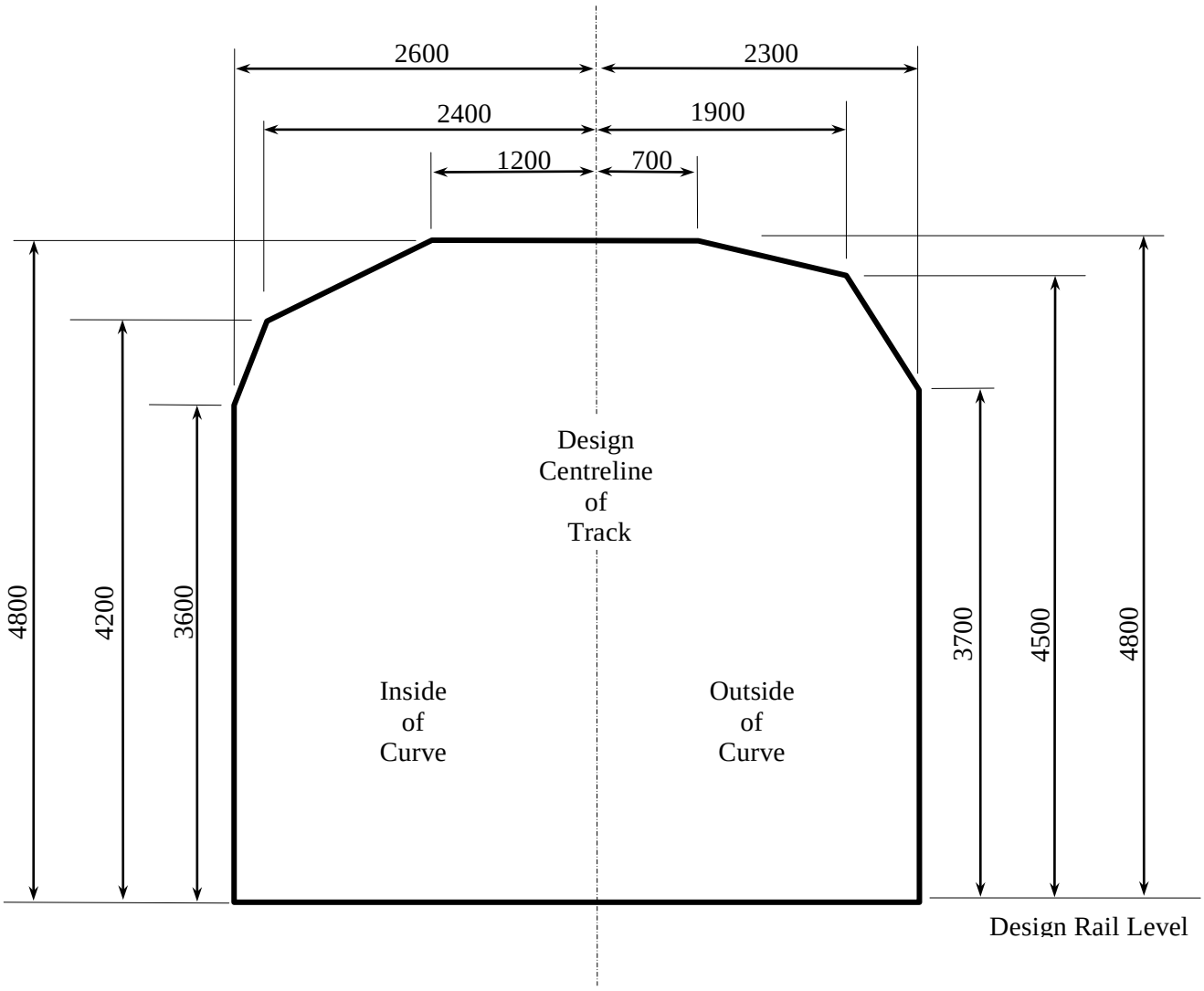
**Figure 7.11 – Structure Outline
Straight Track
Used for Rollingstock Outlines C and D**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

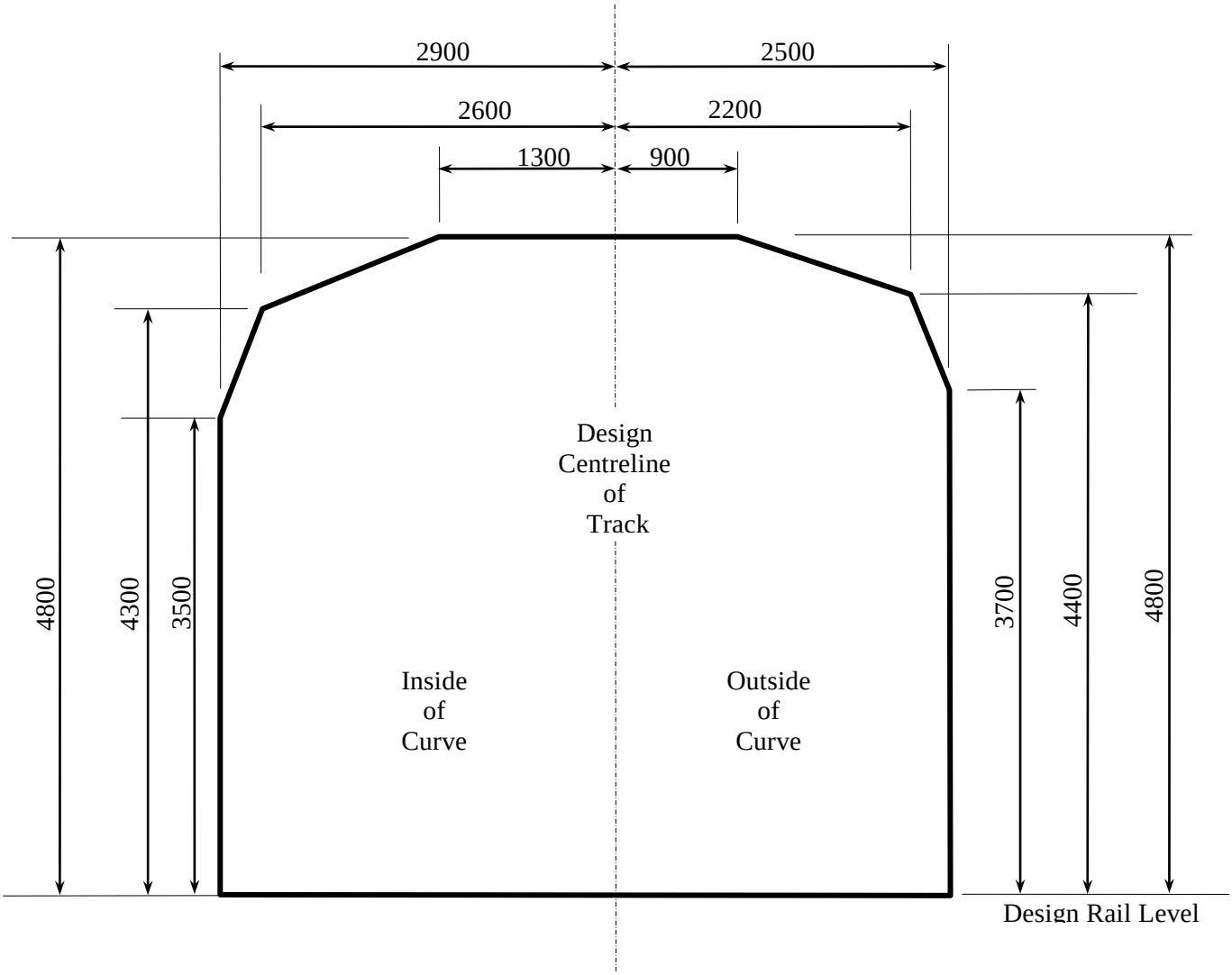
**Figure 7.12 – Structure Outlines
Curved Track ≥ 300 M Radius
Used for Rollingstock Outlines C and D**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

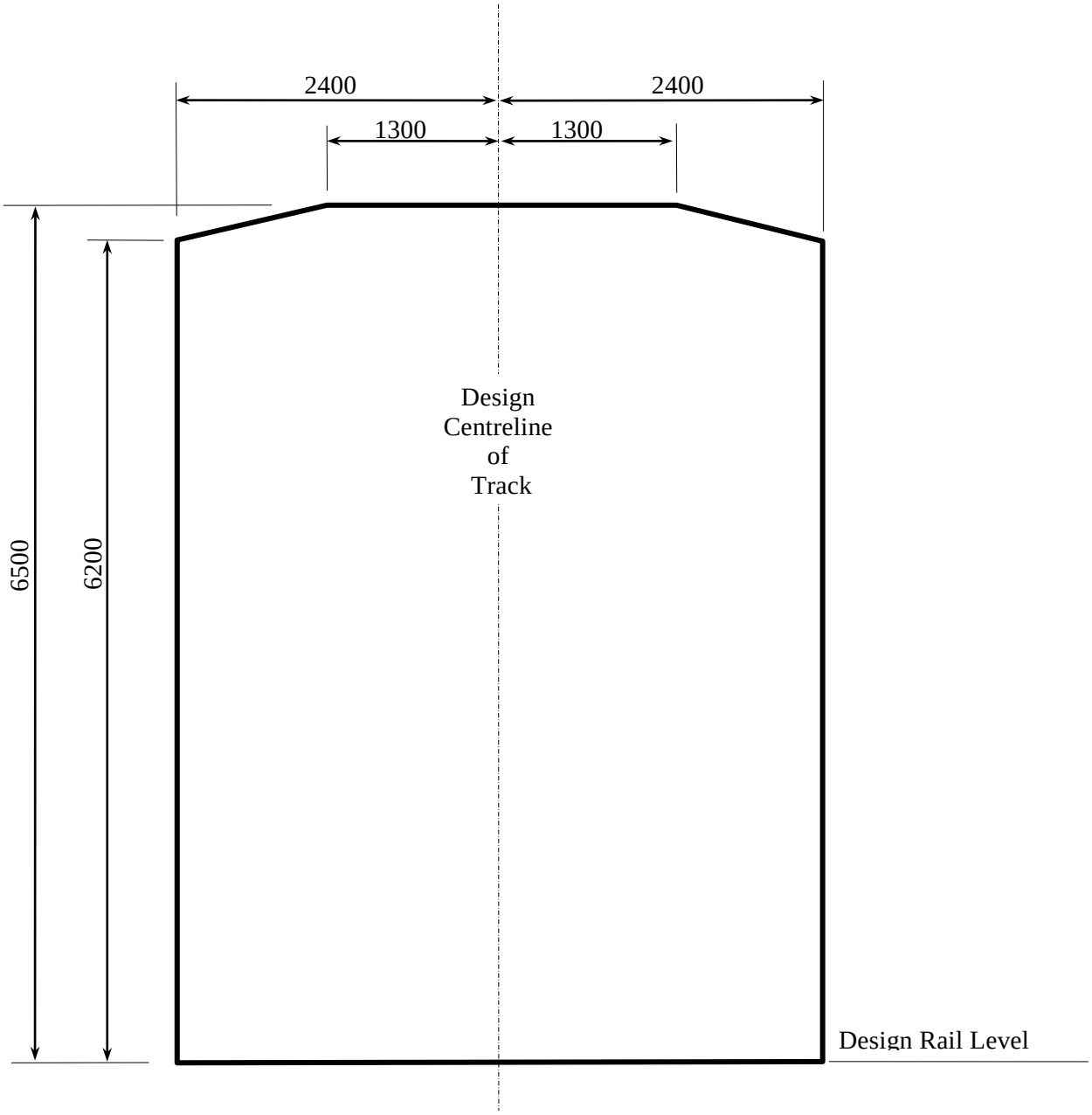
Figure 7.13 – Structure Outline
Curved Track ≥100 M and <300 M Radius
Used for Rollingstock Outlines C and D



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

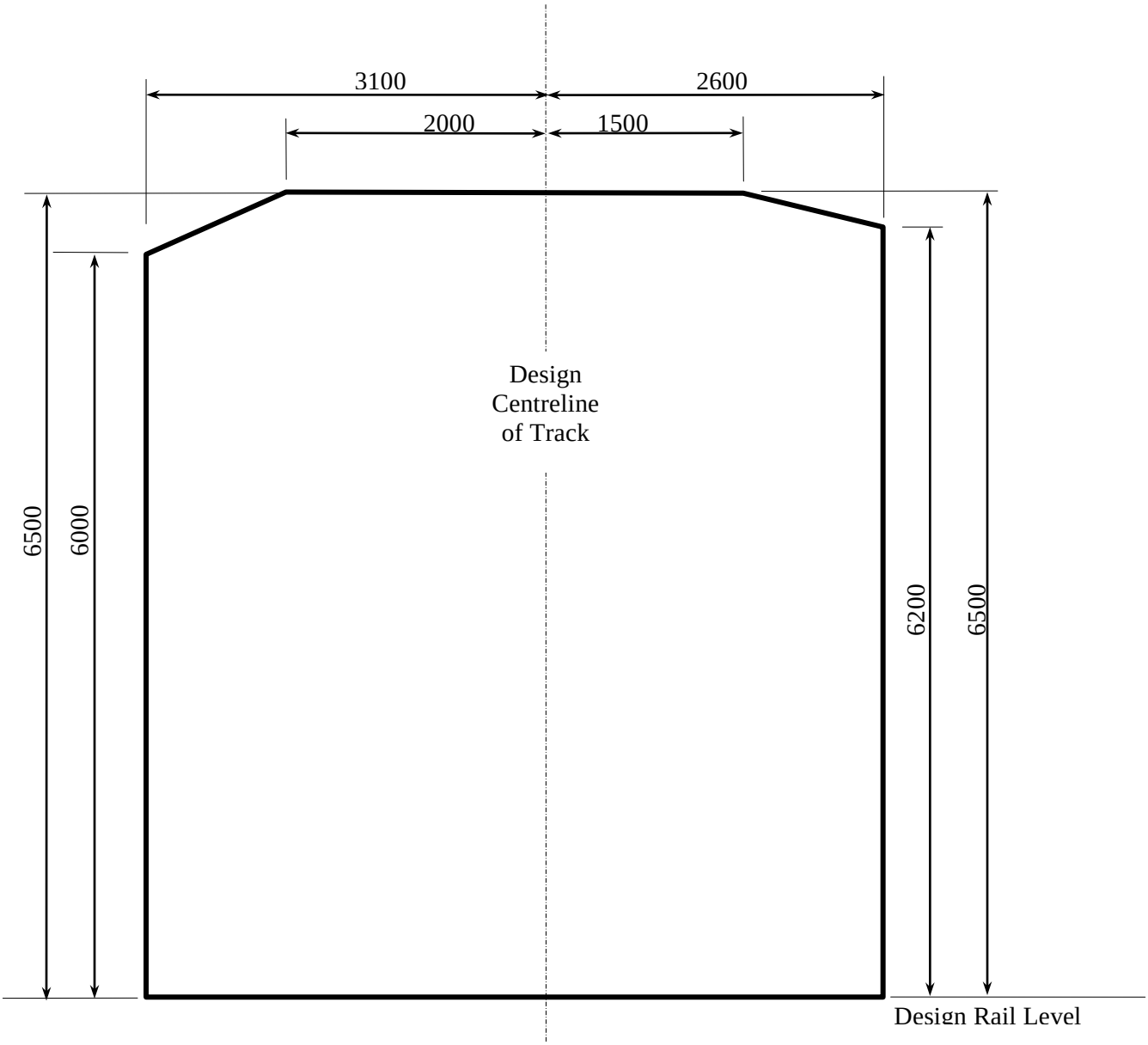
**Figure 7.14 – Structure Outline
Straight Track
Used for Rollingstock Outline E**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

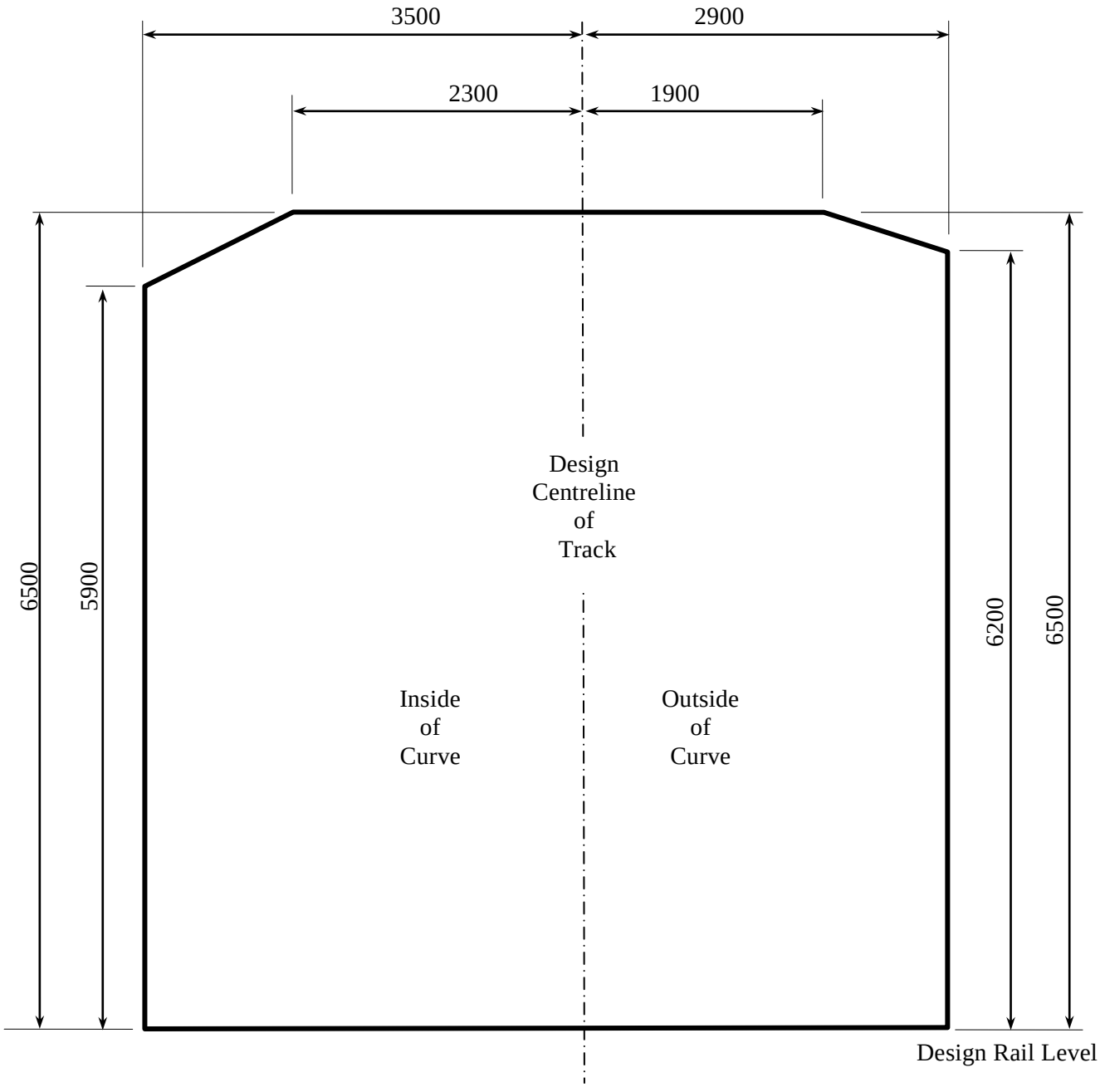
**Figure 7.15 – Structure Outline
Curved Track ≥ 300 M Radius
Used for Rollingstock Outline E**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

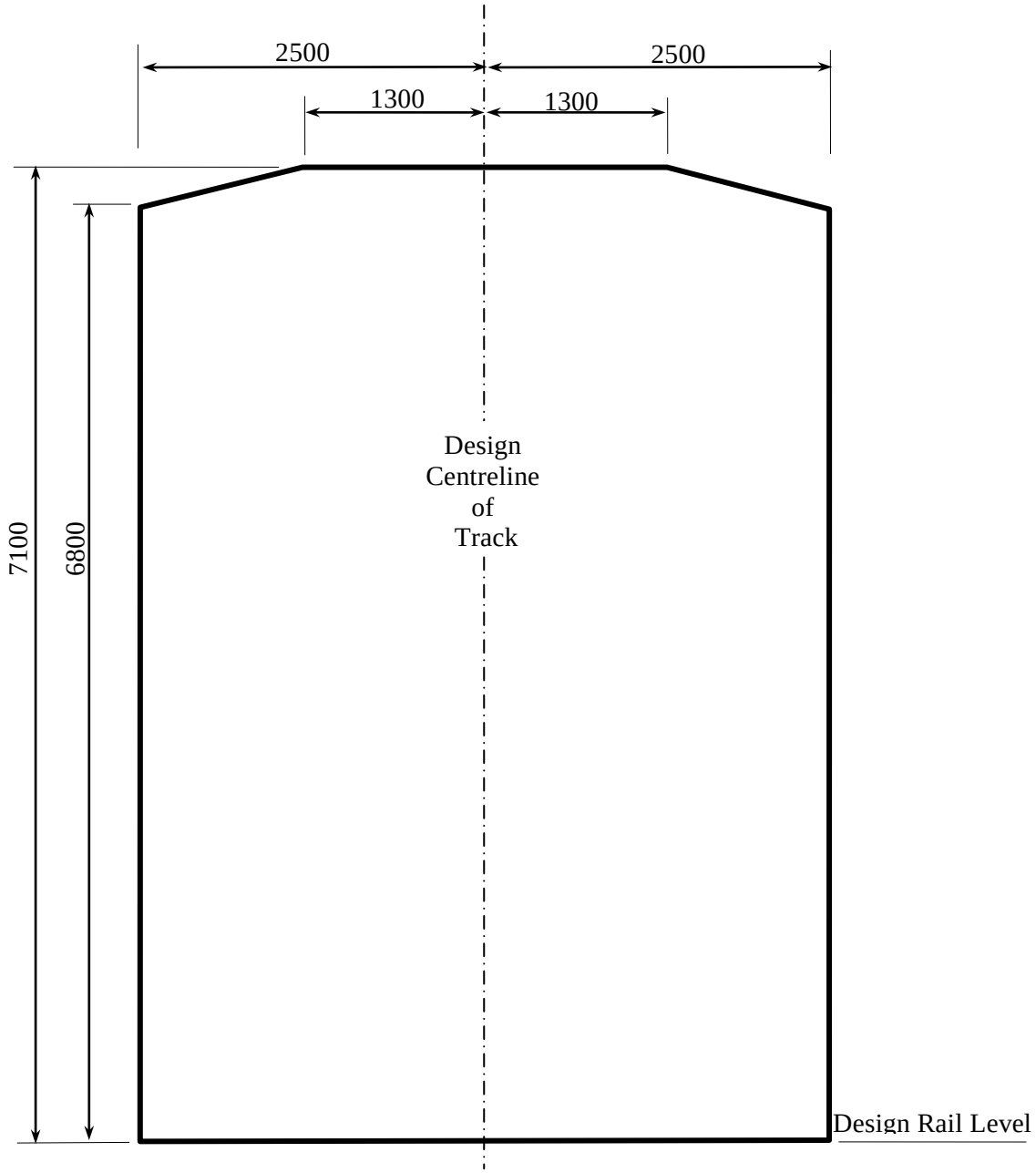
**Figure 7.16 – Structure Outline
Curved Track ≥100 M and <300 M Radius
Used for Rollingstock Outline E**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

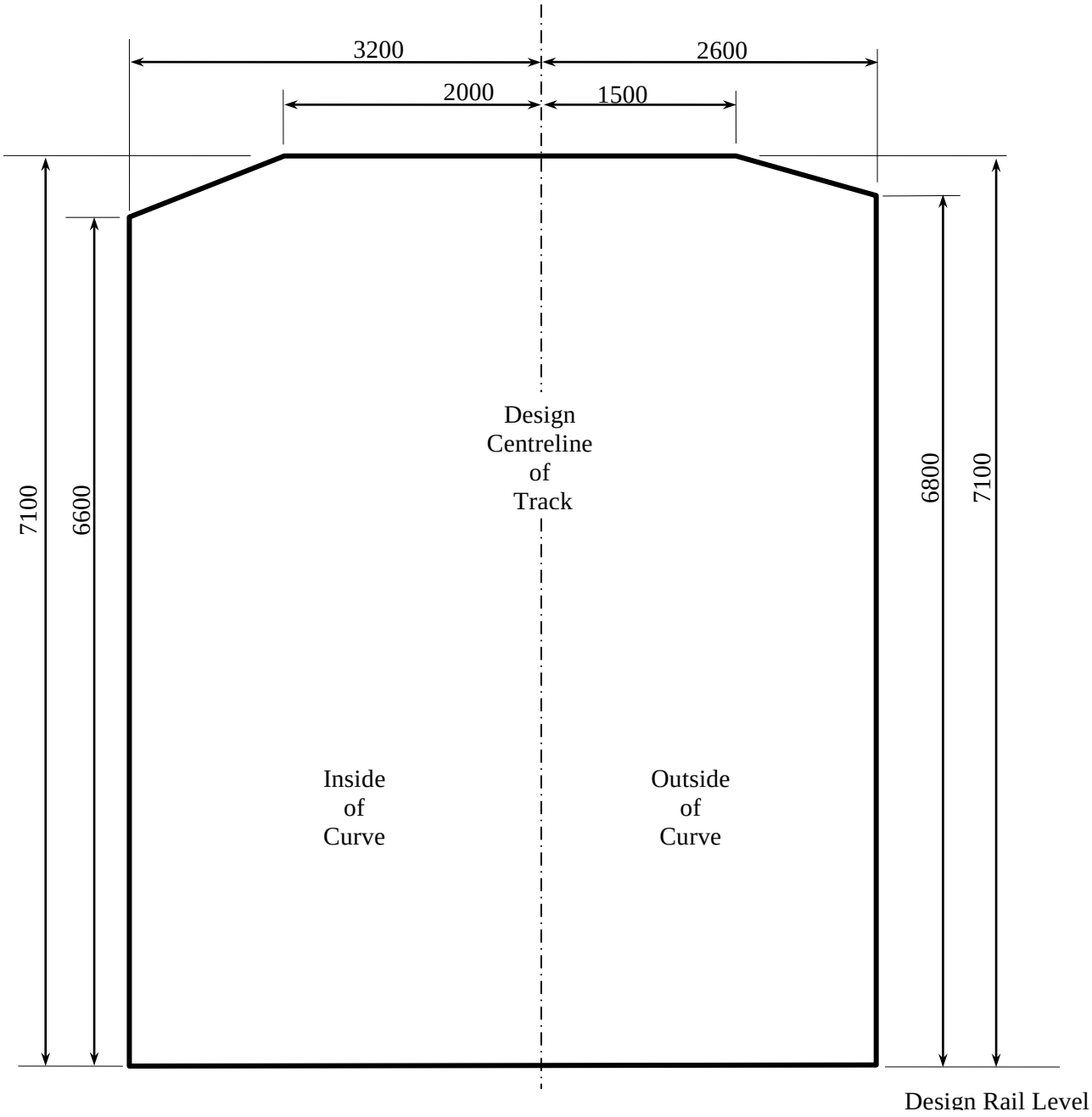
**Figure 7.17 – Structure Outline
Straight Track
Used for Rollingstock Outline F**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

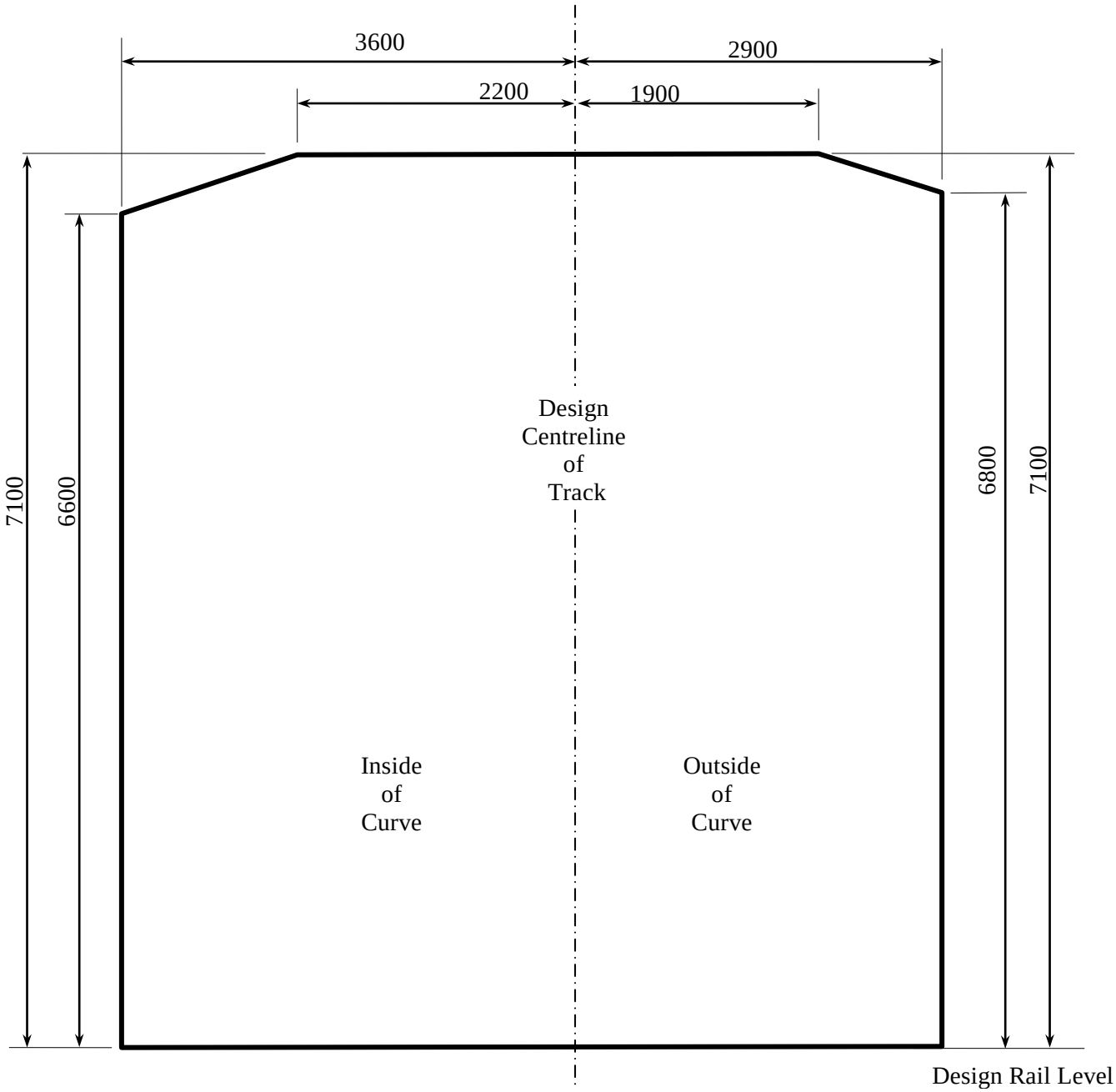
**Figure 7.18 – Structure Outline
Curved Track ≥ 300 M Radius
Used for Rollingstock Outline F**



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

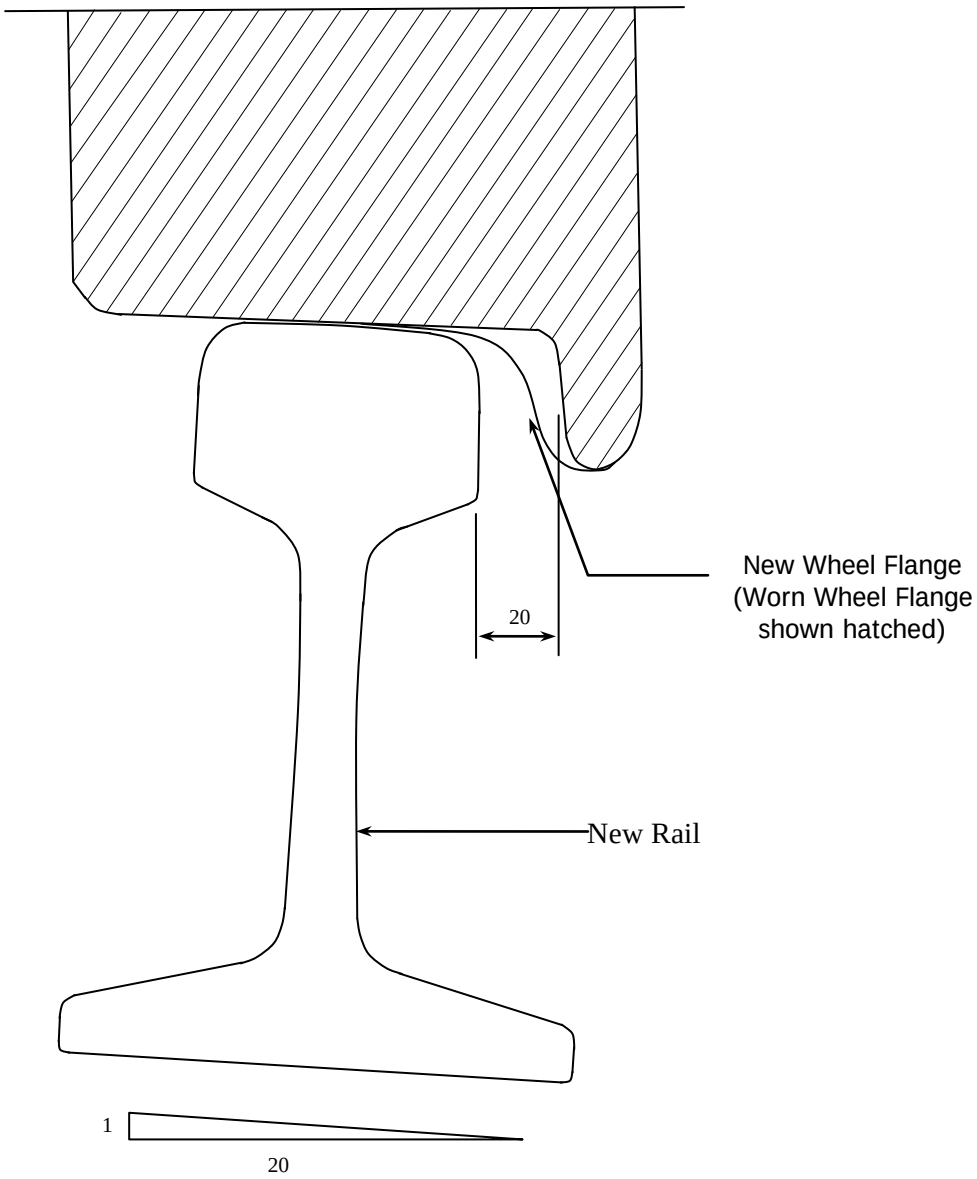
Figure 7.19 – Structure Outline
Curved Track ≥100 M and <300 M Radius
Used for Rollingstock Outline F



Notes:

[1] Uses dynamic rollingstock limits from Table 7.1 and track tolerances from Table 7.2.

Figure 7.20 – Wheel Clearance (Worn Wheel to New Rail)



7.3 Inspection and Assessment

7.3.1 Scheduled clearances inspection (see section 7.2.1 for definitions)

a) Patrol inspection

The purpose of a patrol inspection for clearances is to identify visible clearance infringements and to report any structure or adjacent track that is damaged, unsound or of changed geometry.

The interval between patrol inspections of structure-to-track and track-to-track clearances shall not exceed 7 days or as specified otherwise by ARTC e.g. in an approved Technical Maintenance Plan. Track patrol inspections should keep a lookout for clearance infringements and conditions (i.e. indicators of infringements) that may affect train operations including the following:

(i) track obstructions;

(ii) changes in track or structure location since previous inspection;

(iii) visible markings or damage to structures, including platform edges;

(iv) horizontal and vertical alignment past or through structures;

(v) evidence of recent or current movement;

(vi) fouling point markers are not visible, conspicuous or performing the function intended;

(vii) other obvious defects that may affect clearances.

The speed at which the inspection is carried out should be consistent with the local conditions and the full scope of the inspection being carried out (e.g. the type and number of other infrastructure elements being inspected).

b) General inspections—Compliance

General inspections at locations on the clearance register should confirm compliance with the clearance standards and be able to detect the following:

(i) structures infringing the maintenance intervention standard;

(ii) structures infringing the base operating standard;

(iii) adjacent tracks infringing the maintenance intervention standard;

(iv) adjacent tracks infringing the base operating standard.

These inspections should identify locations of clearance degradation requiring action and determine the need for further specialist inspection.

c) General inspections - Frequency and tasks

General inspections of clearances shall be carried out in a manner and at an interval appropriate to the location, rates of deterioration and other local factors (e.g. track type), and in any case at intervals not greater than those specified below or as otherwise specified by ARTC e.g. in an approved Technical Maintenance Plan. At locations of restricted clearance such as platforms the frequency of general inspection should be increased.

A general inspection including determination of the available clearances should also be carried out when there are suspected defects following work affecting the location of the track(s) or structure or defects are identified from patrol inspections.

The scheduled inspections should include the tasks of the patrol inspection in addition to the measurement of the following:

(i) clearance from datum points to specified locations;

(ii) distance between track centrelines (including fouling clearances at turnouts);

(iii) track superelevation if specified on the datum;

(iv) track curvature if specified on the datum.

A general inspection frequency regime should be specified. The inspection frequency regime should take into account the associated level of risk at the clearance location.

If the clearance standards adopted are based on the design guidelines prescribed in Clause 7.2.7 (or a total air gap of 200 mm or greater is provided) the following rates of scheduled general inspection shall apply:

(A) If the structure is outside the adopted structure outline, scheduled general inspections are not necessary.

(B) If the structure is inside the adopted structure outline inspections shall be carried out as follows:

a. Annually on passenger lines and lines carrying more than 10 million gross tonnes;

b. Every 2 years on all other lines.

7.3.2 Assessment and actions

a) General

Clearances shall be assessed against the clearance standards adopted for each line section.

The results of inspections shall be assessed to determine whether the structure (or the maximum kinematic rollingstock outline on adjacent tracks) infringes the maintenance intervention or base operating standard for clearances, and action taken as set out in Item (b) and (c).

b) Infringement of the maintenance intervention standard

Where the maintenance intervention standard is infringed either—

(i) action should be taken to restore the clearances such that the maintenance intervention standard is not infringed, with clearances monitored until this action is completed; or

(ii) approval should be sought from the owner to register the clearance location as a permanent infringement of the maintenance intervention standard following detailed clearance assessment.

Note: The increased rate of general inspection guidelines in Clause 7.3.1. (c) should be met.

c) Infringement of the base operating standard

Where the base operating standard is infringed either—

(i) action should be taken, prior to the passage of the next train, to restore the clearances such that the base operating standard is not infringed, see Note 1; or

(ii) restrictions should be applied to operations, prior to the passage of the next train, until action can be taken to restore clearances, see Note 2.

Notes:

[1] If this action does not restore clearances such that the maintenance intervention standard is not infringed, Item (b) should then be implemented for infringement of the maintenance intervention standard.

[2] Assessment of an appropriate restriction may be carried out using the general procedures defined in Clause 7.2.

d) Permanent infringements of the base operating standard

Where permanent infringement of the base operating standard for clearances has been permitted the results of inspections should be assessed to determine whether the track tolerances used to specify the clearance standards (see Clause 7.2.7) have been exceeded, see Note 1.

Where the track tolerances have been exceeded either—

(i) action should be taken prior to the passage of the next train, to restore the track position such that the track tolerances are not exceeded; or

(ii) restrictions should be applied to operations, prior to the passage of the next train, until action can be taken to restore the track position, see Note 2.

Notes:

[1] This may be achieved using datum markers on structures, however where this is not the case the relative position of track and structure (or track and adjacent track) should be checked against the clearance standard at the location.

[2] Assessment of an appropriate restriction may be carried out using the general procedures defined in Clause 7.2.

Appendix A – Clearance Design Procedures

A1 Static Rollingstock Outline

The static rollingstock outline for the rollingstock operating on a track section should be determined in conjunction with operators.

The static rollingstock outline should be met by the rollingstock under all maintenance and loading conditions (e.g. at all wheel diameters in the range for new and condemnable worn wheels).

A2 Vehicle Swept Path

The centre throw (C in mm) and end throw (E in mm) of rollingstock on circular curved track may be calculated as follows:

$$C = B^2 / 8R \quad \text{. . . (Eq. B1)}$$

and

$$E = (L^2 - B^2) / 8R \quad \text{. . . (Eq. B2)}$$

where:

B = length between pivot centres of bogies (mm)

L = overall length of vehicle (mm)

R = radius of curve (mm)

The swept path should be based on the static rollingstock outlines operating on the section of track under consideration as follows:

a) On straight (tangent) track the swept path should not be less than the static outlines of the rollingstock.

b) On circular curved track down to 100 m radius the swept path should not be less than the static outlines of the rollingstock plus allowance made for centre and end throw.

A3 Track Tolerances

Track tolerances should be determined for the line section being considered for the following:

a) Rail side wear.

b) Gauge widening on curved track.

c) Gauge from 1435 mm.

d) Track alignment from design.

e) Cross level from design.

f) Rail level from design.

Note: The design track position should be known as well as these tolerances.

A4 Dynamic Rollingstock Limits

The dynamic rollingstock limits should be determined in conjunction with operators for the following displacements:

a) Linear, to each side of the vehicle centreline and parallel to the plane of the top of the rails for lateral translation and for wheel clearance (worn wheel to new rail).

b) Angular, clockwise and anti-clockwise about the roll centre, for body roll.

c) Upward linear displacement normal to the plane of the top of the rails, for bounce.

A5 Maximum Kinematic Rollingstock Outline

The kinematic envelope for an item of rollingstock should represent the largest possible profile it can assume under the most adverse conditions.

It should be determined for the particular track section using the following procedures:

a) Determine the static rollingstock outline (on straight, uncanted track) for the rollingstock operating on the line section.

b) For each point on the static rollingstock outline, apply horizontal displacements to widen the outline on each side of its vertical centreline for—

   (i) rollingstock lateral translation;

   (ii) wheel clearance (worn wheel to new rail);

   (iii) rail side wear;

   (iv) gauge widening of the track;

   (v) gauge tolerance of the track; and

   (vi) centre and end throw of the rollingstock on curved track.

c) From Step (b), apply vertical displacements to extend the outline vertically for rollingstock bounce.

d) From Step (c), apply angular displacements about the point of cant rotation for cant.

e) From Step (d), apply angular displacements about the left hand rail for cross level tolerance.

f) From Step (d), apply angular displacements about the right hand rail for cross level tolerance.

g) From Steps (e) and (f), apply angular displacements about the roll centre of the vehicle for body roll. (In the case of tilt trains, apply additional angular displacements about the tilt centre for body tilt.)

h) From Steps (e), (f) and (g), apply horizontal displacements for track alignment tolerances, and vertical displacements for rail level tolerances.

i) The maximum envelope from steps (e), (f), (g) and (h) defines the maximum kinematic rollingstock outline.

A6 Air Gap Provision

The provision of an air gap between the maximum kinematic rollingstock outline and structures (or maximum kinematic rollingstock outlines on adjacent tracks, see Note) should take into account the following:

a) Base operating standards, maintenance intervention standards, and structure outlines.

b) Inspection intervals.

c) Variations in and rates of change of the parameters used to determine the maximum kinematic rollingstock outline.

d) Potential for movement of the structure.

Note: For a given line section the maximum kinematic rollingstock outline on an adjacent line may be treated in a similar way to a structure over the line.

A7 Base Operating Standard

An air gap should be added to the maximum kinematic rollingstock outline to define the base operating standard for clearances to structures or to the maximum kinematic rollingstock outline on adjacent tracks.

This air gap should provide a safety margin against infringement of the maximum kinematic rollingstock outline.

A8 Maintenance Intervention Standard

An air gap should be added to the base operating standard to define the maintenance intervention standard for clearances to structures or to the maximum kinematic rollingstock outline on adjacent tracks.

This air gap should provide for maintenance action to be taken before infringement of the base operating standard.

A9 Structure Outline

An air gap should be added to the maintenance intervention standard to define the structure outline for clearances to structures or to the maximum kinematic rollingstock outline on adjacent tracks.

This air gap should provide an additional safety margin such that scheduled inspections are not considered necessary for structures (or maximum kinematic rollingstock outlines on adjacent tracks) which fall outside this outline.